



**THE EFFECT OF OPERATIONS AND MANAGEMENT ON THE
RELIABILITY OF RURAL WATER SUPPLY MAINTENANCE AT
AMATHOLE DISTRICT MUNICIPALITY**

BY

KULILE CLOCK

**SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF**

MASTER'S IN BUSINESS ADMINISTRATION (MBA)

IN THE

**FACULTY OF BUSINESS AND ECONOMIC SCIENCES
AT THE NELSON MANDELA UNIVERSITY BUSINESS SCHOOL**

SUPERVISOR: PROF MOHAMED SAHEED BAYAT

APRIL 2023

**PERMISSION TO SUBMIT A TREATISE/DISSERTATION/THESIS
FOR EXAMINATION**

**INTENTION TO SUBMIT TREATISE/DISSERTATION/THESIS FOR ASSESSMENT
TO: FACULTY ACADEMIC ADMINISTRATION OFFICE**

**PLEASE FAX OR EMAIL THE COMPLETED FORM TO THE RELEVANT FACULTY ACADEMIC
ADMINISTRATION MANAGER:**

FACULTY	OFFICE	EMAIL
HUMANITIES	Ms H Mzingelwa	Hombakazi.Mzingelwa@mandela.ac.za
BUSINESS AND ECONOMIC SCIENCES	Mr A Smith	Adanaan.Smith@mandela.ac.za
EDUCATION	Mr R Salie	Ridaa.Salie@mandela.ac.za
ENGINEERING, THE BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY	Mr J Dorothy	Jonathan.Dorothy@mandela.ac.za
HEALTH SCIENCES	Ms M Afrikaner	FPGSC@mandela.ac.za
LAW	Ms N Terblanche	Nikki.Terblanche@mandela.ac.za
SCIENCE	Tessa Penrith	Tessa.Penrith@mandela.ac.za

**DEADLINE FOR SUBMISSION OF THIS FORM FOR POSSIBLE GRADUATION IN APRIL:
31 AUGUST 2022**

When the treatise/dissertation/thesis nears completion, the student must inform the relevant Faculty Academic Administration Office in writing of his/her intention to submit it for examination. Such notice must be given at least three months before the prospective date of submission. See the General Prospectus.

STUDENT DETAILS

FACULTY	Business and Economic Sciences
NAME OF QUALIFICATION	Master in Business Administration
STUDENT NUMBER	223513237
FULL NAMES	Kulile
SURNAME	Clock
STUDY ADDRESS	Nelson Mandela University Graduate School of Business Qgeberha
CONTACT DETAILS	0837953507
TITLE OF RESEARCH PROJECT	THE EFFECT OF OPERATIONS AND MANAGEMENT ON THE RELIABILITY OF RURAL WATER SUPPLY MAINTENANCE AT AMATHOLE DISTRICT MUNICIPALITY
SUPERVISOR'S FULL N AND SURNAME	Prof, Mohamed Saheed Bayat
EMAIL	mbmsaheed@gmail.com
TELEPHONE	0837861326
CO-SUPERVISOR/S FULL NAMES AND SURNAME	

PLEASE INDICATE WITH AN (X) IN THE RELEVANT BOX

<input checked="" type="checkbox"/>	This is to inform you of my intention to submit my research project for examination purposes for possible graduation in April
<input type="checkbox"/>	Non-submission for this cycle
<i>NB for doctoral candidates: Kindly be reminded of the requirement for a publishable manuscript/article to be submitted in accordance with rule G5.14.4 in the General Prospectus</i>	

STUDENT'S signature  Date 26 July 2022

SUPERVISOR'S signature... 

.Date.....26 July 2022.....

NELSON MANDELA UNIVERSITY

DECLARATION BY CANDIDATE

NAME: Kulile Clock

STUDENT NUMBER: 223513237

QUALIFICATION: Master of Business Administration (MBA)

**TITLE OF PROJECT: The effect of operations and management on the
reliability of rural water supply maintenance at Amathole District
Municipality**

In accordance with Rule G5.6.3, I hereby declare that the aforementioned thesis is my work and that it has not previously been submitted for assessment to another university or another qualification.



.....
SIGNATURE

.....
20 August 2022

.....
DATE

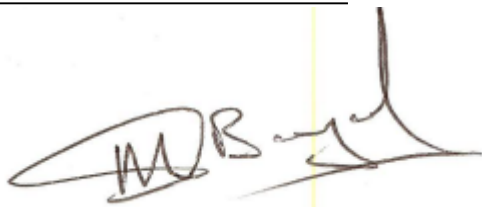
PERMISSION TO SUBMIT FINAL COPIES
OF TREATISE/DISSERTATION/THESIS TO THE EXAMINATION
OFFICE

FACULTY: BUSINESS AND ECONOMIC SCIENCES

SCHOOL/DEPARTMENT: NMU BUSINESS SCHOOL

I, Prof. Bayat M.S. and the supervisor for Mr Clock K. 223513237 a candidate for the Master in Business Administration with a treatise/dissertation/thesis entitled:
THE EFFECT OF OPERATIONS AND MANAGEMENT ON THE RELIABILITY OF RURAL WATER SUPPLY MAINTENANCE AT AMATHOLE DISTRICT MUNICIPALITY

It is hereby certified that the proposed amendments to the treatise/dissertation/thesis have been effected and that **permission is granted to the candidate to submit** the final bound copies of his/her treatise/dissertation/thesis to the examination office.



SUPERVISOR

6 March 2023

DATE

ACKNOWLEDGEMENTS

To my heavenly Father, The Son and The Holy Spirit, thank you, without Him, I would not have pulled through this journey.

To my Supervisor, Prof Mohamed Saheed Bayat, and his wisdom and support throughout. I am privileged and blessed to have him as my supervisor. Thank you for making this MBA journey so worthwhile.

To my late Mother, Nancy Nokwazi Clock, who defied all odds and single-handedly raised three confident, successful children. Thank you for instilling the importance of education and confidence in us.

To my seven siblings, Simphiwe, Portia, Zuko, Soso and Zintle. Both our late mother, Nancy Clock, and father, Papen Clock, raised us well. God has shown me that together, we do great things; our love for each other is enough. I am blessed to have you all.

To my wife, thank you for raising our kids while Daddy was studying and for loving me every day. I love you.

To my in-laws, thank you for the words of encouragement and for being the best grandparents to my kids.

To my friends, whose confidence in me and support have made me believe the impossible. They are God-sent.

To my handsome son, Gcinilizwi, and my beautiful daughters, Linomtha and Minentle, I promise Daddy will be back to his happy life from now on.

To my former boss, Mr S Koyo at Intsika Yethu. He is a true example of a leader, who allowed me to enrol at Nelson Mandela University for self-development.

To my MBA group and MBA East London group, who are the future leaders our generation needs. May you continue to lift others as you climb.

To my employer and colleagues, whose integrity, ethics and upholding the Batho Pele principles have made it worthwhile to be a public servant. Thank you for permitting me to conduct my study in the organisation. I will forever be grateful.

TABLE OF CONTENTS

DECLARATION BY CANDIDATE	iv
ACKNOWLEDGEMENTS.....	ii
LIST OF ANNEXURES	x
LIST OF FIGURES.....	xi

CHAPTER ONE

INTRODUCTION

1.1	INTRODUCTION	1
1.2	BACKGROUND	1
1.3	RESEARCH PROBLEM	2
1.4	RESEARCH OBJECTIVES	3
	1.4.1 Main objective	3
	1.4.2 Secondary objectives	3
1.5	SIGNIFICANCE OF THE STUDY	4
1.6	LITERATURE OVERVIEW	4
	1.6.1 Overview of water management.....	4
	1.6.2 Challenges affecting water supply in South Africa	5
	1.6.3 Ensuring water security.....	5
	1.6.4 Definition of terms	6
1.7	RESEARCH DESIGN AND METHODOLOGY	6
	1.7.1 Research approach.....	6
	1.7.2 Research design	7
	1.7.3 Research philosophy.....	7
	1.7.4 Research strategy	8
	1.7.5 Target population and sampling.....	8
	1.7.6 Data collection.....	9

1.7.7	Data analysis.....	10
1.8	ETHICAL CONSIDERATIONS	10
1.9	OUTLINE OF THE RESEARCH REPORT	10
1.10	LIMITATIONS OF THE STUDY	11
1.11	CHAPTER SUMMARY	11

CHAPTER TWO
LITERATURE REVIEW

2.1	INTRODUCTION	12
2.2	THE FOCUS OF THE LOCAL GOVERNMENT IN SOUTH AFRICA	12
2.2.1	Legislative framework	13
2.3	OVERVIEW OF AMATHOLE DISTRICT MUNICIPALITY	13
2.4	THE WATER SERVICE PROVISION FRAMEWORK IN SOUTH AFRICA ...	14
2.5	OVERVIEW OF SERVICE DELIVERY PROBLEMS IN SOUTH AFRICA	16
2.6	THE WATER CRISIS IN SOUTH AFRICA	17
2.7	WATER DISTRIBUTION SYSTEM COMPONENTS	18
2.7.1	Storage	18
2.7.2	Pipes	19
2.7.3	Pumps.....	19
2.7.4	Valves	19
2.7.5	Water meters.....	20
2.7.6	Chambers.....	20
2.8	WATER OPERATIONS MANAGEMENT.....	21
2.8.1	Pipeline maintenance.....	21
2.8.2	Valve maintenance.....	22
2.8.3	Storage tank maintenance	22
2.8.4	Meter maintenance	23

2.8.5	Leakage control “	23
2.8.6	Pollution control.....	24
2.9	WATER REGULATION POLICIES AND LEGISLATION	24
2.9.1	The Constitution of the Republic of South Africa, 1996.....	24
2.9.2	The Water Services Act, 1997 (Act No. 108 of 1997).....	24
2.9.3	The White Paper on Water Supply and Sanitation Policy, 1994	25
2.10	BENEFITS OF SUFFICIENT WATER SUPPLY	25
2.10.1	Effect on community livelihood and projects	25
2.10.2	Effect on crop yields.....	26
2.10.3	Effect on health and social relations.....	26
2.10.4	The impact on development.....	26
2.11	CHALLENGES AFFECTING WATER DISTRIBUTION	27
2.11.1	Artificial or human factors.....	27
2.11.2	Natural factors.....	28
2.12	WAYS OF CONSERVING WATER	28
2.12.1	Eliminating leakages	28
2.12.2	Removing illegal connections.....	29
2.12.3	Capturing rainwater.....	29
2.12.4	Drilling boreholes	29
2.12.5	Creating an extensive pipeline network.....	29
2.12.6	Desalination	30
2.12.7	Household use control	30
2.13	CHAPTER SUMMARY	30

CHAPTER THREE

RESEARCH METHODOLOGY

3.1	INTRODUCTION	31
-----	--------------------	----

3.2	RESEARCH DESIGN AND METHODOLOGY	31
3.2.1	Research approach.....	31
3.2.1.1	<i>Quantitative research</i>	31
3.2.1.2	<i>Qualitative research</i>	32
3.2.2	Research design	32
3.2.2.1	<i>Descriptive research design</i>	32
3.2.2.2	<i>Explanatory research design</i>	33
3.2.2.3	<i>Causal-comparative research design</i>	33
3.2.2.4	<i>Correlational research design</i>	33
3.2.2.5	<i>Exploratory research design</i>	33
3.2.3	Research philosophy.....	34
3.2.4	Research strategy	34
3.3	SAMPLING	35
3.3.1	Target population	35
3.3.2	Sampling strategy	36
3.3.3	Sample size.....	37
3.4	DATA COLLECTION	37
3.4.1	Data collection strategy.....	37
3.4.2	Conducting interviews	38
3.5	DATA ANALYSIS.....	38
3.6	PILOT STUDY	39
3.7	TRUSTWORTHINESS	39
3.7.1	Credibility	39
3.7.2	Transferability.....	40
3.7.3	Dependability	40
3.7.4	Confirmability	40
3.8	LIMITATIONS OF THE STUDY	40

3.9	ELIMINATION OF BIAS.....	41
3.10	ETHICAL CONSIDERATIONS	41
	3.10.1 Informed consent	41
	3.10.2 Ensuring no harm comes to participants	42
	3.10.3 Confidentiality and anonymity	42
	3.10.4 Obtain permission to conduct the study	42
3.11	CONCLUSION.....	42

CHAPTER FOUR

ANALYSIS AND PRESENTATION OF FINDINGS

4.1	INTRODUCTION	44
4.2	DEMOGRAPHIC INFORMATION.....	44
	4.2.1 Age of participants	44
	4.2.2 Gender of respondents	45
	4.2.3 Years of working experience	45
4.3	DATA ANALYSIS PROCESS	46
4.4	ENTREPRENEURIAL ECOSYSTEM FEATURES AND NATURE	48
	4.4.1 Components of Amathole District Municipality water distribution system.....	48
	4.4.2 Status of water supply and distribution.....	48
4.5	RELEVANCE OF WATER MAINTENANCE AND DISTRIBUTION OPERATIONS	50
	4.5.1 Benefits of efficient water supply to households.....	50
	4.5.2 Relevance of water distribution and supply to the municipal economy	50
4.6	CHALLENGES HINDERING WATER DISTRIBUTION AND SUPPLY	51
	4.6.1 Municipal structure and process challenges	51
	4.6.2 Systematic and legislative challenges.....	52

4.7	SUSTAINABLE STRATEGIES FOR ENHANCING WATER SUPPLY	52
4.7.1	Amathole District Municipality internal strategies	52
4.7.2	National water management policy reforms	53
4.8	CHAPTER SUMMARY	54

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1	INTRODUCTION	55
5.1.1	Research objectives	55
5.1.1.1	<i>Main objective</i>	55
5.1.1.2	<i>Secondary objectives</i>	55
5.2	FINDINGS FROM THE STUDY	55
5.2.1	Findings from the literature	55
5.2.2	Findings from primary research	57
5.3	RECOMMENDATIONS	58
5.3.1	Recommendations to the national government of South Africa	58
5.3.2	Recommendations to the Amathole District Municipality	58
5.3.3	Recommendations to households	59
5.4	CHAPTER SUMMARY	59
	REFERENCES	60

LIST OF ANNEXURES

Annexure A: Ethics Clearance Approval	65
Annexure B: Covering letter to respondents.....	68
Annexure C: Questionnaire	69
Annexure D: Turnitin Results	75
Annexure E: Technical Editing Letter	76
Annexure F: Proofreading Certificate	77

LIST OF FIGURES

Figure 2.1: Institutional framework for water management in South Africa	15
Figure 4.1: Age of participants	44
Figure 4.2: Gender of participants	45
Figure 4.3: Years of working experience	46
Figure 4.4: Themes and code generation.....	47

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

The growing population in South Africa's rural municipalities, coupled with industrial expansion, continue to exert pressure on the available water resources. While service delivery demands are becoming a serious concern among residents in various municipalities, local governments need to improve the supply of essentials, such as water. This study examines water scantiness in the rural side of the Amathole District Municipality (ADM), with a prime focus on the water distribution and maintenance system.

1.2 BACKGROUND

Global water levels have drastically changed in recent years. Several factors determine the stock of freshwater resources. The various determinants include the evaporation rate, precipitation type, topography of the land, porosity of surface rock and the general climate (Novienyo and Amoah, 2021). The calamitous effects of climate change have been evident in all parts of the globe, with erratic rainfall patterns, extremely cold winters and unbearably hot summers. Climate change has inarguably affected the quantity and quality of water resources worldwide. Extreme temperatures from global warming have adversely disturbed the natural hydrological cycle, resulting in shrinking river flows, groundwater supply and precipitation levels (Erasmus, 2020).

Africa is endowed with plenteous water resources, including basins, lakes and large rivers, such as the Nile, Congo and Niger (Rodina, 2019). Furthermore, the African continent receives very high annual rainfall around the equatorial region and relatively lower annual rainfall in the lower southern and northern regions. Despite receiving seemingly substantial average rainfall, freshwater resources remain unevenly distributed across the African continent, while some communities struggle to access drinking water (Makhari, 2016). Uses of water in the African region broadly include tourism, industrial production, domestic consumption and agriculture. Freshwater availability challenges in Southern Africa are accelerated by erratic rainfall, growing population, broken water pipes and high water purification costs (United Nations, 2020).

South Africa is one of the Southern African countries, classified as a water-scarce country. In South Africa, the past decade has been marked by fluctuating precipitation patterns, characterised by years of drought and moderate rainfall. According to Zhuwakinyu (2017), various hydrolysis research, conducted in South Africa, revealed that the extent of water scantiness is dependent on the intricate relationship between groundwater replenishment, streamflow and precipitation. Access to clean and sufficient water is a constitutional right for every citizen and is enshrined in the South African Constitution, 1996 (Act No. 108 of 1996) under Section 27(1)(b) (Kokos, 2018). Since attaining independence, South Africa has made significant strides towards improving the living conditions of previously marginalised communities. One of the milestones includes the increase in water and electricity distribution across urban and rural areas (Unicef, 2021). Despite the significant efforts to improve wide access to basic service delivery, challenges to accessing water and sanitation persist in South Africa.

When a sizeable area or region has no adequate water supply, the place may be categorised as water scarcity. The classification of a water-scarce community largely depends on commercial, environmental and domestic consumption needs (BCG, 2017). This study is contextualized for the Amathole District Municipality (ADM), located in the Eastern Cape province of South Africa. Amathole spans a large area, including six additional nearby towns and municipalities, including Alice, Butterworth, Dutywa and Fort Beaufort, among others (ECSEC, 2017). The water crisis remains a struggle for residents of the Amathole District Municipality, where some parts of the district have been water scarce for years.

1.3 RESEARCH PROBLEM

Against the background of unpredictable natural water supply, poor infrastructure maintenance, deteriorating water quality and unskilled water engineers, it is imminent to devise research-based solutions. The attainment of an appropriate water balance is essential for sustainable development; a lack thereof could impede economic growth (Donnenfeld, Crookes and Hedden, 2018). A report by Zhuwakinyu (2017), reveals that the average daily water supply to the rural parts of the Amathole District Municipality has significantly depleted. Leaking pipes, residents' dismal bill payment, illegal connections and erratic groundwater supply were cited among the attributing

factors. While the persistent water insecurity situation is affecting the ADM, negating research on ways to salvage the crisis could perpetuate it further.

A broad range of past studies have been done in South Africa around the water crisis and more aspects need to be explored. A study by Brouwer et al. (2019) found that access to safe drinking water remains a significant challenge in rural areas of South Africa, with many communities relying on untreated surface water sources. The study identified the need for improved infrastructure and management of water resources to address this issue. A study by Dube et al. (2017) examined the challenges facing rural communities in the Amathole District Municipality in accessing safe drinking water. The study found that a lack of infrastructure, poor water quality, and inadequate management were key factors contributing to the problem. A study by van der Merwe et al. (2016) assessed the water quality of different sources in rural areas of the Eastern Cape, including the Amathole District Municipality. The study found that many water sources were contaminated with bacteria and other pollutants, highlighting the need for improved water treatment and management. A study by Tarr et al. (2015) examined the impact of climate change on water resources in the Amathole District Municipality. The study found that changes in precipitation patterns and increased temperatures were likely to exacerbate water scarcity in the region, highlighting the need for more sustainable water management practices.

1.4 RESEARCH OBJECTIVES

1.4.1 Main objective

This study's primary goal is to develop strategies for improving the rural water supply in the Amathole District Municipality.

1.4.2 Secondary objectives

- To investigate how water is managed in South Africa's rural municipalities
- To pinpoint the advantages of water in rural communities
- To investigate the problems that South Africa's water supply is facing
- To create plans for enhancing the management, distribution and use of water in rural municipalities.

1.5 SIGNIFICANCE OF THE STUDY

For a country that is experiencing numerous service delivery protests, municipalities must neutralise the chaos by addressing pressure groups' concerns. This study is primarily important to decision-makers in the ADM's water management department. Furthermore, the literature, uncovered by this study, and the findings pronounce the obligations of ordinary citizens towards improving water conservation. This study is crucially important for planning committees in the three levels of government in South Africa. The output from this study offers deep insights which are an important input to future budgeting and planning decisions. Furthermore, the strategies and recommendations of this study will help rural municipalities in other South African provinces. Finally, this study will also be used as reference work for subsequent research in the field.

1.6 LITERATURE OVERVIEW

The literature review section, provided in this chapter, is an overview of the literature sections which are broadly explored in the second chapter of this study.

1.6.1 Overview of water management

According to UNCTAD, (2020), up to date, over 10 million households in the rural parts of South Africa remain without reliable access to water. Furthermore, it is also notable that water treatment works (WTWs) and wastewater treatment are in urgent need of skilled operators and urgent rehabilitation because they are in a poor state. Over the past two decades, the ecological conditions of most major rivers in South Africa have sharply deteriorated at unprecedented rates (Boshoff, 2017). Some municipalities are unable to implement any service delivery plans because they have not set development priorities or allocated funds. According to Makale (2015), a lack of developmental priorities paints an impression that the politicians are deceptive and offer promises that they are not able to satisfy in due time. In some cases, South Africa's ongoing service delivery protests have led to vandalism and the destruction of priceless public property (Muthwa, 2016).

1.6.2 Challenges affecting water supply in South Africa

The scarcity of water in South Africa makes it a highly expensive resource, as dictated by the law of supply (Chetty, Lievart & Palmer., 2016). The rural parts of South Africa are hit the hardest by the persistent water shortages problem. Kouga (2010, p23) claims that "in the villages where people cannot afford to buy water, they resort to fetching water from rivers, wells, and springs," all of which are untreated and may be dangerous for human consumption. Water pollution is caused by the use of agricultural pesticides and fertilizers, claim Ndevu and Muller (2017). Both developed and developing nations, including South Africa, struggle with this problem. The unprecedented growth in population in South Africa hurts the sufficiency of the water supply. Immigration, coupled with an increased birth rate, has created a huge demand for water in South Africa in recent years (European Commission, 2018). Municipalities in South Africa lose a lot of water to illegal connections. According to Ndevu and Muller's (2017) case, illegal tap connections significantly contribute to water scarcity.

1.6.3 Ensuring water security

Balancing the requirements and supply of water in South Africa's municipalities must take a two-sided approach. First, the quantity of water, demanded and used by households, farms and industries, must be reduced. Second, supply side elements and means must be devised to increase the volume of supplied water. Watering gardens and washing cars represent how water is inefficiently used in several homes. The public must understand the value of water and the necessity of conserving every drop (European Commission, 2018). Hosepipes and sprinklers may not be used domestically, according to water companies. Rainfall water may be collected through roof gutter systems with storage tanks, erected at every household (European Commission, 2018). The disparities in the water supply are sometimes due to the unequal distribution of the pipeline system. Mostly in rural settings, many places do not possess access to main water pipes, making it difficult to supply water to every household. The municipalities need to invest huge sums of money in extending the network of existing pipe networks. The long-distance conveyance of water is expensive, yet, inevitable and essential (Viljoen and Walt, 2019).

1.6.4 Definition of terms

Local government – The lowest level of government in South Africa, comprising local municipalities, which are in contact with the communities.

Water distribution system – The system, used in the distribution of water, comprises pipes, storage, pumps, water meters and chambers.

Water operations management - The actions necessary to keep the water supply and treatment system in good working order can be summed up as water operations and maintenance. Preventive, corrective and crisis maintenance are its subcategories.

Water regulation policies – They comprise various government and water boards that regulate the usage and storage of water resources.

1.7 RESEARCH DESIGN AND METHODOLOGY

The approach and design of the study comprise sections, covering the research approach, design, philosophy and strategy that guided this study.

1.7.1 Research approach

The researcher used two common research approaches when conducting the research. The two approaches fall into broad categories of qualitative and quantitative research (Saunders, Lewis and Thornhill, 2009a).

According to Burns and Bush (2014: 78), the quantitative approach is synonymous with the use of numbers and seeks to assign measurable values to research. The positivistic paradigm and the quantitative research approach complement each other well. It uses numbers and, therefore, applies measurable units in establishing relationships among variables as well as in the confirmation of relationships. When conducting quantitative research, researchers follow a structured approach, making use of closed-ended questionnaires (Creswell, 2013).

Contrastingly, the qualitative approach employs unstructured research instruments, with open-ended questions. Known for being exploratory in character, the qualitative technique aims to learn more about the attitudes and opinions of the group being studied (Bradley, 2013). Qualitative research aids in understanding the significance

that people give to events (Saunders, Lewis and Thornhill, 2009). A qualitative research approach was used in this study because it permits access to in-depth information regarding the water maintenance and operations management system under study.

1.7.2 Research design

A research design serves a crucially important role in guiding the research process, including providing a framework for data collection and analysis (Maholtra, 2012). For every study, researchers normally choose to follow one of the five common research designs, such as descriptive research design, explanatory research design, causal-comparative research design, correlational research design and exploratory research design. This study used the exploratory research design because it sought to assess how operations and maintenance have affected the reliability of groundwater supply at the Amathole District Municipality during droughts.

When a study seeks to investigate a largely unexplored subject, the exploratory research design is used (Wiid and Diggins, 2013). The exploratory research design, according to Berndt and Petzer (2011), enables researchers to comprehend the nature of the research problem. The qualitative research proposal heavily relies on interviews, focus groups and sometimes questionnaires. The qualitative research design makes it possible for the researcher to gain insight into the research problem under study (Wiid and Diggins, 2013).

1.7.3 Research philosophy

The two broad research philosophies fall under epistemological views, namely, positivism and interpretivism (Bryman and Bell, 2011). According to Creswell (2013), positivist research is deductive and provides a means to determine a cause-and-effect relationship. In contrast, the interpretivist approach allows researchers to come up with new knowledge and insights into a research phenomenon concerning the researcher's perspective (Quinlan, 2011). In the interpretivist paradigm, researchers have the freedom to develop theories by extracting meaning from the surrounding world. Using

the interpretivist approach, this study explored new theoretical dimensions of water maintenance and operation systems in Amathole.

1.7.4 Research strategy

A research strategy provides guidelines for the research process. Numerous applicable research strategies may be used in research (Quinlan, 2011). Every research strategy lends itself to a particular research design which guides how the study must be conducted. Along with the phenomenology strategy, case studies, interviews, grounded theory and ethnography are employed (Thomas, 2010). A case study method allows the collection of in-depth information about a research problem, using real-life contexts. It is usually used together with interviews (Saunders, Lewis and Thornhill, 2012). When it is necessary to gather in-depth data on people's opinions, beliefs, experiences and feelings, interviews are a suitable way. When the topic of inquiry involves matters that call for complicated questions and extensive investigation, interviews are useful (Easwaramoorthy and Zarinpoush, 2006). This study used an interview strategy as its research strategy because the study seeks to uncover in-depth knowledge, experiences and thoughts about the subject under investigation.

1.7.5 Target population and sampling

Target population refers to the total number of elements, containing the random variable of interest (Berndt and Petzer, 2011). Elements, making up the target population, could be organisations or individuals, among others. Owing to administrative and cost constraints, Burns and Bush (2014) state that a sample must be selected to collect the data effectively. When conducting research, it is hardly possible to interview all the members of the true population under study. A sample is defined as a subcategory of the target population and carries the representative attributes of the true population elements (Zikmund and Babin, 2010). The target population for the study is employees at the Amathole District Municipality who work in the water and sanitation department (operations and maintenance unit), including the section heads and the managers.

A sampling strategy provides details on how researchers select the interviewed research subjects (Cant, Gerber-Nel, Nel and Kotze, 2005). Two broad sampling

techniques are applicable in research, namely, the probability and the non-probability sampling techniques. In contrast with the probability sampling technique, is the non-probability sampling technique, which incorporates all the elements without an equal chance of being selected (Berndt and Petzer, 2011).

the purposive sampling technique allows the researcher to select respondents, based on qualities, known to the interviewer (Saunders, Lewis and Thornhill, 2009b). The purposive sampling technique was applied in this study.

For this study, the study sample comprises selected employees from the Amathole District Municipality, who were working in the water distribution and supply section. The sample, used in this study, covered a small sample of ten respondents. Qualitative research studies put more focus on the notion of saturation in sampling matters and a total of 10 respondents is usually recommended (Wiid and Diggines, 2013).

1.7.6 Data collection

This study used both primary and secondary data to answer the research problem. Secondary data refers to data that has previously been used in the context of other research with a purpose other than this study (Zikmund, 2010). Forms of secondary data include online journals, conference papers, reports, newspapers, journals, White and working papers, and published book chapters. In this study, secondary data were used to review past studies in reconciliation with the current study, particularly in the literature chapters.

The collection of primary data was informed by the research design and the chosen research approach. The most applicable methods when collecting primary data include “field observations, focus groups, interviews, document analysis and ethnography” (Bryman and Bell, 2011 p543).

This research study used interviews because interviews are a qualitative data collection technique where a respondent has to answer structured or semi-structured questions intensively (Clarke and Braun, 2013). The three different types of interview techniques are as follows: structured, semi-structured and unstructured interviews. In a structured interview, the researcher follows a specific set of questions in a predetermined order with a limited number of response categorisations (Stuckey,

2018). This research study used semi-structured interviews because questions are planned and are based on open-ended questions.

1.7.7 Data analysis

The collected data undergo a process of data cleaning to retain high-quality responses. Qualitative studies normally use either content analysis or thematic analysis. Content analysis, according to Thomas (2010), involves the use of words or text to identify relationships among themes and concepts. According to Braun, Clarke and Terry (2014), thematic analysis is a method for systematically identifying, organising and offering insight into patterns of meaning (themes) across a data set. The thematic analysis follows phased steps while the researcher becomes familiar with the data codes generation, theme development, as well as report-writing (Clarke and Braun, 2013). This study employed thematic analysis to deduce the hidden insights. In this study, the analysis phase employed the NVivo 12 (Windows) as an aid to identify the themes.

1.8 ETHICAL CONSIDERATIONS

Every study is required to comply with the compliance standards of the Research Ethics Committee (REC) of the university. Owing to the mandatory requirement to conduct ethical research, for this study, the investigator applied to the REC for the ethical clearance certificate. Saunders, Lewis and Thornhill (2015, p.343) posit that at least three steps must be complied with in research during data collection: “(1) preservation of the confidentiality of data and anonymity of the participants; (2) notifying the participants of the voluntary nature of the study and their privilege to withdraw or participate in the study, and (3) participants must be informed of how the data collected will be used as well as the third parties who might have access to the data”. Additionally, the investigators must ensure that all participants take part voluntarily and confidentiality will be guaranteed to all participants.

1.9 OUTLINE OF THE RESEARCH REPORT

Chapter 1 provides an introduction and background of the study, focusing on the research problem and objectives.

Chapter 2 outlines an overview of the local government in South Africa, with a specific focus on the Amathole District Municipality.

Chapter 3 outlines the research methodology of the study, expanding on the research philosophy, data collection techniques and data analysis processes.

Chapter 4 presents the findings from the gathered primary evidence and proposes a solution to the research problem.

Chapter 5 provides a summary of the entire study, highlighting its significance of the study, outlining the unique contribution of this study and making suggestions for future research.

1.10 LIMITATIONS OF THE STUDY

Like any other study, this study has several limitations. This study was conducted only in one province of South Africa, which is the Eastern Cape. Furthermore, this study used a considerably small sample size, comprising 10 respondents. The sample size might be considered insufficient in providing a wide perspective on the subject. In terms of the research methodology, this study was only confined to the qualitative research method and could have used the mixed research methodology. The limitation of the selected research methodology is that it did not use quantitative techniques to determine patterns and causative factors. This study was only a cross-sectional study which is one-time focussed, compared to the longitudinal studies, which are the other alternative.

1.11 CHAPTER SUMMARY

This chapter mostly comprised introductory segments. The chapter launched with a brief view of the water scarcity situation in the Amathole district, narrowed down to the relevance of the water resource for domestic and commercial usage in the rural municipalities of South Africa. Importantly, Chapter One lays out the research objectives, as informed by the research background and problem statement. The chapter concluded with sections on the research methodology, ethical considerations and limitations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The second literature chapter of this study is premised on the foundation laid out in the preliminary chapter of the study, which contained the introduction. The introductory chapter outlined the research problem and the research objectives that are guiding this study. In the second chapter, an overview of service delivery problems, affecting South Africa, is briefly discussed, including the water crisis. Furthermore, the chapter covered sections on the rural and urban water systems, used in South Africa, as well as factors causing water shortages. Importantly, the chapter outlines the numerous benefits of effective water management and strategies that could be employed to improve the water situation.

2.2 THE FOCUS OF THE LOCAL GOVERNMENT IN SOUTH AFRICA

Across the world, the structure of government differs while some countries maintain unitary structures and others use federal systems. Federal governments, such as the United States of America, have autonomous government systems, where each state functions independently from the others. South Africa follows a unitary government system, which is subdivided into three major layers. The national government is at the apex, followed by the provincial government, while the local government occupies the bottom level. Of the three government levels in South Africa, the local government is closest to the people and executes duties that are mostly concerned with community development issues.

The local government which is at the municipal level is considered the most accessible to the public and handles all matters that need to be communicated to the higher government levels (Riensburn, 2015). Importantly, the municipal government in South Africa provides service delivery needs, such as water, electricity and waste collection, among others. In contrast to the national government, which oversees matters of wide national interest, the provincial government works closely with the local government, executing orders from the national government.

2.2.1 Legislative framework

The South African legislative framework has clear provisions regarding the administration of the local government. Under Section 152 of the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996) the main objective of the local government is to ensure self-governing and responsible government practices for local citizens (Melinjani, 2017). The requirement implies that citizens, living in different municipal regions, have the right to equal access and rights to social services. This, therefore, implies that local municipalities must maintain equality among different racial groups and social classes. Furthermore, one of the overarching goals is to influence social and economic development through a balanced approach (Civicus, 2017). It follows that municipalities have a role to play in the facilitation of socioeconomic development programmes in communities. Furthermore, it is the constitutional responsibility of the local government to ensure a healthy and safe environment for citizens (BCM, 2016). This can be achieved by removing poisonous substances, dealing with pollution and eliminating hazardous physical features in the environment. The Constitution outlines that the municipality must encourage the community to participate in matters of local governance (Zigomo, 2017). In South Africa's Constitution, it is further stipulated that the pastoral and development responsibilities of communities are the primary responsibility of the municipalities. Important to keep in mind is that South Africa's local government is also guided by municipal by-laws, standing orders and municipal policy in addition to the country's Constitution and legislation (Huq, 2012).

2.3 OVERVIEW OF AMATHOLE DISTRICT MUNICIPALITY

The Amathole District Municipality is classified as a Category C municipality under the three main municipality classifications, used in South Africa. Category A municipalities are metropolitan municipalities, while Category B municipalities are mostly urban but relatively smaller in size. Category C municipalities, such as Amathole, mostly comprise rural settlements. The Amathole municipality covers an area of over 21 114km², stretching along the coastal and interior parts of the Eastern Cape province of South Africa. Six sublocal municipalities make up the Amathole District Municipality, namely, Mbhashe, Mnquma, Great Kei, Amahlathi, Ngqushwa and Raymond Mhlaba. Among other economic activities, the Amathole District Municipality is known for

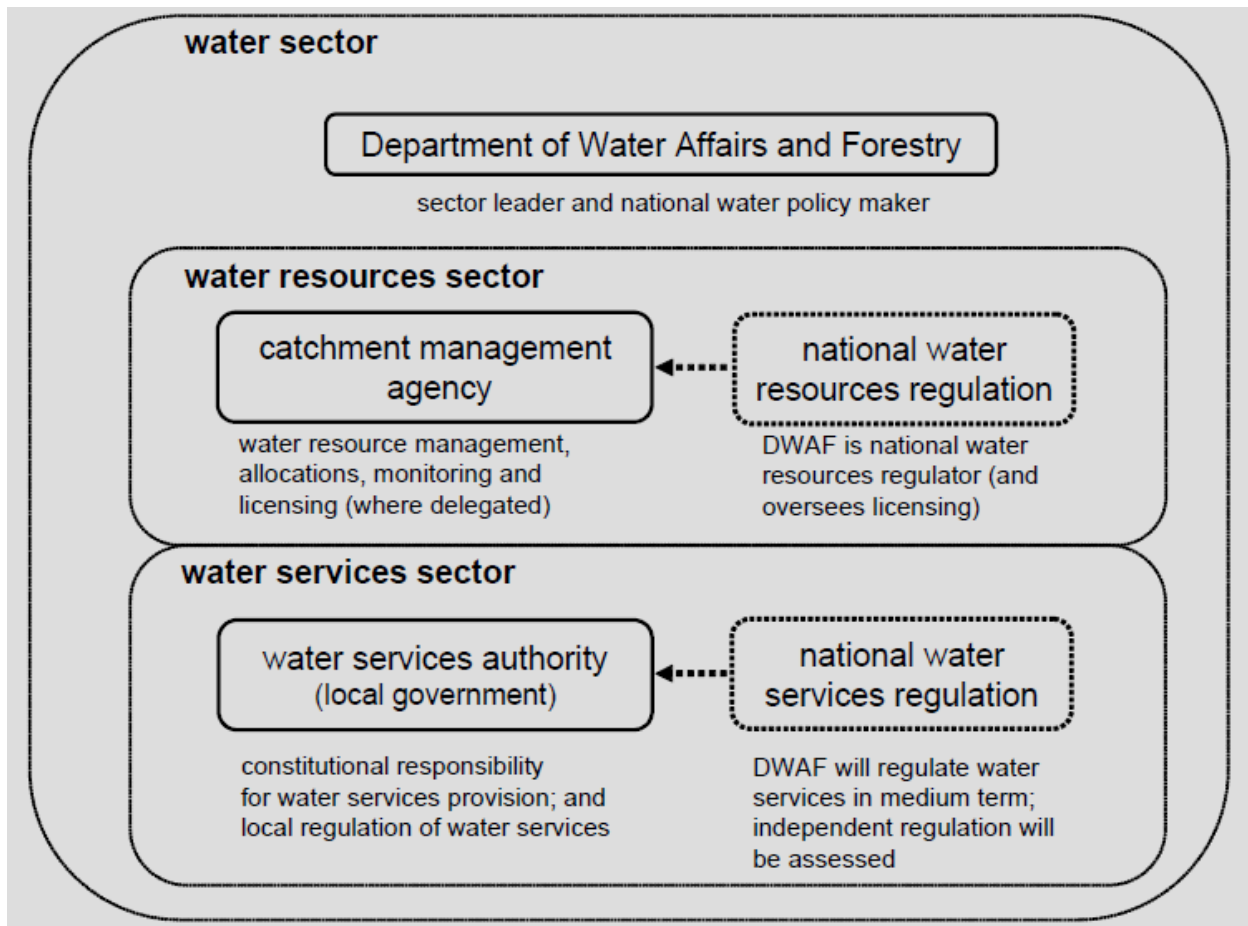
covering tourism routes and secluded remote rural zones. The Amathole District Municipality is a niche market area for rural-urban agricultural markets with huge potential for forestry and livestock farming as well as agricultural farming. In terms of service delivery, the Amathole municipality provides water and sanitation, human settlements, waste management, electricity and transport. Water provision in the Amathole District Municipality remains very low, while at least 31.24% of households have access to piped water and a greater portion have no formal piped water.

In terms of the amended Municipal Structures Act, 1998 (Act No. 117 of 1998), the engineering services department is responsible for planning, designing, constructing, operating and maintaining all municipal engineering services. Furthermore, the engineering department is split into two, comprising the operations division and the planning and programming implementation division. The two engineering departments in the Amathole District Municipality are led by the director of engineering services. Regarding water provision, the engineering operations division provides all the infrastructure-based servicing activities.

The community services department in the ADM has the sole duty of ensuring that all people have at least access to basic services. Water service provision is one of the five basic services, provided by the community services department. The community services division serves an agency role for the various departments, which include the Department of Health and the Department of Water Affairs, among others.

2.4 THE WATER SERVICE PROVISION FRAMEWORK IN SOUTH AFRICA

South Africa's strategic framework for the water service sector serves as an important guide to the management of water resources countrywide. The framework, which was developed from the extensive consultation of multiple stakeholders, helps in the attainment of the water management vision of the country (Weaver, keeffe & Hamer., 2017). The figure below presents the institutional framework for water management in South Africa.



Source: (Kasrils, 2003)

Figure 2.1: Institutional framework for water management in South Africa

The overall custodian and high authority in the management of water affairs in South Africa is the Department of Water Affairs and Forestry (DWAF). The DWAF's activities involve overseeing water sector institutions and regulating water resources and water services (Rodina, 2019). Together with the DWAF, catchment management agencies (CMAs) help in the management of water in all regional areas. The DWAF delegate such activities, which include licensing water use and discharges (Kokos, 2018). According to the institutional framework of water resource management, water service authorities, such as the provincial and local governments, have the constitutional responsibility for ensuring access to water services in their area of jurisdiction. Furthermore, the water service authorities may regulate the provision of water services in their local area through by-laws and contracts (Weaver *et al.*, 2017).

2.5 OVERVIEW OF SERVICE DELIVERY PROBLEMS IN SOUTH AFRICA

South African municipalities have been characterised by widespread protests that are related to service delivery. The main reasons for the unending protests have been varied, such as the inefficiency and dysfunctionality of the supply of basic services, namely, water and sanitation. While these problems have been persistent for a lengthy period, efforts to address these matters permanently have been futile (De Visser, 2010). From one point of argument, the insufficiency of resources has been one of the cited major causes. In rural areas, the payment of utilities is a serious problem in South Africa. Services, such as water, electricity and firefighting bills, are not consistently paid to municipalities, resulting in low revenue for municipalities. Such a culture of non-payment emanates from a sense of entitlement and excessive dependency on government aid (Makale, 2015).

Based on the corruption reports that have been flying in the news for years, it is arguable that resources have been an impeding factor in service delivery. Corruption, lack of transparency, poor accountability and incompetence of public servants are among the major causes of service delivery deficiencies, as cited by Aadnesgaard and Willows (2016). Non-compliance with the principles of good governance has been an adverse problem, inhibiting the development of municipalities. Therefore, more stringent measures are desperately needed to hold public servants accountable for their actions to improve efficiency in service delivery (Kiparsk, Milman & Owen., 2017).

The failure of municipalities to set development priorities and allocate funds constrains some municipalities from implementing service delivery plans. According to Makale (2015), a lack of developmental priorities paints an impression that the politicians are deceptive and offer promises that they are not able to satisfy in due time. The continued service delivery protests in South Africa have, in some instances, resulted in vandalism and the destruction of valuable public property (Muthwa, 2016). If left unsolved for a prolonged period, the local protests may lead to rebellion and uprisings.

Muthwa (2016) argues that the service delivery problems in South Africa have impacted the power dynamics of labour movements and trade unions. Repeated strikes and repeated negotiations between public employees and the state have been ongoing for far too long. Poor working conditions and the underpayment of employees

further lead to poor service delivery, especially refuse collection around urban places (Aadnesgaard and Willows, 2016). The conspicuous spending of senior government officials is fuelled by self-ambition which seeks self-enrichment at the expense of the public employees and society.

2.6 THE WATER CRISIS IN SOUTH AFRICA

By 2017, millions of South Africans used sanitation facilities that are far below the standard that is expected for the Reconstruction and Development Programme (RDP) infrastructure. According to UN Conference of Trade and Development UNCTAD, (2020), up to date, over 10 million households in the rural parts of South Africa remain without reliable access to water. Furthermore, it is also notable that water treatment works (WTWs) and wastewater treatment in the country are in poor or critical condition and need urgent rehabilitation and skilled operators.

Over the past two decades, the ecological conditions of most major rivers in South Africa have sharply deteriorated at unprecedented rates (Boshoff, 2017). Some of these rivers have been pushed beyond the point of recovery and much needs to be done to improve the conditions of the rivers. According to Mokgobu (2017, p.19), “South Africa has lost over 50% of its wetlands, and of the remaining 3.2 million hectares (ha), that is, one third are already in a poor condition”. In these catastrophic conditions, at least 5% of the natural water supply sustains the agricultural sector, comprising small-scale farmers. The scarcity of water in South Africa makes it a highly expensive resource, as dictated by the law of supply (Chetty *et al.*, 2016).

Compared to other regional countries, water in South Africa is severely under-priced and this makes it difficult for the water management bodies to manage the water supply sustainably (Boshoff, 2017). To realise water security in South Africa, huge investments are needed in the next few years as well as establishing an improved revenue generation and a significant reduction of costs. Furthermore, the sustainability of water use might be improved through the education of communities on the value and importance of water conservation and preservation.

The rural parts of South Africa are hit the hardest by the persistent water shortages problem. According to Kouga (2010, p.43), “in the villages where people cannot afford to buy water, they resort to fetching water from rivers, wells and springs and these

sources are not treated and may be harmful for human consumption". Water from such unsafe sources may cause diseases and this could adversely threaten the lives of many people (Chetty *et al.*, 2016). The greater proportion of the waterborne disease outbreaks that were reported between 1971 and 1998 was from community water systems (CWSs) and non-community water systems (NCWSs). The following section provides an account of the water distribution system in South Africa.

2.7 WATER DISTRIBUTION SYSTEM COMPONENTS

The design of a water supply system comprises of numerous components which serve a crucial role in managing and monitoring water supply. The section below presents the various components that are essential in the design of a water supply system.

2.7.1 Storage

Tanks and reservoirs are available for the storage of water. According to Chetty *et al.* (2016), the tanks and reservoirs are used in a water distribution system (WDS) to fulfil the changing demand on the network by producing continuous water, supplying water in times of emergency and maintaining steady pressures. When there is a supply shortage, it is important to ensure that water is available for firefighting and to provide emergency storage, for instance, when the reservoir supply pipe is cut off. A planned system is also made possible by water storage (Kouga, 2010).

Chlorination and other water treatment procedures are halted and contact time is provided. Water storage tanks or reservoirs that are buried below the ground, situated at ground level, or both can be elevated by using a concrete or steel tower. Receptacles are typically constructed out of reinforced concrete. Reinforced concrete or steel panels are used to construct water towers and raised water storage containers, while bricks or steel panels are occasionally used to construct smaller reservoirs (Boshoff, 2017). Reservoirs can also be constructed with ferro-cement, which consists of one part cement and two parts sand. Masonry, galvanised steel, asbestos cement, plastic, fibreglass, polyethene and rubber tanks are some of the types of tanks. For rural locations, ferro-cement and galvanised tanks are appropriate (Chetty *et al.*, 2016). The installation of galvanised storage tanks is highly expensive and not economically feasible because of the great distances between metropolitan centres and rural populations.

2.7.2 Pipes

Pipes provide the channel through which water can be transported from one place to another. The kinds of pipes are trunk mains, secondary mains, distribution mains and service mains. Water is delivered through trunk mains from the treatment facility to the distribution area. Subsidiary mains act as the structural framework of distribution systems. Service mains are pipes that carry water from secondary mains to a single customer, whereas distribution mains transport water from secondary mains to many consumers through public or private connections (Machethe, 2011). Pipes are made from a variety of materials and sizes, including steel, cast iron, fibreglass, asbestos cement, reinforced concrete, polyvinyl chloride (PVC) and polyethylene. Considerations when choosing a pipe include market accessibility, purchasing price, cost of accessories and fittings, resistance to corrosion, mechanical damage, material ageing, storage, and some other factors.

2.7.3 Pumps

Water is given energy through the use of pumps to transfer it to a higher elevation, increase pressure or speed up its flow rate (CWD, 2015). A pump is a machine or mechanical device that uses a reciprocating motion to propel fluid out of a discharge port while drawing fluid into itself through an inlet port. Positive displacement pumps and dynamic pumps are two general categories of pumps. Positive displacement pumps move discrete "packets" of water, whereas dynamic pumps use a rotating mechanism to create a continuous stream of water (Chetty *et al.*, 2016). Dynamic pumps are the most popular type of pumps, used in water distribution systems, which generate a continuous stream of water, using a spinning mechanism.

2.7.4 Valves

Valves regulate water flow in a network by adjusting the speed and direction of the flow of water at each location (Machethe, 2011). Isolation, air, scour, non-return or check and control valves are the basic categories of valves. For maintenance and other purposes, isolating valves isolate specific network segments, and air valves limit the build-up of air at pipelines' high points (Viljoen and Walt, 2019). In contrast to pressure-lowering valves, which are used to lower fixed output pressure by reducing high incoming pressure, scour valves are used to drain a specific area of the system.

Non-return valves are frequently used to control flow in one direction while preventing flow in the opposing direction.

2.7.5 Water meters

A water meter is a machine that counts the amount of water that flows through it in a predetermined amount of time. The four different types of water meters are as follows: mechanical, electromagnetic and ultrasonic (Viljoen and Walt, 2019). It serves as the foundation for water billing as well. Some meters are useful for measuring flow in trunk mains where accuracy is not a major concern, based on the pressure difference between two cross-sections.

An electromagnetic flow meter, according to Machethe (2011), measures velocity and is frequently used to measure bulk flows in pump stations and main trunks. Utilising ultrasonic waves, ultrasonic flow meters can measure the velocity profile inside a pipe. Meters are also categorised based on their intended use.

Some consumer meters are used to measure water, delivered to different consumers. Bulk transfer meters are used to transfer water from a bulk supplier to a municipality and management meters are used to measure the distribution of water to different parts of the WDS (Donnenfeld, Crookes and Hedden, 2018).

Customers are billed for the water they receive through meters and two main metering strategies are used in this process. A variety of meters is on the market right now and it is crucial to choose a meter based on its use, accessibility and mechanism (Donnenfeld, Crookes and Hedden, 2018). When using meters, accuracy is of the utmost importance. Therefore, when choosing meters for rural and urban use, it is also important to consider the operation, reading, spare parts availability and calibration of the meter.

2.7.6 Chambers

Valve and meter fittings, among others, are housed in chambers for convenient access for maintenance or replacement. For small chambers, reinforced concrete, bricks, cast iron or even plastic may be used in their construction (Viljoen and Walt, 2019). The working area in the chambers should be enough and the ceiling slab should be removable. Cover slabs must be higher than average ground level, and air valve

chamber venting must provide sufficient airflow (Donnenfeld, Crookes and Hedden, 2018). These chambers must also have an access hole with lockable covers to safeguard exposed elements of the network from damage and vandalism, anchor pipes in the valve chamber walls and take precautions to prevent chamber covers from being covered by soil.

2.8 WATER OPERATIONS MANAGEMENT

The necessary actions to keep the water treatment and delivery system in good working order can be summed up as water operations and maintenance (Mokgobu, 2017). It is further divided into crisis maintenance, corrective and preventive categories. Preventative maintenance involves routinely inspecting and maintaining system parts. Preventive operations' major objective is to minimise or completely avoid interruptions in the water supply. Preventive maintenance is the ongoing application of routine operations, necessary to maintain the water utility plant and equipment in excellent condition, according to Boshoff (2017).

To maintain reliable services, corrective maintenance measures include replacing worn-out and broken parts (Mokgobu, 2017). Crisis maintenance is a different type of maintenance that includes unanticipated responses to unexpected failures and user complaints to restore faulty supply. When an unexpected disaster happens, such as a pipe burst or an equipment breakdown, reactive maintenance is required (Donnenfeld, Crookes and Hedden, 2018). Most operations and maintenance (O&M) tasks should be preventative in nature, which entails inspecting the entire network and all fittings to make sure they are in good working order. Activities related to operations and maintenance are listed below.

2.8.1 Pipeline maintenance

Regular leak checks should be performed on pipelines and each segment should be examined separately. The section's water balance should serve as the inspection's guidance and inconsistencies between produced and consumed volume should be examined (Mokgobu, 2017). Techniques for pressure management may also be used to find and stop leaks in a WDS. It is important to measure the pressure in each pipeline section and investigate pressure losses because pipe leaks may be to blame.

Old pipelines and those prone to leaks must be inspected often. According to Chetty *et al.* (2016), the maintenance of distribution pipes should include checking for corrosion and scale build-up in addition to leakage detection and correction. Flushing the system regularly enhances water quality and lessens the need for reactive maintenance. Flushing helps to remove encrustation, silt, corrosion products and bacterial development.

2.8.2 Valve maintenance

Water distribution systems (WDSs) are designed with several valves to isolate system breaks. Valves serve an important role in the elimination of broken parts during reparation times (Donnenfeld, Crookes and Hedden, 2018). Valves generally save the entire water system from being shut down when major faults occur in one part of the supply system. It is, therefore, important to examine the valves in the system at least once a year (Mokgobu, 2017). Depending on the condition and age of the valves on a water system, the frequency of repairing and servicing may vary, but must at least be done semi-annually. Though the reparation of valves seems like an unimportant exercise, the benefits of it repay during cases of emergency.

2.8.3 Storage tank maintenance

Following a significant inspection and maintenance, it is best practice to clean, disinfect and reactivate elevated storage tanks and ground-level reservoirs. To clean, the reservoir must be emptied, accumulated sediments must be removed, the walls and floor must be washed and rinsed, and the interior surfaces and joints must be inspected to make sure they are in excellent condition (Mokgobu, 2017). Before adding water for distribution, the tank needs to be cleaned and disinfected. Before distribution starts, the water quality needs to be evaluated.

Once a year, a tank should be maintained, which should include checking all openings to make sure they are properly screened and making sure vents and screens are unobstructed (Boshoff, 2017). Checking for the degradation of the tank walls and foundations is also important. The national standards bodies shall certify materials or chemicals, used to recoat and repair a tank's inside. If proper storage tank maintenance is not carried out, this may damage the quality of the water leaving the

storage tank for distribution in addition to causing the tank's structure to deteriorate (Mokgobu, 2017).

2.8.4 Meter maintenance

Cleaning and testing meters, as well as replacing worn-out parts, are all part of meter maintenance. The repair work is often done in a repair shop setting (Boshoff, 2017). It is not a complicated process and one of the skilled maintenance staff members could manage it (Mokgobu, 2017). Many meters need to be meticulously examined, cleaned and regularly checked for leaks. The registering unit should be replaced whenever it becomes damaged or when it becomes necessary. Household meters need to be examined frequently since sometimes individuals tamper with them.

Chetty *et al.* (2016) write that "Maintenance plans should include the cleaning of strainers, cleaning and repair of meter boxes, and replacing registers". In some circumstances, it will be necessary to do maintenance elsewhere and the meter can be transported.

2.8.5 Leakage control

Leaks should be found and fixed as soon as possible to minimise the amount of water lost through leaks. This can be accomplished by taking whatever steps are technically and financially feasible (Chetty *et al.*, 2016). A water utility ought to establish guidelines for finding leaks, reporting them, fixing them and keeping track of them. Both the staff and the consumers should be aware of and actively involved in this process (DBSA, 2010). Leak detection technology, especially for undetectable leaks, is available. With the help of this device, a user can locate a leak's location and size by 'listening' to the water flowing through pipes.

In small water systems, this method is simple to carry out, but in large, complicated systems, it may be challenging and frequently impractical (Mokgobu, 2017). Measuring provided water and billed water can help to find the locations with excessive water loss by splitting the overall system into separate pieces. The search for leaks is then expanded to areas where a significant rate of water loss has been detected. Additionally, it aids in locating unauthorised water connections. By using the right

plumbing techniques and optimising how the main water supply is tapped, leakage through housing connections can be reduced (Chetty *et al.*, 2016).

2.8.6 Pollution control

Water in controlled supply systems may sometimes be contaminated, such as sewer and industrial waste. Leakages in the piping system expose clean water to contamination from dirty water (Muinamia, 2015). When clean WDS pressures are lower than those in the non-portable system, the cross-connection of the two systems may allow non-portable water to enter the clean WDS (Muinamia, 2015). Since contaminated water may enter mains during off-peak hours through leaking joints and pipes, intermittent water deliveries can exacerbate pollution from hazardous sources.

2.9 WATER REGULATION POLICIES AND LEGISLATION

The Water Services Act, 1997 (Act No. 108, 1997) the *White Paper on Water Supply and Sanitation Policy* and the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996) (hereafter called The Constitution) are all included in this section's discussion of water regulation.

2.9.1 The Constitution of the Republic of South Africa, 1996

The Bill of Rights, which is the cornerstone of South Africa's democracy, is contained in Chapter 2 of the Constitution of South Africa, 1996. The rights of individuals, as outlined in the Bill of Rights, shall be respected, supported and upheld, according to Section 7(2) of the Constitution. The Constitution also upholds the right to equality. Additionally, the Constitution also safeguards the rights to social security, food and health care. Everyone has the legal right to enough food and drink, according to Section 27(1)(b). This section's second paragraph makes it very apparent that it is the state's responsibility to ensure that these rights are gradually realised.

2.9.2 The Water Services Act, 1997 (Act No. 108 of 1997)

Access to basic water and sanitation is guaranteed by the Water Services Act, 1997 (Act No. 108 of 1997). This Act also makes provisions for the creation of water boards and water service committees. Realising the rights of access to a basic water supply and sanitation will guarantee a healthy environment for the society. Everyone has the right to access basic water supply and sanitation under the Water Services Act.

Every water authority must include provisions for this entitlement in its water services development plan. The people must be treated fairly and equally while receiving water.

2.9.3 The White Paper on Water Supply and Sanitation Policy, 1994

Since water and sanitation were essential to the RDP process, this White Paper was released. More than 12 million people were without access to basic water and sanitation. The Department of Water Affairs and Forestry was established by the new administration, following the apartheid era (Muinamia, 2015). The topic of water supply was scheduled to be covered with employment and housing. The *White Paper on Water Delivery and Sanitation*, 1994 was introduced because of the sad lack of equity in water supply in the Republic of South Africa. At the end of the nineteenth century, South Africa was still dealing with significant water supply inequalities (Muinamia, 2015).

The government's reconstruction and development programme called for basic water provision to all citizens, regardless of race, according to the *White Paper on Water Supply and Sanitation Policy* (1994).

The role of water boards as local DWAF representatives is also described in this White Paper. One of the responsibilities of the water boards is the development of local water supply and sanitation services (The *White Paper On Water Supply and Sanitation Policy*, 1994).

2.10 BENEFITS OF SUFFICIENT WATER SUPPLY

This section discusses the effects of water scarcity on social interactions, agricultural productivity and community livelihood. It will also discuss how water scarcity affects development. The reviewed material was used to guide the discussion of all the aforementioned points.

2.10.1 Effect on community livelihood and projects

It is well known that tasks like gardening and brickmaking require a lot of water to be successful. Water dependant projects offer employment to some villagers, so when the water resource is scarce, there exists high risk of failure (European Commission, 2018). For households that depend on these ventures for their livelihood, the collapse can lead to unemployment. Water scarcity in this village has a significant impact on

the community's way of life. Water scarcity is a problem that affects agriculture, industry and public health. People want water for a variety of reasons and this causes water shortage, claims Abaqulusi (2017). To name a few, water is needed for daily household use, agriculture, and industrial endeavours.

2.10.2 Effect on crop yields

Water scarcity may also result in fewer harvests, which hurts the local communities. In other words, there will be hunger (Muinamia, 2015). Crop production has decreased as a result of rainfall deficits. If there is no water to break down the manure, using it will not aid the crops. The detrimental effects of a water shortage could cause poverty. Diseases, death and hunger can all be brought on by a lack of water. Lack of water harms people, animals and plants (European Commission, 2018). According to the aforementioned source, a lack of water has a direct impact on livelihoods in many ways, including food security.

2.10.3 Effect on health and social relations

Poor water and sanitation conditions in South Africa are responsible for 30% of all child fatalities. In addition to health issues, people, particularly women and children, sacrifice social time when searching for water when it is not available in or close to their houses (European Commission, 2018). Since they will be looking for water elsewhere, women and children miss out on spending meaningful time as a family with their fathers or husbands. Humans live in healthier environments when they have access to safe and clean water. Malnutrition brought on by a lack of water can be extremely hazardous for children (Muinamia, 2015). Water shortages can lead to illnesses like diarrhoea and gastrointestinal motility disorders.

2.10.4 The impact on development

Water scarcity also prevents the construction of bridges, complexes and other types of infrastructure (SALGA, 2017). Water availability is essential to the survival of these enterprises. Water supply is negatively impacted by the lack of infrastructure development in primarily impoverished provinces. It is impossible to complete sustainable projects without water (European Commission, 2018). Economic growth may be hampered by water shortages on a local, state and federal level.

2.11 CHALLENGES AFFECTING WATER DISTRIBUTION

The following sections provide a discussion of the factors that have affected water distribution in South Africa. The factors are divided into two main classes, namely, artificial factors and natural factors.

2.11.1 Artificial or human factors

According to the reviewed literature, the following human causes of water scarcity are discussed, namely, the disparity in water supply, illegal tap connections, urbanisation and population growth, contamination of existing water sources and leaking pipes.

Municipalities in South Africa lose a lot of water to illegal connections. According to the case by Ndevu and Muller (2017), illegal tap connections significantly contribute to water scarcity. In many instances, illegal connectors abuse water resources and disadvantage legal users.

A flawed water supply is attributed to disparities in the way the villages receive water. While uninterrupted water supply reportedly exists in some villages, numerous interruptions are experienced in some places (European Commission, 2018). The disparity of water supply in the same district or municipality is among the factors that led to the introduction of the White Paper on water provision.

The unprecedented growth in population in South Africa has harmed the sufficiency of the water supply. Immigration, coupled with an increased birth rate, has created a huge demand for water in South Africa in recent years (European Commission, 2018). The world population continues to grow at alarming rates, further projections estimate close to 7.9 billion world population size which is over 50% more than what it was in 1990.

The pollution of water sources by human activities, such as farming, poorly treated sewage from municipal works and industrial actions, are among the major causes of insufficient water supply in South Africa. Unsanitary environments increase the risk of fly-borne diseases, such as cholera. According to Ndevu and Muller (2017), the use of agricultural fertilizers and pesticides results in water pollution. This is a problem in both developed and developing countries like South Africa.

2.11.2 Natural factors

According to the literature assessment, the following are the main natural causes of water scarcity: drought, climate change, surface runoff, earthquakes, evaporation and transpiration.

The distribution of water in the world has changed significantly because of climate change. This conclusion states that the availability of water depends on the weather (Ndevu and Muller, 2017). Additional evidence suggests a connection between summertime, low flow times and residential water scarcity. More water is needed for agriculture during these times because of the high temperatures.

A lengthy period of extremely dry weather is known as a drought; this condition results in minimal rainfall, which depletes aquifers and may cause water shortages even for residents (European Commission, 2018). Owing to below-average rainfall, some catchments experience a decline in water levels. In agricultural areas, a balance must be kept between the delivered water and the surface runoff to replace it.

According to Swartz's (2009) theory, a lack of drinkable water can also be caused by surface runoff. This is because floods bring various items from the ground into sources of drinkable water. During severe flooding, as well as a few days or weeks after the storm, the rivers, fountains and dams that typically supply water to homes may become unusable. Sometimes a river that serves as the community's only source of clean water can also cause flooding. This may lead to a situation whereby the community is left without water for household use (European Commission, 2018).

2.12 WAYS OF CONSERVING WATER

The reviewed literature in this study outlines several problems that cause water shortages, experienced in both rural and urban places in South Africa. The following sections provide the various means through which water can be conserved.

2.12.1 Eliminating leakages

South Africa's water supply infrastructure loses millions of litres of water each year as a result of leaks. Particularly in older homes with pipes that have been in use for a long time, water leaks are common (CWD, 2015). Another reason for water leaks during

construction projects is unintentional pipe bursts. The bodies responsible for water distribution must keep a close eye on leaks.

2.12.2 Removing illegal connections

In a similar case like 'izinyoka', illegal electricity connections that have been a long-term plight of Eskom in South Africa, the water supply bodies also suffer due to illegal connections (Boshoff, 2012). Though it is a very complicated task to track all water pipes manually and identify illegal connections, it is crucially important for such an exercise to be done continuously to save water.

2.12.3 Capturing rainwater

Rainwater, if well harvested and stored in proper facilities, could go a long way in minimising the water crisis in South Africa. Rainfall water can be collected through roof gutter systems with storage tanks, erected at every household (European Commission, 2018). Furthermore, municipalities could benefit from channelling surface water runoffs by constructing proper drainage systems that divert water to dams and natural reservoirs.

2.12.4 Drilling boreholes

The groundwater resource is another significant source of water and might be used to complement the rivers. Water leaks from conveyance systems and irrigation plans may artificially recharge the aquifers. Even though recharging is frequently unanticipated, this may prevent excessive groundwater use (European Commission, 2018).

2.12.5 Creating an extensive pipeline network

The disparities in the water supply are sometimes due to the unequal distribution of the pipeline system. Mostly in rural areas, many places do not have access to main water pipes, making it difficult for the water to be transported to every household. The municipalities need to invest huge sums of money in extending the network of existing pipe networks. The long-distance conveyance of water, though expensive, is inevitable and essential (Viljoen and Walt, 2019).

2.12.6 Desalination

South Africa's coastal belts and some interior parts have plenty of salty water and such water is usually not used for domestic use. Chemical processes must be used to treat salty water and make it drinkable and also usable for other household activities (European Commission, 2018). Such a process may require specific technologies, usually costly and requiring large-scale operations.

2.12.7 Household use control

According to Viljoen and Walt (2019), households are the major wasters of precious water and could save water by using buckets instead of running taps. Watering gardens and washing cars represent some of how water is inefficiently used in several homes. The general population needs to be conscious of the value of water and the need for saving every drop (European Commission, 2018). Water companies may impose a ban on the domestic use of hosepipes and sprinklers.

2.13 CHAPTER SUMMARY

The third chapter of this study provided an extensive discussion of the major problems, related to water supply shortages in South Africa. An overview of the service delivery problems, affecting the country, was laid out before explaining the water crisis. The causes of water shortages, suggested solutions and legislation were also discussed in the chapter. Human effort is crucial and central to the elimination of the persistent crisis.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Chapter Three of this study is based on the research methodology of the study. In the first chapter of this study, the researcher presents the background of the study, the research problem and the research objectives. The literature review chapter expands on the various elements of the water maintenance and distribution systems. Chapter Three contains the research approach and design, guiding this study, in addition to the chosen data collection and analysis method. Furthermore, the third chapter contains the chosen sampling techniques and ethical considerations of the current study.

3.2 RESEARCH DESIGN AND METHODOLOGY

The research design and methodology comprise sections, covering the research approach, design, philosophy and strategy, that guided this study.

3.2.1 Research approach

The researchers used two common research approaches when conducting the research. The two approaches fall into broad categories of qualitative and quantitative research (Saunders, Lewis and Thornhill, 2009a). The below section provides a discussion of the two approaches as well as the motivation for the selected one.

3.2.1.1 *Quantitative research*

According to Burns and Bush (2014), the quantitative approach is synonymous with the use of numbers and seeks to assign measurable values to research. The quantitative research approach works well with the positivistic paradigm. It uses numbers and, therefore, applies measurable units in establishing relationships among variables as well as confirming relationships. When conducting quantitative research, researchers follow a structured approach, making use of closed-ended questionnaires (Creswell, 2013). Contrastingly, the qualitative approach employs unstructured research instruments, with open-ended questions. In the quantitative research approach, variables are separated between independent and dependent variables, also known as a predictor and predicted, which are can be analysed statistically

(Burns, Alvin, Bush & Ronald, 2014). The quantitative approach has limitations in terms of developing new knowledge and theories.

3.2.1.2 Qualitative research

The qualitative approach is known to be exploratory in nature; it seeks to gain insights into the attitudes and opinions of the population under study (Bradley, 2013:86). It brings out deep insights into the research phenomenon, using words, videos and images, as opposed to the use of numbers (Wiid and Diggines, 2013). With this approach, researchers deduce meaning and patterns from non-numeric data, comprised of facts related to the research questions. This study intends neither to confirm the existence of a relationship between the variables nor to establish new patterns among the variables. This necessitated the use of the qualitative approach.

Using the qualitative research approach, this study was able to create an interactive relationship with the interviewees. Qualitative inquiry helps in gaining an understanding of the meaning that humans attach to events (Saunders, Lewis and Thornhill, 2009). A qualitative research approach was used in this study because it permits access to in-depth information regarding the water maintenance and operations management system under study. This study did not seek to measure causality between the variables; hence, qualitative methods were the most appropriate.

3.2.2 Research design

A research design serves a crucial role in guiding the research process, including providing a framework for data collection and analysis (Maholtra, 2012). For every study, researchers normally choose to follow one of the five common research designs, such as the descriptive research design, explanatory research design, causal-comparative research design, correlational research design and exploratory research design.

3.2.2.1 Descriptive research design

The descriptive research design is useful when describing statistical patterns, observable among the variables under study (Wiid and Diggines, 2013). Descriptive research is especially useful when studying cases where knowledge of the

phenomenon is vaguely defined. The descriptive research design applies to quantitative types of studies (Shiu *et al.*, 2009; Berndt and Petzer, 2011).

3.2.2.2 Explanatory research design

An explanatory research design is employable in a situation where the research problem was previously studied but not thoroughly conducted. The explanatory design permits operational definitions and improved models (Zikmund and Babin, 2010). The explanatory design is centred on explaining major aspects of the research problem. Unlike the exploratory research design which focuses on hypothetical ideas, explanatory studies focus on known variables and concepts (Berndt and Petzer, 2011).

3.2.2.3 Causal-comparative research design

When the relationship between a predictor and a predicted variable needs to be explained, researchers may resort to the use of the causal research design. In some texts, causal research is referred to as experimental research. This can sometimes be conducted by means of laboratory or field experiments and can also be linked to predictive studies (Wiid and Diggins, 2013). The causal research design is incompatible with the interpretivist paradigm and for that reason, this study did not adopt the design.

3.2.2.4 Correlational research design

The correlational research design refers to research that focuses on statistically establishing the correlation between two variables. It permits the identification of the extent to which one variable is influenced by another (Creswell, 2013). The outcomes of correlation research show a negative, positive or no relation between two variables of interest. The correlation research design applies to quantitative studies and for that reason, it was not chosen for this research.

3.2.2.5 Exploratory research design

The exploratory research design is applied when a study seeks to explore a relatively unknown area (Wiid and Diggins, 2013). It is one of the most commonly applied research designs when conducting qualitative research. Proponents argue that exploratory research is inclined towards social research and draws reality from social

settings. Berndt and Petzer (2011) note that exploratory research design allows researchers to understand the nature of the research problem. It is sometimes used during the primary phase of research. The exploratory research design works well with the qualitative research approach and combines unstructured methods with informal techniques for data collection (Creswell, 2014). This study used an exploratory research design because a qualitative research design heavily relies on interviews, focus groups and sometimes questionnaires. The qualitative research design makes it possible for the researcher to gain insights into the research problem under study (Wiid and Diggins, 2013). Justification for using an exploratory research design was also because this study sought to assess how operations and maintenance have affected the reliability of groundwater supply at the Amatole District Municipality during droughts.

3.2.3 Research philosophy

Bryman and Bell (2011) note that a research paradigm is informed by research philosophies. The two broad research philosophies, namely, positivism and interpretivism, fall under epistemological views (Bryman and Bell, 2011). According to Creswell (2013), positivist research is deductive and provides the means to determine a cause-and-effect relationship. The methodology of this study, however, did not use the positivistic paradigm. In contrast with positivism, interpretivism allows researchers to come up with new knowledge and insights into a research phenomenon concerning the researcher's perspective (Quinlan, 2011).

Based on the aforementioned distinctions, this study is informed by the interpretivist paradigm. Using the interpretivist approach, this study explored new theoretical dimensions of water maintenance and operations systems in Amathole. With the interpretivist paradigm, researchers are allowed the freedom to develop theories by extracting sense from the surrounding world.

3.2.4 Research strategy

A research strategy provides guidelines for the research process (Quinlan, 2011). Several different research strategies can be used to conduct the aforementioned research designs. Every research strategy lends itself to a particular research design which guides how the study must be conducted. Along with the phenomenology

strategy, case studies, interviews, grounded theory and ethnography are employed. A case study method allows the collection of in-depth information about a research problem, using real-life contexts. It is usually used with interviews. A phenomenology strategy guided this study, which is compatible with the exploratory research design (Saunders, Lewis and Thornhill, 2012). The grounded theory is compatible with the exploratory and descriptive types of studies. The grounded theory begins with existing basic knowledge about a theory and develops new insights, based on lived experiences of actors (Thomas, 2010).

This study used an interview strategy as its research strategy because the study seeks to uncover in-depth information in areas where research participants have opinions, knowledge, experiences and thoughts about the subject under investigation. Interviews are also an appropriate method when in-depth information needs to be collected on people's opinions, thoughts, experiences and feelings. Interviews are useful when the topic of inquiry relates to matters that require complex questioning and considerable probing.

3.3 SAMPLING

This section explains how sampling was conducted to collect primary data. The section explains the target population, sampling techniques and sample size and composition.

3.3.1 Target population

Target population refers to the total number of elements containing the random variable of interest (Berndt and Petzer, 2011). Elements making up the target population could be organisations or individuals, among others. Owing to administrative and cost constraints, Burns and Bush (2014) state that a sample must be selected to collect data effectively. When conducting research, it is hardly possible to interview all the members of the true population under study. A sample is defined as a subcategory of the target population and carries the representative attributes of the true population elements (Zikmund and Babin, 2010). The target population of the study is employees at Amathole District Municipality who work in the water and sanitation department (Operations and Maintenance Unit), including the section heads and the managers.

3.3.2 Sampling strategy

A sampling strategy provides details on how researchers select the interviewed research subjects (Cant, Gerber-Nel, Nel and Kotze, 2005). Two broad sampling techniques are applicable in research, namely, the probability and the non-probability sampling techniques. The probability sampling strategy proposes that every population element share an equal chance of being selected. With this type of sampling strategy, each sampling unit possesses a known non-zero chance of being included in the sample (Churchill, Brown and Suter, 2009). Probability sampling techniques apply to quantitative studies and their suitability is mainly because probability sampling techniques require very large samples. Techniques that could be used under the probability sampling strategy include simple random sampling, systematic sampling and stratified sampling (Berndt and Petzer, 2011).

Contrasted with the probability sampling technique, is the non-probability sampling technique, which incorporates all the elements where each element does not have an equal chance of being selected (Berndt and Petzer, 2011, 323). Numerous variations of non-probability sampling techniques exist, namely, “snowball, quota, maximum variation convenience, and purposive sampling methods” (Creswell, 2013; Saunders, Lewis, Thornhill, 2009b; Yin, 2009). Snowball sampling, also known as chain-referral sampling, is a non-probability sampling technique in which the samples have traits that are rare to find (Creswell, 2013). In this sampling technique, existing subjects provide referrals to recruit samples, required for a research study.

Non-probability sampling was used in this study where the participants were selected because they were easy to access. Through the non-probability sampling technique, it is possible to study phenomena with the potential to generate valuable insights (Showkat and Parveen, 2017:7). The purposive sampling technique allows the respondent to select respondents, based on certain qualities, known to the interviewer (Saunders, Lewis and Thornhill, 2009b). The purposive sampling technique was applied in this study because the researcher wanted to benefit from the easy accessibility of participants as well as their appropriateness in answering research questions.

3.3.3 Sample size

For this study, the study sample comprised selected employees from the Amathole District Municipality who were working in the water distribution and supply section. The sample, used in this study, covered a small sample of ten respondents. Qualitative research studies put more focus on the notion of saturation in sampling matters and a total of 10 respondents is usually recommended (Wiid and Diggines, 2013).

3.4 DATA COLLECTION

The data collection section provides the steps that were followed to collect the primary data, which were used to answer the research question, informing this study.

3.4.1 Data collection strategy

This study used both primary and secondary data to answer the research problem. Secondary data refer to data that has previously been used in other research with a different purpose than this study (Zikmund, 2010). Forms of secondary data include online journals, conference papers, reports, newspapers, journals, white and working papers, and published book chapters. In this study, secondary data were used to review past studies in reconciliation with the current study, particularly in the literature chapters. When conducting research, the data that were collected for the first time and specifically to serve a definite purpose is known as primary data (Shiu, Hair, Bush and Ortinau, 2009). The collection of primary informed by the research design and the chosen research approach. The most applicable methods when collecting primary data include “field observations, focus groups, interviews, document analysis and ethnography” (Bryman and Bell, 2011, p221).

Field observations involve the observation of people in real-life environments as a way of collecting information about their behavioural patterns (Wiid and Diggines, 2013). It is mostly used in studies, related to technical work, such as electrical and construction engineering. Focus groups are more similar to interviews and are used to gain insight into perceptions about a research problem (Bryman and Bell, 2011). Focus groups normally involve small groups of at most ten people, answering unstructured questions with the help of a moderator. This research study used interviews because interviews are a qualitative data collection technique which involves a respondent’s intensive answering of structured or semi-structured questions (Clarke and Braun, 2013).

Three types of interview techniques may be classified, namely, structured, semi-structured and unstructured interviews. In a structured interview, the researcher follows a specific set of questions in a predetermined order with a limited number of response categorisations (Stuckey, 2018). In semi-structured interviews, questions or topics are planned and are based on open-ended questions (Fox, 2009). Unstructured interviews are a ubiquitous tool for making screening decisions despite vast literature suggesting that they have little validity (Dana, Dawes and Peterson, 2013). This research study used semi-structured interviews because questions were planned and were based on open-ended questions.

3.4.2 Conducting interviews

This study was guided by the qualitative research approach, necessitating the collection of primary data, using interviews. This study used semi-structured interviews, conducted through online media to avoid the risk of Covid-19.

The Microsoft Outlook email software was used to send the list of interview questions and the informed consent form. The same tool was used to receive the participants' recorded interview answers. Interview questions and the informed consent form were sent to all the targeted research participants. The research participants are given four days to complete the documented list of interview questions. The research participants were advised to return the signed consent form and their recorded interview answers through email. The Zoom platform was used to interview the participants.

3.5 DATA ANALYSIS

The collected data underwent a process of data cleaning to retain high-quality responses. The findings were captured in a Microsoft Word document before the actual data analysis procedures. Qualitative studies normally choose between content analysis and thematic analysis. Content analysis, according to Thomas (2010), involves the use of words or text to identify relationships between themes and concepts. According to Braun, Clarke and Terry (2014), thematic analysis is a method for systematically identifying, organising and offering insight into patterns of meaning (themes) across a data set. The thematic analysis follows phased steps while familiarising oneself with the data, code generation, theme development as well as report-writing (Clarke and Braun, 2013). This study used thematic analysis to deduce

the hidden insights. In this study, the analysis phase employed the NVivo 12 (Windows) as an aid to identify the themes.

3.6 PILOT STUDY

A pilot study asks whether something can be done, should the researchers proceed with it, and if so, how. However, a pilot study also has a specific design feature; it is conducted on a smaller scale than the main or full-scale study. In other words, the pilot study is important for the improvement of the quality and efficiency of the main study (Creswell, 2013). In addition, it was conducted to assess the safety of treatment or interventions and recruitment potentials, to examine the randomisation and blinding process, to increase the researchers' experience with the study methods or medicine and interventions, and to provide estimates for sample size calculation. This review was discussed with a focus on the misconceptions and the ethical aspect of a pilot study. Additionally, how to interpret the results of a pilot study is also introduced in this review (In, 2017). The pilot study targeted at least three respondents to determine whether all the interview questions were understood and clear to all the participants.

3.7 TRUSTWORTHINESS

Critics of the qualitative research approach argue against matters, such as the trustworthiness, bias and reliability of findings from exploratory research. However, according to Cooper and Schindler (2014), the terms that justify qualitative studies are dependability, credibility, transferability and confirmability. The below section provides a brief discussion of each of the elements.

3.7.1 Credibility

Credibility is a technique that is applied in qualitative studies when determining the objectivity and subjectivity of the research (Zikmund and Babin, 2010). It is a crucial and imperative quality test when conducting qualitative research. In this study, the sample comprised at least three different groups of respondents to ensure credibility. The groups were employees from the three selected departments at the Amathole water management offices. Creswell (2013) notes that using triangulation methods in data collection could also help with ensuring the credibility of research findings.

3.7.2 Transferability

According to Zikmund and Babin (2010, p78), “transferability relates to the ease with which results from qualitative research could be transferrable to similar settings elsewhere as an interpretivist equivalent of generalizability”. In this research, transferability was achieved by satisfactorily articulating all the relevant descriptive processes of the study setting as well as the data collection procedures to ensure that the study could be replicated.

3.7.3 Dependability

Dependability in qualitative research relates to the solidity and reliability of the research results over time (Zikmund and Babin, 2010). A procedure is used in evaluating the dependability of findings in research. This entails allowing sample participants to evaluate the findings and checking whether the research objectives have been achieved (Yeganeh, Su and Chrystome, 2004). In some instances, selected respondents are required to check the cleaned data to identify if alterations were made to the transcribed data.

3.7.4 Confirmability

The corroboration of findings is a fundamental matter in research. For the findings of a study to be credible, dependable and trustworthy, they must be corroborated with other findings from studies in the same continuum (Wiid and Diggins, 2013). Comparison with other researchers’ works in the same context permits validation or confirmation. Confirmability is a technique, employed to eliminate bias in research. It ensures objectivity (Saunders, Lewis and Thornhill, 2009).

3.8 LIMITATIONS OF THE STUDY

One of the outstanding limitations of this study was that it was conducted only in one province of South Africa, which is the Eastern Cape. In addition, the sample size, used in this study, was only limited to 10 respondents which is not substantial enough to gain a wide perspective on the subject. While the research study could use the mixed research methodology, this research study was confined to the qualitative approach owing to the shortage of time. The downside of the chosen research methodology was that it did not use quantitative techniques to determine patterns and causative factors.

The time factor could be pointed out as another limiting factor. Alternative to the cross-sectional research, the research study could have made use of longitudinal methods.

3.9 ELIMINATION OF BIAS

When researching at least five main types of bias are prominent. These five include design, sampling, interviewer, response and reporting bias, among others (Maholtra, 2012). Design bias occurs when the researcher uses a design that he prefers even if the design is inappropriate for the study. Sampling bias exists when respondents are selected, based on bias, while response bias occurs when respondents offer answers that are not in line with the objective of the study (Zikmund and Babin, 2010). To eliminate sampling bias, this study selected the most appropriate employees from the ADM. Reporting bias must be eliminated by ensuring that the research results were not manipulated subjectively. During the interview process, objectivity was maintained throughout and influencing respondents was avoided at all costs.

3.10 ETHICAL CONSIDERATIONS

When conducting this research study, it was imperative to observe and abide by certain ethical principles. Academic research was regulated by the Research Ethics Committee of the university. The sections below explain the main research concerns.

3.10.1 Informed consent

Informed consent is an imperative principle in ethical practices when conducting research. According to Creswell (2013), every research participant must participate voluntarily, knowingly and intelligently. This implies that participation in the research is subject to a thorough understanding of the research objectives and implications of participation (Wiid and Diggins, 2013). For this study, all the participants were provided with detailed information about the study before accepting or rejecting the invitation. The rights of the participants were maintained when conducting the research; it is an ethical necessity. Through informed consent, it was disclosed to participants that they will not be intimidated throughout the course of the process. As such, at any point in time, participants were not bound to continue and could discontinue willingly. The respondents were equally guaranteed and granted the right not to participate in the research when they felt that their rights were violated.

3.10.2 Ensuring no harm comes to participants

The potential harm, such as physical, emotional or psychological harm, was closely monitored and thoroughly studied. The research participants were not harmed emotionally, physically or psychologically at the time of voluntarily participating in this research study (Helsinki, 2009).

3.10.3 Confidentiality and anonymity

Participants were guaranteed the right to confidentiality during the research. The information, provided by the research participants, must not be disseminated in a manner that could compromise the reputation of the respondents. As such, anonymity was maintained for all participants who voluntarily participated in the study. Confidentiality refers to the management of information, disclosed by participants in trust (Saunders *et al.*, 2009a). The researcher and the respective supervisor will store the collected data for five years and access may only be granted to the Research Ethics Committee when needed. The data were collected electronically to minimise the risk of transmission of contagious diseases, particularly Covid-19.

3.10.4 Obtain permission to conduct the study

It is still advisable to send a letter or email to the intended organisation and outline the proposed research requirements. The introductory letter, requesting access, should outline the purpose of your research, how the selected person might be able to help and what would be required (Saunders, Lewis and Thornhill, 2007).

The letter was sent to the Amathole District Municipality, requesting permission to conduct the research study. Permission to conduct this research was sought from the relevant municipal managers.

3.11 CONCLUSION

The third chapter of this study contained the research methodology. In this chapter, it was outlined that this study was based on the qualitative research approach. Importantly, it was stated that the research was based on an exploratory design, compatible with the chosen research philosophy which was interpretivist. The study targeted employees, working in the water maintenance and operations, from which the sample of the study was then drawn. Respondents were selected, using the purposive

sampling technique, permitting the collection of qualitative data through interviews. Furthermore, the chapter mentioned thematic analysis as the data analysis method of choice. Chapter Four focuses on the results, discussion and interpretations of findings. It also presents the findings from the gathered primary evidence and proposes a solution to the research problem.

CHAPTER FOUR

ANALYSIS AND PRESENTATION OF FINDINGS

4.1 INTRODUCTION

The research methodology, provided by the third chapter of this study, guided the analysis in this chapter. Unstructured questionnaires were used to collect the data from selected employees from the Amathole District Municipality, who were working in the water distribution and supply section. The analysis in this chapter follows the process that was discussed in the third chapter of this study. The main aim of this study was to examine the water maintenance and distribution of the Amatole District Municipality. The findings, presented in this chapter, comprised a blend of secondary information from literature analysis and primary data, collected from the respondents.

4.2 DEMOGRAPHIC INFORMATION

In this section, the presented demographic analysis covers the age of participants, gender of respondents, age of business and the form of ownership.

4.2.1 Age of participants

Figure 4.2.1 presents the analysis of the age of respondents.

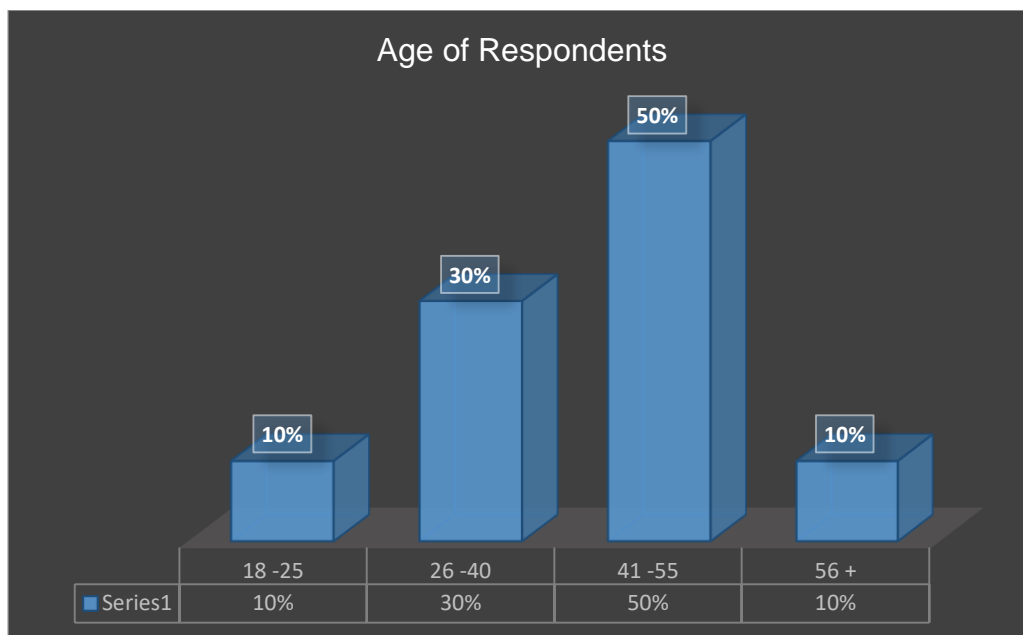


Figure 4.1: Age of participants

Based on the figure above, the largest proportion of respondents was aged 25 years or more while only 10% of the respondents fell into the 18 to 25 age range. People between the ages of 41 to 45 years made up the highest proportion of the population. The analysis of the age standings indicates that most of the interviewed ADM employees were senior in terms of age.

4.2.2 Gender of respondents

The below figure presents the analysis of the demographic standings of the respondents who participated in this study.

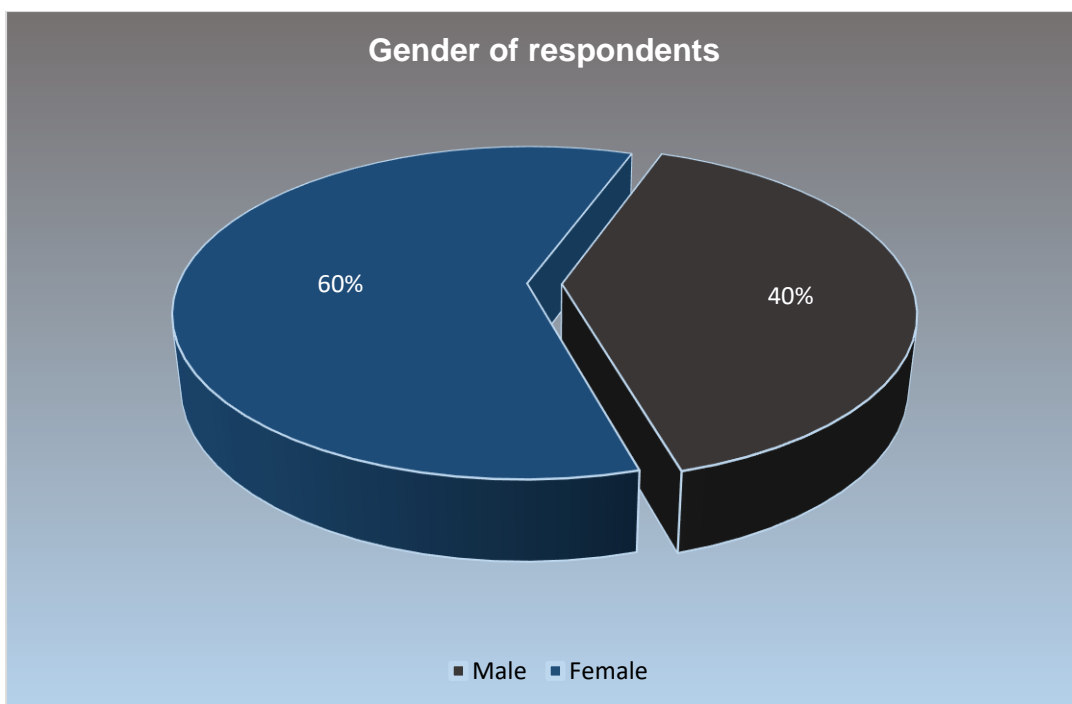


Figure 4.2: Gender of participants

The pie chart above shows that at least 10% more males participated in the study, compared to female respondents. The implication of the finding could be that more males are employed in the selected ADM.

4.2.3 Years of working experience

The demographic statistics, analysed in this study, also examined the number of years of working experience of the participants.

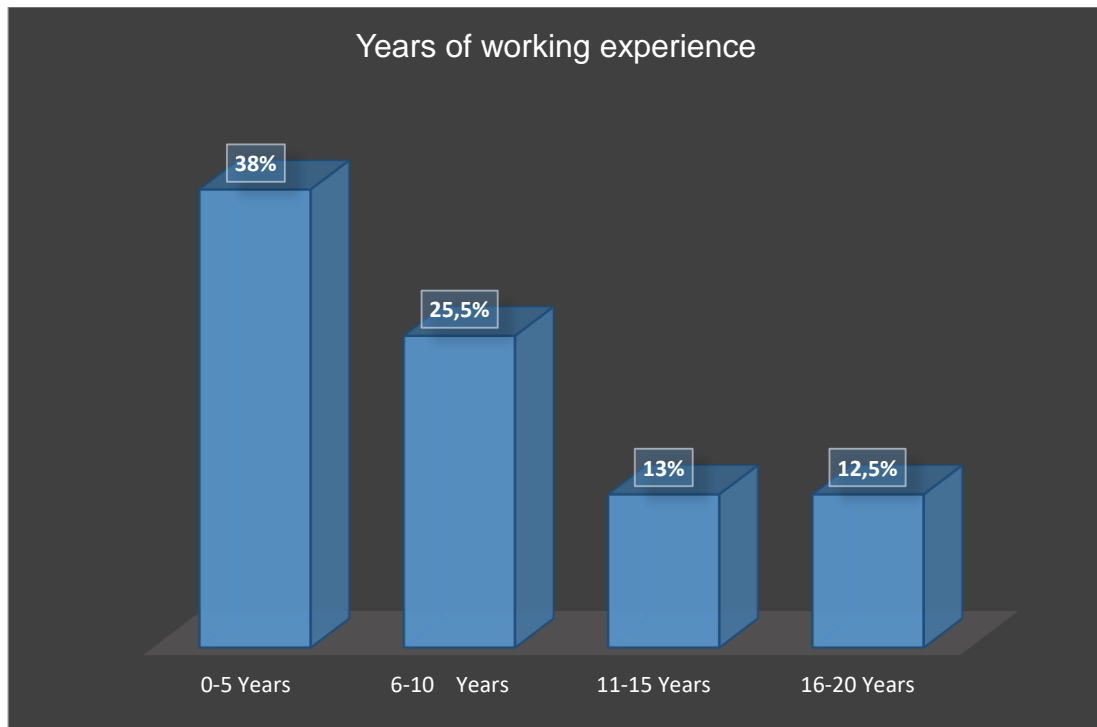


Figure 4.3: Years of working experience

The above statistics from figure 4.2.3 shows that most of the participants had working experience below 10 years. At least 38% of the employees had experience below five years. Furthermore, the graph reveals those employees with working experience beyond 10 years account for at least 25% of the total participants.

4.3 DATA ANALYSIS PROCESS

The third chapter of this study presented the research methodology which detailed how the data were collected, processed and analysed. Chapter Three reveals that the qualitative research approach was selected as the research methodology. The analysis of the collected primary data for this study was guided by thematic analysis. Braun and Clarke (2006, p88) note that “thematic analysis offers the advantage of ensuring that the researcher remains objective”. Before the actual analysis, the collected data were cleaned before categories were deduced from each questionnaire using NVivo analyses. Lastly, themes and subthemes were deduced from the categories, as presented in the figure below.

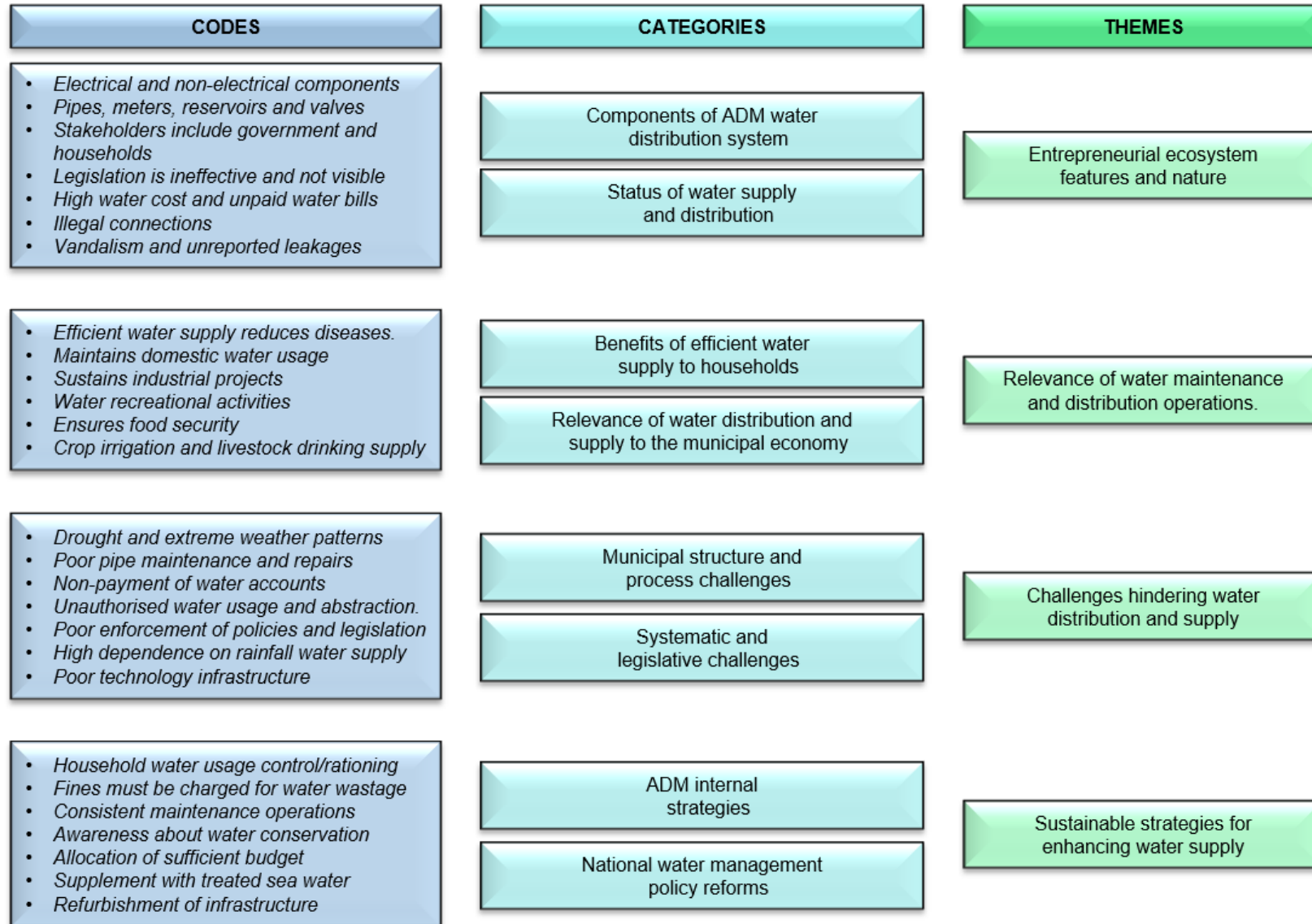


Figure 4.4: Themes and code generation

4.4 ENTREPRENEURIAL ECOSYSTEM FEATURES AND NATURE

4.4.1 Components of Amathole District Municipality water distribution system

Respondents were required to provide their understanding of the water distribution system, including its main components. According to respondent R1, “the water distribution system comprises of *electrical and non-electrical components*”. The response was consistent with the literature, which revealed that the design of a water supply system comprises of numerous components which serve a crucial role in managing and monitoring water supply. Respondents R3, R7 and R10 indicated that the most vital components of a water distribution system are pipes and reservoirs or tanks. Water storage is provided in the form of reservoirs or tanks. These are used in a water distribution system (WDS) to meet variable supply to the network with constant water production, provide water during emergencies and maintain stable pressures (Chetty *et al.*, 2016).

Respondent R2 highlighted that meters are a crucial component of a water distribution system. The assertion was consistent with Viljoen and Walt’s (2019) literature, which revealed that meters play a crucial role in the management of water pressure and velocity as well as in billing consumers. Furthermore, respondents R9 and R2 highlighted the important role of valves and pumps in the water distribution and management system. Pumps, according to the literature review, were defined as the channel through which water is transported from one place to another. Pipes can be classified as trunk mains, secondary mains, distribution mains and service mains (Viljoen and Walt, 2019). Respondent R6 revealed, “*the water distribution system cannot optimally operate without the involvement of its various stakeholders which include the government and households*”. Water operations and maintenance can be explained as “the activities required to sustain the water treatment and supply system in a proper working condition” (Mokgobu, 2017,p23). It is sub-classified into preventive, corrective and crisis maintenance.

4.4.2 Status of water supply and distribution

According to Mokgobu (2017, p24), “South Africa has lost over 50% of its wetlands, and of the remaining 3.2 million hectares (ha), that is, one third are already in a poor condition and the scarcity of water in South Africa makes it a highly expensive resource

as dictated by the law of supply.” With regards to the current status of the water situation in South Africa, respondent R5 highlighted that “*there are too many illegal water connection leading to huge water losses from the main supply system*”. The illegal water connections mean that the government of South Africa loses out on revenue due to users who use water without paying. Furthermore, the millions of litres, lost through illegal connections, significantly reduce the volume of water available for deserving users. The literature review showed that according to UNCTAD (2020), up to date, over 10 million households in the rural parts of South Africa remain without reliable water supply. Further exploration of the dire water situation revealed that the water distribution in South Africa is not sufficiently controlled. Respondents R10 and R3 shared the common view that the existing legislation for controlling water distribution and supply is inefficient and not visible. The government of South Africa is under pressure to improve its water regulation to keep abreast with contemporary international standards for developing nations.

Respondent R2 indicated that “*the water supply situation system in South Africa is characterised by high water cost and unpaid water bills*”. Based on the assertions from the respondent, it is notable that the water-supplying bodies struggle to collect revenue from the consumers. Furthermore, it is apparent that owing to the scantiness of the water supply, the price per cubic litre is expensive. Respondent R1 revealed that “*the water distribution and supply infrastructure has been severely vandalised, especially in the remote parts where there is no security*”. The vandalism of the water distribution infrastructure is one of the major current challenges of the water distribution system. Respondents R7 and R8 shared a common response, indicating that a large volume of water is lost to leakages that are in the water piping system. The various leakages may be attributed to deteriorating pipes and the lack of proper maintenance. While some of these faults have to do with situations beyond the government, some are purely emanating from a lack of due diligence.

4.5 RELEVANCE OF WATER MAINTENANCE AND DISTRIBUTION OPERATIONS

4.5.1 Benefits of efficient water supply to households

Water scarcity is also a hindrance to a variety of development projects, such as road construction and bridge complexes (SALGA, 2017). Respondents were also required to give their views about the merits of efficient water supply in rural and urban places in South Africa. According to respondent R1, “*efficient water supply reduces diseases*”. The respondent’s sentiments are consistent with the literature review, which noted that safe and clean water promotes a healthy living environment for human beings. Respondent R6, furthermore, specified that “*the lack of water is particularly dangerous to young children*”. The literature supports this assertion, which revealed that the lack of water may lead to malnutrition and may be severely dangerous to children (Muinamia, 2015). Above all other essential resources for the survival of human beings, water remains the most basic yet very essential need. Respondents R1 and R5 both indicated that a consistent supply of clean water is essential for the sustenance of domestic household requirements. Based on the understanding that households use a very large volume of water daily, the shortage of water supply adversely hampers their progress. Respondent R9 noted that “*water essential because it sustains industrial projects*”. The predicament of water scarcity limits public health, industry and agriculture.

4.5.2 Relevance of water distribution and supply to the municipal economy

It was also important for this study to examine how the scarcity of water supply might affect the municipal economy. According to respondent R3, “*the scantiness of water adversely affects water recreational activities*”. Activities, such as fishing, boat cruises and water-based tourism, may adversely suffer during times of low water supply. Respondents, R5, R8 and R10 shared a common response, highlighting that water is essential for food security. The reviewed literature supports the sentiments of the respondents, which pointed out that farming cannot be viable without a sufficient water supply. Scarcity of water may also lead to fewer crops, a situation that harms the communities. Put simply, there will be hunger and food insecurity if there is not enough water supply (Muinamia, 2015). When doing either crop or livestock farming, water is regarded as the lifeblood of the production process. Respondent R2 highlighted that

“crops in dry regions of South Africa survive on irrigation and the livestock also needs water for drinking purposes”. The analysis of the assertions of the respondents affirms the idea that irregular water supply is detrimental to the rural economy of South Africa, which is essentially hinged on farming. Not having a reliable water supply would hamper agricultural activities, especially in the dry regions which do not normally receive adequate water supply consistently.

4.6 CHALLENGES HINDERING WATER DISTRIBUTION AND SUPPLY

4.6.1 Municipal structure and process challenges

This study also sought to understand the role of municipal structures and processes in the limited supply of water in the rural parts of the country. The analysis of the responses of three respondents revealed that respondents R1, R6 and R7 agree that the municipality's poor maintenance has caused faulty systems. The literature review indicated that the municipality has a crucial role to play in the maintenance of the water management systems. This, therefore, implies that the system must function efficiently for a fairly long period. Respondent R9 indicated that *“the traditional structure of rural municipalities does not have a water management department that suitably addresses the existing water challenges”*. Based on the assertion, it is clear that the structure of the municipality departments and roles must be reorganised owing to changes that have taken place over recent years.

Further analysis of the responses of respondents R2 and R5 revealed that unauthorised water use has been a huge problem for South African municipalities. The problem of illegal water connections may take longer to solve as has been the case for illegal electricity connections. From the literature review, Ndevu and Muller (2017) indicated that illegal tap connections, urbanisation and population growth, contamination of existing water sources and leaking pipes are a hindrance to efficient water distribution and supply. Respondent R10 mentioned that *“there existing water pumps are not powerful enough to consistently force water uphill to homes located on the highlands”*. A flawed water supply in such a case would be attributed to inadequate and ageing infrastructure. The ageing system could be an indication that the municipality has not been doing commendable work in maintaining the whole water supply and distribution system.

4.6.2 Systematic and legislative challenges

Several challenges were examined as some of the major causes of erratic water distribution and supply. Among the challenges, respondents R1, R7 and R10 declared that in South Africa, the lack of policy enforcement is a common problem across the entire public sector. In many sectors, the government prepares the monitoring and regulating authorities but lags in the follow-up. About the systematic causes of erratic water supply, respondent R4 noted that *“the effects of drought and extreme weather patterns cannot be underestimated when examining water supply issues”*. The literature analysis supports that climate change is a major cause of change in the distribution of the world’s water. This conclusion boils down to the fact that water availability is also dependent on climatic conditions (Ndevu and Muller, 2017). It is important to note that changes that are beyond the powers of the local municipalities will likely remain in place for long and may also cause further devastating effects.

The fourth industrial revolution has revolutionised every aspect of human life, including the way municipalities manage water resources. Respondents R3 and R9 shared the common view that local municipalities do not have the appropriate modern technology, used in water resource management. Such technologies include the drone concept, GIS software and other state-of-the-art equipment that monitor water reservoir and pipeline systems. Respondent R2 contributed that *“the high dependence on rainfall water supply by municipalities is an additional challenge”*. While boreholes and the purification of seawater are available options, South African municipalities need to explore other supply options.

4.7 SUSTAINABLE STRATEGIES FOR ENHANCING WATER SUPPLY

4.7.1 Amathole District Municipality internal strategies

According to Viljoen and Walt (2019), households are the major wasters of precious water and could save water by using buckets instead of running taps. The findings from the literature support the response from R5 who notes that *“household water usage control is very crucial if ever South Africa is to solve its persistent water woes”*. By following the template of cities such as Cape Town, other municipalities can implement the rationing water system, providing limited litres of water supply to each household. Respondent R8 highlighted that *“anyone caught wasting water must pay a*

fine that is charged for water wastage". The fining system could go a long way in deterring reckless households from unnecessary spilling of water. The water supply system in South Africa loses millions of litres of water annually due to leakages. Water leakages are prevalent in especially old residential places which have pipes that have served for a long time (CWD, 2015).

Respondents R1, R6 and R10 indicated that consistent maintenance and repairs are very much essential in solving the water problems in South Africa. The suggestion is a response to the current deteriorating infrastructure in the country. In a similar case, like 'izinyoka', where illegal electricity connections have been a long-term plight of Eskom in South Africa, the water supply bodies also suffer due to illegal connections (Boshoff, 2012). Respondent R7 proposed that municipalities must work with the police in resolving cases of illegal water connections. It also surfaced that the high tariffs, which the ADM charges, discourage water users from paying their bills. Respondent R4 pointed out that "*reducing water tariffs could go a long way in encouraging consumers to settle their accounts, thereby increasing revenue collection*". The literature of Ndevu and Muller (2017) in the second chapter of this study, revealed that water is very expensive in South Africa.

4.7.2 National water management policy reforms

Respondents were also required to provide their suggestions with reg to what changes could be made to the water management policy at a national level. Respondents R3 and R5 revealed that the general awareness about water conservation among water users must be increased. A huge proportion of the rural population is ignorant about the dimensions of water scarcity in the country and the role that each party must play. According to respondent R4, "*beyond human behavioural control, the national government must increase the budget allocated to water distribution and supply in the country*". The allocation of sufficient financial resources would implicate the national treasury.

South Africa has access to abundant seawater, and respondent R2 highlighted that "*the government of South Africa must devise technology that purifies seawater for the purpose of non-drinking uses*". The literature review pointed out that municipalities could benefit from channelling surface water runoffs by constructing proper drainage

system dams and drilling boreholes. Furthermore, respondents R6 and R10 reiterated that the existing water distribution system must be refurbished at a national scale owing to the growth in population that transpired over the past years. The literature supported this notion, which pointed out that disparities and shortages in the water supply are sometimes due to the unequal distribution of the pipeline system. Such a process may require specific technologies, usually costly and requiring large-scale operations (Viljoen and Walt, 2019).

4.8 CHAPTER SUMMARY

The analysis chapter formed the fourth chapter of this study. The approach and steps, followed in this study, were based on the interpretivist methodology. The main sections of the chapter examined the components of a water distribution and supply system, the relevance of water supply and challenges inhibiting consistent water supply in South African municipalities. It emerged that leakages, lack of infrastructure meters and illegal connections are some of the factors that are adversely affecting the water supply. Importantly, this chapter also discussed some of the possible strategies for solving the scantiness of the water supply. Among other crucial strategies, fining people, who waste water resources, was suggested. Furthermore, it was suggested that the government of South Africa must increase awareness about water conservation among the general population. Regular maintenance and refurbishments of the old infrastructure also emerged among the proposed solutions.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The fifth chapter of this study is the concluding chapter of the current study and comprises of the conclusions and suggestions for future research. The main elements of this chapter include the summarised findings from the literature review and the analysed primary data. After the presentation of the summarised findings, this chapter delves into the conclusions and recommendations of the study. The following section provides a recap of the research objectives that guided this research.

5.1.1 Research objectives

5.1.1.1 *Main objective*

The main objective of this study is to provide recommendations for enhancing the rural water supply in the Amathole District Municipality.

5.1.1.2 *Secondary objectives*

- To examine the nature of water management in the rural municipalities of South Africa
- To identify the benefits of water in rural municipalities
- To examine the challenges affecting water supply in South Africa
- To develop strategies for enhancing water operations, maintenance and distribution in rural municipalities.

5.2 FINDINGS FROM THE STUDY

The following section provides the findings from this study, which were separated into two main classes. The below section presents the findings from the literature section, followed by the findings from the primary research.

5.2.1 Findings from the literature

An examination of the literature revealed that the status of the ecological condition of most rivers in South Africa has sharply deteriorated at unprecedented rates (Boshoff, 2017). It was discovered that many rivers have been pushed beyond the point of

recovery and a lot needs to be done to improve the conditions of the rivers. Additionally, it was also found that South Africa has lost huge tracts of wetlands, further depleting the stock of groundwater. With such catastrophic conditions, water-reliant economic activities have been compromised. The literature review also showed that water in South Africa is severely underpriced, compared to other countries in the Southern African Development Community (SADC) region. This makes it difficult for water management bodies to sustainably manage the water supply. The rural parts of South Africa were identified as the areas which were affected the most by the persistent water shortage problems. According to Kouga (2010), in villages where people cannot afford to buy water, they resort to fetching water from rivers, wells and springs, and these sources are not treated and may be harmful to human consumption.

It was explained that water operations and maintenance are required to keep the water treatment and supply system in proper working condition. Importantly, the operations and maintenance activities subdivide into preventive, corrective and crisis maintenance. The preventative typology is imperative and entails checking and servicing system components from time to time. The corrective type of maintenance comprises activities, such as replacing broken and worn-out parts to sustain reliable services. Another typology of maintenance is crisis maintenance, which encompasses unplanned responses to emergency breakdowns and user complaints to restore failed supply.

Challenges, affecting the distribution and supply, were classified into two factors: artificial factors and natural factors. According to the reviewed literature, the following human causes of water scarcity were discussed, namely, the disparity in water supply, illegal tap connections, urbanisation and population growth, contamination of existing water sources and leaking pipes. The following are, in terms of the reviewed literature, the natural causes of water scarcity in most areas, namely, drought, climate change, surface runoff, earthquakes as well as evaporation and transpiration.

It was noted from the literature that water leakage is prevalent in especially old residential places which have pipes that have served for a long time. With regards to the magnitude of the illegal water connection problem, a similar case to 'izinyoka', is experienced, namely, illegal electricity connections that have been a long-term plight

of Eskom in South Africa. Challenges around the high cost of long-distance water conveyance must be discussed inevitably and essentially.

5.2.2 Findings from primary research

The nature and status of water distribution and supply in the ADM area were examined by means of interviews. Participants indicated that the status of water supply and distribution was at very dire levels. From the employees working in the ADM, it emerged that the water supply was constrained by erratic rainfall patterns, contamination of rivers and theft of infrastructure. About the current status of the water situation in South Africa, participants highlighted that too many illegal water connections lead to huge water losses from the main supply system.

An analysis of the interviews with the participants revealed that stakeholders' involvement is crucial in finding solutions to the water problem. The government, households, environmentalists, private companies and non-governmental organisations must partake in the process. From the primary research, it was also discovered that the water supply situation in South Africa is characterised by high water costs and unpaid water bills. It emerged that owing to the scantiness of the water supply, the price per cubic litre is expensive.

Furthermore, the water distribution and supply infrastructure in the ADM has been severely vandalised, especially in the remote parts where there is no security. The vandalism of the water distribution infrastructure is one of the major challenges of the water distribution system. To improve health and sanitation in the ADM, experts cite that an efficient water supply reduces diseases. Communities with inadequate water supply may suffer from malnutrition and may be severely dangerous to children. The scantiness of water adversely affects water recreational activities, such as fishing, boat cruises and other water games.

Another challenge, noted from the primary research, was that the existing water pumps are not powerful enough to consistently force water uphill to homes, located on the highlands. Additionally, the effects of drought and extreme weather patterns cannot be underestimated when examining water supply problems. As part of the solutions, municipalities are recommended to minimise the high dependence on rainfall water supply.

5.3 RECOMMENDATIONS

The below section outlines the recommendations, developed from this study. The recommendations are broadly directed at all the stakeholders in the South African rural water distribution and supply.

5.3.1 Recommendations to the national government of South Africa

- Strict measures must be implemented to control unauthorised water use. The government must amend the laws, punishing criminals who are involved in water equipment and resources.
- While boreholes and the purification of seawater are available options, the South African government needs to explore other supply options. An investment must be made in extensive water-related research.
- The national government must increase the budget, allocated to water distribution and supply in the country. The allocation of sufficient financial resources would implicate the national treasury.
- Unequal distribution of the pipeline system is a notable cause for disparities and shortages in the water supply. The national government of South Africa must devise a grand plan to improve the spread of the pipeline network of water distribution to widen access even to the most remote rural parts of the country.

5.3.2 Recommendations to the Amathole District Municipality

- Water infrastructure, including pipes, reserve tanks and valves that have served for a long period, must be replaced with newer equipment.
- The municipality must lower its high dependence on rainfall water supply and reservoirs must be constructed to harvest much water during the rainy season.
- Water rationing is one of the practical solutions that the municipality must administer properly.
- Skilled municipal employees must do preventive, corrective and crisis maintenance consistently. Old parts of the water distribution infrastructure must be replaced by new parts.
- The municipality must reduce the water tariffs to encourage consumers to settle their accounts thereby increasing revenue collection. Some long-standing debts must be slashed and arrangements must be made for repayment plans.

5.3.3 Recommendations to households

- Households must take a leading role in controlling their use of water resources. Water regulation and supply authorities must punish the wastage of water with severe consequences.
- Households in the Amathole municipality area must comply with water rationing measures, implemented by the authorities.
- General awareness about water conservation must be increased among water users. Households and the community at large must be educated about the dimensions of water scarcity and the necessary preventive measures that are required, including each party's role.
- Households must plant drought-resistant crops in the area to reduce the requirement for irrigation. All farming households in the Amathole district area must avoid crops that require much water.

5.4 CHAPTER SUMMARY

This study sought to provide recommendations for enhancing rural water supply in the Amathole District Municipality. The study took a qualitative research approach, necessitating the use of grounded theory as the research strategy. A sample of employees of the Amathole District Municipality provided the analysed data in this study. Unstructured interviews served as the means through which the study collected the primary data. The literature review showed that most rural parts of South Africa are in dire water crises. Erratic rainfall, global climate change, ageing water distribution infrastructure and illegal water connections are some of the factors, acerbating the crisis. High water costs and low revenue collection of municipalities were also cited among the factors, affecting the continuous supply of the water resource. Among other recommendations, this study challenged the government to amend laws and by-laws, regulating water usage. Municipalities were also challenged to improve the water distribution system by repairing infrastructure. Tighter measures must be taken against illegal water connections and industries must pay huge taxes for polluting open-water sources.

REFERENCES

- Aadnesgaard, V. and Willows, G. (2016) 'Audit outcomes and the level of service delivery within local government municipalities in South Africa', *Corporate Ownership and Control*, 13(2CONT3), pp. 546–552. doi: 10.22495/cocv13i2c3p5.
- Abaqulusi (2017) *Cost Containment Policy*. Pretoria. Available at: [https://www.google.com/search?sxsrf=ALeKk00IRw0bWVRCiKvKQVu47NrrsvTG6g%3A1627212379835&lei=W0r9YLi-Mo2k1fAPxNo-&q=www abaqulusi municipality gov za&ved=2ahUKEwj41_6-jv7xAhUNUHUIHUSStDwAQsKwBKAB6BAglEAE](https://www.google.com/search?sxsrf=ALeKk00IRw0bWVRCiKvKQVu47NrrsvTG6g%3A1627212379835&lei=W0r9YLi-Mo2k1fAPxNo-&q=www+abaqulusi+municipality+gov+za&ved=2ahUKEwj41_6-jv7xAhUNUHUIHUSStDwAQsKwBKAB6BAglEAE).
- BCG (2017) *Scenarios for the Future of Water in South Africa*. Pretoria.
- Berndt, A. and Petzer, D. (2011) *Marketing Research*. 1st edn. Cape Town: Pearson.
- Bitou, M. (2017) 'Asset Management Policy'.
- Boshoff, C. (2012) 'Can firms overdo service recovery? An assesment of non-linearity in service recovery satisfaction', *South African Journal of Business management*, 43(3), pp. 1–12.
- Boshoff, L. (2017) 'Municipal infrastructure care in South Africa', (August), pp. 1–10.
- Bradley, N. (2013) *Marketing Research tools and techniques*. Third edit. Oxford: Oxford University Press.
- Brouwer, R., Cairncross, S., & Brauer, M. (2019). Water, sanitation and hygiene interventions to combat childhood diarrhoea in developing countries. *Bulletin of the World Health Organization*, 97(3), 245-254.
- Burns, alvin, C. and Bush, Ronald, F. (2014) *Marketing research*. Internatio. Edited by S. Wall. Essex: Pearson Education.
- Chetty, L. *et al.* (2016) 'Infrastructure Delivery Management Toolkit'. Durban: Ethekwini Municipality.

Creswell, J. W. (2013) 'Qualitative, quantitative, and mixed methods approaches', in *Research design*. 2nd edn. Sage publications, pp. 1–26. doi: 10.2307/3152153.

CWD (2015) 'Cape Town wetland maintenance and management policy'. Cape Town: Cape Town Municipality.

DBSA (2010) 'Training for Township Renewal Initiative', (March).

De Visser, J. (2010) 'The Political-administrative interface in South African municipalities: Assessing the quality of local democracies', *Commonwealth Journal of Local Governance*, pp. 86–101. doi: 10.5130/cjlg.v0i5.1473.

Donnenfeld, Z., Crookes, C. and Hedden, S. (2018) *A delicate balance Water scarcity in South Africa*. Denver.

Dube, T., Mlenga, H., & Zungu, L. (2017). Challenges facing rural communities in accessing safe drinking water: The case of Amathole District Municipality, South Africa. *Water SA*, 43(1), 53-59.

ECSEC (2017) *Amathole District Municipality Socio - Economic Review*. East London.

Erasmus, J. (2020) *Corruption in South Africa's water sector*. Berlin. Available at: Water Integrity Network.

European-Commission (2018) *2018 – Drought and Water Crisis in Southern Africa*. Luembourg. doi: 10.2760/81873.

Kiparsky, M. *et al.* (2017) 'The importance of institutional design for distributed local-level governance of groundwater: The case of California's sustainable groundwater Management Act', *Water (Switzerland)*, 9(10), pp. 1–17. doi: 10.3390/w9100755.

Kokos, A. (2018) 'Policy Analysis of the Water Crisis in Cape Town, South Africa', 18(2).

- Kouga (2010) 'Development of Waterworks and Terms of Reference Notice 194 / 2010 Contract No : Scm3TECH'. Limpopo: Kouga Municipality, pp. 1–7.
- Machethe, E. (2011) *The causes and impact of water shortage on the households of Ga-Kgapane Township in the Limpopo Province*. Faculty of Law at the School of Economics & Management & TGSL. University of Limpopo.
- Maholtra, K. (2012) *Basic Marketing Research*. Fourth edi. Hagerstown: Prentice Hall.
- Makale, T. (2015) *Service Delivery in South African Rural Municipalities*. Faculty of Arts, at the Department of Geography and Environmental Studies. Stellenbosch University.
- Makhari, C. L. (2016) *Assessment of Water Service Delivery in the Municipalities of City of Tshwane, City of Cape Town and Ethekewini*. Faculty of Natural Sciences, at Department of Earth Science at University of Western Cape.
- Mokgobu, M, L. (2017) *Challenges of the Repairs and Maintenance of Water Infrastructure in Aganang Municipality in the Province of Limpopo*. Durban University of Technology.
- Muinamia, E, V. (2015) *Comparative study of Urban and Rural operations and maintenance practices of water distribution systems*. Cape Town.
- Muthwa, E. X. (2016) *Community perception of service delivery*. University of KZN.
- Ndevu, Z. and Muller, K. (2017) 'A conceptual framework for improving service delivery at local government in South Africa', *African Journal of Public Affairs*, 9(7), pp. 13–24.
- Novienyo, L. and Amoah, A. (2021) 'Water Scarcity and Food Security in Ngqeleni Locality in the Eastern Cape Province- South Africa', *African Journal of Hospitality, Tourism and Leisure*, 10(1), pp. 40–53.
- Rodina, L. (2019) 'Water resilience lessons from Cape Town ' s water crisis', *Wiley Water*, 2(July), pp. 1–7. doi: 10.1002/wat2.1376.

- SALGA (2017) *SALGA: Strategic & Annual Performance Plan*. Capetown.
- Saunders, M., Lewis, P. and Thornhill, A. (2009) *Research Methods for Business Students(5th ed)*, *Research methods for business students*. Pearson Educationl.
- Shiu, E. *et al.* (2009) *Marketing Research*. New York: MacGraw-Hill.
- Swartz, C. (2009) *Guidelines for the Sustainable Operation and Maintenance of Small Water Treatment Plants Operation and Maintenance of*. Cape Town.
- Tarr, P. T., Jacobs, S. M., Venter, F. J., & Steenkamp, K. (2015). Climate change impacts on water resources in the Amathole District Municipality, South Africa. *Water SA*, 41(1), 58-67.
- UNCTAD (2020) *Impact of the COVID-19 pandemic on trade and development*, *United Nations*.
- Unicef (2021) *Urban water scarcity guidance note*. Pretoria.
- United-Nations (2020) *Water in the green economy in practice*. AKRA.
- van der Merwe, M. R., Momba, M. N. B., & Korsten, L. (2016). Microbial quality of various water sources in rural areas of the Eastern Cape Province, South Africa, with special reference to diarrhoeagenic *Escherichia coli*. *Journal of Water and Health*, 14(3), 466-476.
- Viljoen, G. and Walt, K. Van Der (2019) 'South Africa's water crisis - An interdisciplinary approach', *Journal of water and agriculture*, 3(September 2018), pp. 2–19. doi: 10.17159/2224-7912/2018/v58n3a3.
- Wiid, J. and Diggines, C. (2013) *Marketing Research*. Second Edi. Edited by W. Prillaid. Cape Town: Juta.
- Zhuwakinyu, M. (2017) *A review of South Africa's water sector*. Johannesburg.
- Zikmund, W. and Babin, B. (2010) *Essentials of marketing research*. 9th edn. South Western: Cengage.

Annexure A: Ethics Clearance Approval



PO Box 77000, Nelson Mandela University, Port Elizabeth, 6031, South Africa | mandela.ac.za

Chairperson: Faculty Research Ethics Committee (Human)
Tel: +27 (0)41 504 2906

Ref: [H21-BES-BUS-139] / Approval]

15 November 2021

Prof C Arnolds
Department: Graduate School

Dear Prof Arnolds,

TITLE OF STUDY: RELIABILITY OF RUAL WATER SUPPLY ATTRIBUTED TO OPERATION AND MAINTENANCE AT AMATHOLE DISTRICT MUNICIPALITY (MASTERS) (H21-BES-BUS-139)

PRP: Prof C Arnolds
PI: K Clock

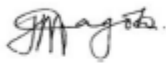
Your above-entitled application served at the *Faculty Ethics Committee of the Faculty of Business and Economic Science, (25 June 2021)* for approval. The study is classified as a negligible/low risk study. The ethics clearance reference number is **H21-BES-BUS-139** and approval is subject to the following conditions:

1. The immediate completion and return of the attached acknowledgement to Lindie@mandela.ac.za, the date of receipt of such returned acknowledgement determining the final date of approval for the study where after data collection may commence.
2. Approval for data collection is for 1 calendar year from date of receipt of above mentioned acknowledgement.
3. The submission of an annual progress report by the PRP on the data collection activities of the study (form RECH-004 to be made available shortly on Research Ethics Committee (Human) portal) by 15 December this year for studies approved/extended in the period October of the previous year up to and including September of this year, or 15 November next year for studies approved/extended after September this year.
4. In the event of a requirement to extend the period of data collection (i.e. for a period in excess of 1 calendar year from date of approval), completion of an extension request is required (form RECH-005 to be made available shortly on Research Ethics Committee (Human) portal)
5. In the event of any changes made to the study (excluding extension of the study), completion of an amendments form is required (form RECH-006 to be made available shortly on Research Ethics Committee (Human) portal).
6. **In the event of any changes made to the study (excluding extension of the study), RECH will have to approve such amendments and completion of an amendments form is required PRIOR to implementation (form RECH-006 available on Research Ethics Committee (Human) portal).**
7. Immediate submission (and possible discontinuation of the study in the case of serious events) of the relevant report to RECH (form RECH-007 to be made available shortly on Research Ethics Committee (Human) portal) in the event of any unanticipated problems, serious incidents or adverse events observed during the course of the study.
8. Immediate submission of a Study Termination Report to RECH (form RECH-008 to be made available shortly on Research Ethics Committee (Human) portal) upon unexpected closure/termination of study.
9. Immediate submission of a Study Exception Report of RECH (form RECH-009 to be made available shortly on Research Ethics Committee (Human) portal) in the event of any study deviations, violations and/or exceptions.
10. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of Research Ethics Committee (Human)

Please quote the ethics clearance reference number in all correspondence and enquiries related to the study. For speedy processing of email queries (to be directed to Lindie@mandela.ac.za), it is recommended that the ethics clearance reference number together with an indication of the query appear in the subject line of the email.

We wish you well with the study.

Yours sincerely

A handwritten signature in black ink, appearing to read 'S Mago', enclosed within a thin black rectangular border.

Prof S Mago

Cc: Department of Research Capacity Development
Faculty Research Co-ordinator: Lindie van Rensburg

ACKNOWLEDGEMENT OF CONDITIONS FOR ETHICS APPROVAL
--

I, Prof C Arnolds (PRP) of the study **RELIABILITY OF RUAL WATER SUPPLY ATTRIBUTED TO OPERATION AND MAINTENANCE AT AMATHOLE DISTRICT MUNICIPALITY (MASTERS) (H21-BES-BUS-139)** do hereby agree to the following approval conditions:

1. The submission of an annual progress report by myself on the data collection activities of the study by 15 December this year for studies approved in the period October of the previous year up to and including September of this year, or 15 December next year for studies approved after September this year. It is noted that there will be no call for the submission thereof. The onus for submission of the annual report by the stipulated date rests on myself.
2. Submission of the relevant request to Faculty RECH in the event of any amendments to the study for approval by Faculty RECH prior to any partial or full implementation thereof.
3. Submission of the relevant request to Faculty RECH in the event of any extension to the study for approval by Faculty RECH prior to the implementation thereof.
4. Immediate submission of the relevant report to Faculty RECH in the event of any unanticipated problems, serious incidents or adverse events.
5. Immediate discontinuation of the study in the event of any serious unanticipated problems, serious incidents or serious adverse events.
6. Immediate submission of the relevant report to Faculty RECH in the event of the unexpected closure/discontinuation of the study (for example, de-registration of the PI).
7. Immediate submission of the relevant report to Faculty RECH in the event of study deviations, violations and/or exceptions.
8. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of Faculty RECH.

Signed: _____


C. A. Arnolds

Date: 13 September 2021

Annexure B: Covering letter to respondents



August 2021

Dear Respondent

I am conducting research with the main objective of examining the reliability of rural water supply attributed to Operation and Maintenance at Amathole District Municipality. I am conducting my research under the supervision of Mohamed Saheed Bayat. Your participation in this study will assist in gaining a better understanding of operations and maintenance of Amathole District Municipality water schemes.

The completion of the attached questionnaire will take no more than 30 minutes of your time; the questions are to the point and concise and require you to provide information that is brief enough to fully answer the questions in a satisfactory manner. Participation in this study is voluntary and confidentiality will be maintained; you are not required to provide any of your identifiable information. The questionnaires will be emailed back to the researcher after completion. The PI is the only individual that will have access to the email addresses of the participants and will strictly not share the information with any other unauthorized party.

The results of this study will be submitted to the Nelson Mandela Metropolitan University in partial fulfillment of a Master's degree in Business Administration (MBA). Additionally, it will be available for public purposes in the university library.

Your opinion is considered valuable and I appreciate you taking time to express your opinion on this topic.

Thank you for your participation.

Kulile Clock (083 795 3507)

MBA Student - Nelson Mandela University

For authentication matters, contact my supervisor on email address: mbmsaheed@gmail.com

Annexure C: Questionnaire



RESEARCH QUESTIONNAIRE

SECTION A: BIOGRAPHICAL INFORMATION OF RESPONDENTS

Please answer the following questions by putting a cross [X] next to your answer and/or by writing down the answer in the space provided.

SECTION A: DEMOGRAPHIC INFORMATION

PLEASE INDICATE WITH A TICK IN THE APPROPRIATE BOX

Gender:	
Male	
Female	

Age:			
18 – 25	26 – 40	41 – 55	56 and Above

Number of working years			
0 – 5	6 – 10	11 – 15	15 + years

SECTION B: COMPONENTS OF RURAL WATER OPERATIONS AND DISTRIBUTION

1. In your own view and understanding, what are the main components of a water maintenance and distribution system?

2. What roles do the existing legislation and government policies play in water supply in municipalities ?

3. What is the status of water supply in rural municipalities?

SECTION C: BENEFITS OF EFFICIENT RURAL WATER SUPPLY

4. State any ways in which water supply is essential for the health and cleanliness of the rural communities.

5. Stakeholders exert considerable influence on municipalities. Which stakeholder is in a position to benefit the most from improved rural water supply?

Households	X
Businesses	X
Government	X

6. How is sustainable water supply important to farmers and the achievement of food security ?

SECTION D: OPERATIONS & MAINTENANCE CHALLENGES AFFECTING RELIABLE WATER SUPPLY

7. In your own view, what are the major challenges surrounding the supply of water in South Africa?

8. Highlight any artificial or human factors inhibiting continuous water supply in rural municipalities.

9. In your own view, what natural factors make it difficult for municipalities to supply enough water to households?

**SECTION E: STRATEGIES FOR IMPROVING WATER OPERATIONS,
MAINTENANCE AND DISTRIBUTION**

10. In what ways can technology be used in order to improve water distribution and conservation?

Factors needing attention for water supply improvement

Municipal water management policy

Household water usage control

Water distribution infrastructure

11. For the factors indicated above, what kind of change would you desire to be made?

12. Provide any other general comment on ways of conserving the water resource.

RESPONDENTS INFORMED CONSENT:

I hereby agree to participate in research examining the water maintenance and distribution for the Amatole District Municipality.

I understand that I am participating freely and without being forced in any way to do so. I also understand that I can stop this interview at any point should I not want to continue and that this decision will not in any way affect me negatively.

I understand that this is a research project whose purpose is not necessarily to benefit me personally. I have received the contact details of a person to contact should I need to speak about any issues which may arise in this interview.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential. I also understand that if at all possible, feedback will be given to me if I so wish once the research is complete.

.....

Signature of respondent

.....

Date:

Thank You!!!!!!

Annexure D: Turnitin Results

The screenshot shows a web browser window displaying a Turnitin submission page. The browser's address bar shows the URL: `incoko.mandela.ac.za/mod/turnitintooltwo/view.php?id=35708#`. The page header includes the logo for 'iNGOKO' and the text 'MBR5TR: Business Research Project'. The navigation menu includes 'Home', 'Dashboard', 'Events', 'My Courses', 'This course', and 'Course search'. The breadcrumb trail indicates the user is in 'My courses > Academic Degree Programme > MBA > MBA Year 2 > MBR5TR-2022 > Turnitin > MBA Treatise Submission'. The main content area is titled 'My Submissions' and shows a table for 'Part 1'.

Title	Start Date	Due Date	Post Date	Marks Available
MBA Treatise Submission - Part 1	2 Jan 2021 - 13:12	31 Dec 2022 - 13:12	1 Dec 2022 - 13:12	100

Below the table, there is a 'Refresh Submissions' button. A detailed submission entry is shown below:

Submission Title	Turnitin Paper ID	Submitted	Similarity	Grade
View Digital Receipt K.Clock Reaserch	1539578641	20/08/22, 13:13	20%	N/A

The bottom of the screenshot shows the Windows taskbar with the search bar, taskbar icons, and system tray showing the time as 20:34 on 2022/08/20.

Annexure E: Technical Editing Letter



18 Woltemade Street
Kabega Park
Port Elizabeth
6045

TO WHOM IT MAY CONCERN

I, Wynand Steenberg, declare that I have done the technical editing for the treatise of **KULILE CLOCK** (223513237)

entitled:

**Reliability of rural water supply attributed to
water operations and maintenance in the
Amathole District Municipality.
Reliability of Water Supply
Water Distribution System
Water Operations and Maintenance**

Submitted in partial fulfilment of the requirements for the degree Master of Business Administration (MBA) in the Faculty of Business and Economic Sciences at the at the Nelson Mandela Business School.

Any other queries related to the technical editing of this treatise can be directed to me at 076 481 8341

Signed at Port Elizabeth on 25August 2022.

.....
Wynand. Steenberg
060 520 1047

Annexure F: Proofreading Certificate



Proofreading Certificate

It is hereby certified that this treatise has been proofread and edited for spelling, grammar and punctuation by a professional English language editor from www.OneStopSolution.co.za

Client

KULILE CLOCK

RELIABILITY OF RURAL WATER SUPPLY ATTRIBUTED
TO WATER OPERATIONS AND MAINTENANCE IN THE
AMATHOLE DISTRICT MUNICIPALITY
RELIABILITY OF WATER SUPPLY
WATER DISTRIBUTION SYSTEM
WATER OPERATIONS AND MAINTENANCE

Editor

S Mac Lachlan

Name

Signature

14 October 2022

Date

I cannot guarantee that the changes that I have suggested have been implemented nor do I take responsibility for any other changes or additions that may have been made subsequently. The track changes of the language editing will be available for inspection upon enquiry, for a period of one year.

Contact

One Stop Solution
18 Woltemade str
Kabega Park
Port Elizabeth
6045

Redène Steenberg
076 481 8341
www.OneStopSolution.co.za