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**Discipline of Marketing and Supply Chain Management
Westville Campus**

**Assessing water management practices within the KwaZulu-Natal region:
A case study of eThekweni Municipality**

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Abstract

Our primary source of supply of water is through rainfall. It can be simply said that water is stored in dams, purified, and released at a cost to the public. Municipalities purchase water from their suppliers, and in the case of eThekweni, from Umgeni Water.

Rainfall patterns have changed over a period and we are experiencing the effects of El Nino, a phenomenon that warms the Pacific Ocean and leads to drought in the southern hemisphere. The climate change scenario means lower and erratic rainfall and reduced water supply. The country will get drier, supply will be reduced while at the same time population increases, and economic and other activities create a huge water demand.

Failure to supply water and failure to develop effective and adequate mitigating strategies carry grave human costs in the modern era. Economic losses due to water shortages are immense, impacting food supply, manufacturing, tourism, and other activities. The social cost includes a negative impact on the wealth of people and increasing the gap in living standards in society. The current water crisis affects millions.

One of the main objectives of this study was to investigate the accessibility of water supply to consumers within the eThekweni Municipality region. The focus is on investigating the challenges experienced when trying to access water during erratic rainfall patterns. The rationale for conducting this study is therefore to help familiarise citizens of KwaZulu-Natal (KZN) with the various restrictions and remedies that can help them conserve and utilise water more effectively and efficiently. This study emphasised the importance, causes, impacts, and current quality management system used for the limited water supply that is affecting not only the KZN province but South Africa.

The study utilised an exploratory case study method to assess the water management practices within KwaZulu- Natal. A qualitative research approach was used which provided more value when determining the critical issues experienced during the supply of water. The research study was conducted in KwaZulu-Natal at the eThekweni Municipality Water and Sanitation Department. Purposive sampling was employed, with the sample size consisting of nine participants. Face-to-face, semi-structured interviews were used as a data collection tool. NVivo 12 was employed as the software tool for thematic analysis for this qualitative study.

This research study contributed to the creation of knowledge on a new implementation of a quality management system and how ISO 9001 can be used to ensure effective and efficient

quality by implementing new practices that will ensure continuous improvement.

Findings revealed that water accessibility is seen as a continuous water supply despite the implementation of water restrictions. It was noted that the current water scarcity situation has had an impact on the current water supply and dam levels. Findings also indicated that the eThekweni Municipality and Umgeni Reservoir had a very strong and healthy business relationship and that Umgeni Reservoir was supplying approximately 790MR litres of water daily. The SCADA system was the only criterion that could be used in the implementation of water restrictions. Water management practices were effectively managed in high consumption areas such as Umlazi and Tongaat. There was no actual quality management system in place and the eThekweni Municipality water and sanitation department were using various measures to meet the required quality standards. SANS241 and aggressive awareness programs were suggested to assist sensitive consumers. Revenue leakages were identified within the water supply system and recommendation for smart water metering was suggested for better reading, identifying water flow interruptions and illegal connections.

Key concepts: Water supply accessibility, water restrictions, quality management system, water shortage, water loss, water detection method.

Declaration

I, Alexander Samuels declare that

(i) The research reported in this dissertation/thesis, except where otherwise indicated, is my original research.

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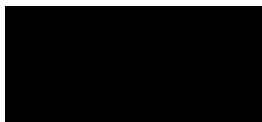
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Alexander Samuels



Date: 2 March 2020

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Abbreviations

CBD	Central Business Direct
EMA	eThekwin Municipality Area
EMWS	eThekwin Municipality Water and Sanitation
KZN	KwaZulu-Natal
QDA	Qualitative Data Analysis
QMS	Quality Management System
SA	South Africa
SCM	Supply Chain Management
SLA	Service Level Agreement
UKZN	University of KwaZulu-Natal
US	United States
WSA	Water Service Authority
WSP	Water Service Provider

Chapter One

Introduction

1.1 Introduction

Water is becoming a scarce commodity in South Africa. Statistical data confirms the effect of climate change and the increase in erratic rainfall patterns. Blignaut (2009) asserts that, major drought conditions are only one of the contributory factors leading to a shortage in the water supply. The other major concerning issue is the quality of the maintenance of the infrastructure that carries the water supply. The loss of water through leakage and burst pipes is identified as a major critical issue in South Africa (Schulze, 2014).

South Africa has for many years managed its water management practices in a very effective and efficient manner. The infrequent requirement for imposed water restrictions by eThekweni Municipality has become an important element by strategic users in the major systems of the country, despite the contributory factors of a semi-arid climate. In addition, the department of water and sanitation at the eThekweni Municipality has always placed future water resource management planning as a priority on the management function list (Sinha and Itumeleng, 2011). This allowed the Municipality to have sufficient time to prepare and strategise and construct new schemes to ensure minimum disruptions with major users.

In South Africa, there are many challenges relating to water management practices, hence inadequate rainfall may contribute to the mismanagement eThekweni's Municipality water practices. Some of the major challenges experienced by the eThekweni Municipality Water and Sanitation department are limited physical resources; scarcity of rain, rapid population growth, and stagnating economy (Sunderland, 2014). Water management practices are crucial for human security as almost everyone is affected by the mismanagement of the water resource in South Africa. Thus, citizens in poor communities are the most affected as they live in areas that do not have access to potable water and proper sanitation (Health, Parker and Weatherhead, 2010). The main objective of this study is to assess the water management practices within the KwaZulu- Natal region, which will assess the concerning factors such as water shortage; water loss and their contributory impacts on water management practices.

This chapter will provide a brief background to the problem of water management practices within the eThekweni Municipality and will highlight the research methodology for this study.

1.2 Background

With the recent water crisis in Cape Town, the issue of water management has become a topical and relevant area of research. According to eThekweni Municipality (2018), in July 2017 Cape Town's dam levels were just over 26%, requiring water management solutions to be implemented to conserve the remaining water in dams.

Generally in South Africa, the shortage of water supply has been attributed to the lack of rainfall; however, there are additional contributory factors aspects such as high population consumption and water demand growth, unreported agricultural use, invasive species sucking water out of catchments, poor planning and mismanagement of the water supply system, and lack of foresight in development of new water sources (Wolski, 2018).

Water is a necessity that must be provided to all South African citizens, as premised in Section 27(1)(b) of the Constitution of the Republic of South Africa. The right of access to sufficient water in Section s27(2) should be understood that government is not obliged to provide water freely to South African citizens, businesses, households, but is under the obligation to create technological mechanisms that will enable citizens to have access to water supply (Health, Parker and Weatherhead, 2010).

The primary source of water supply is through rainfall (Movik, 2012). Water is stored in dams, put through a purification process, and then released to the public at cost. The Municipality purchases its water from reliable suppliers. Umgeni Water is the main water supplier to the eThekweni Municipality and ensures that rainwater is purified and meets the required safety and quality standards. In this study, the eThekweni Municipality will be discussed, with specific reference to the Water Department and their current water management practices.

1.3 Research Statement

In South Africa, rainfall has become a growing concern to both water suppliers and consumers, like municipalities (Taylor et al, 2014). Rainfall patterns have changed over the years and businesses and households are experiencing the effects of El Nino (Filho, 2017), a phenomenon that warms the ocean with the warm current in the Pacific Ocean and leads to increasing drought in the southern hemisphere. The effects of this climate change are lower and erratic rainfall and reduced water supply.

Stewart and Howell (2003), As the concern over rainfall increases, the country will become drier and the supply of water will be reduced. Meanwhile, the population increases together

with economic and other activities that increase the water demand.

South African citizens are already using the term “crisis” when addressing the issue of water supply (Viljoen, 2018). South Africa has become the 30th driest country in the world and is now classified as semi-arid, even though it is in the sub-tropic region. In the eThekweni region, dam levels are 20% lower than at the start of 2010, according to the eThekweni Municipality (2018). These statistics indicate that even in a good year of rainfall, water resources to households and businesses will still be restricted (Stewart and Howell, 2003).

Water security has been a major concern on the agenda for many years, but the recent extended drought period in South Africa has affected many provinces, making it a number one priority. Water loss becomes inevitable and replenishes over time, however, water needs to be managed more effectively and efficiently as rainfall patterns become more intermittent (White, 2012).

Although water replenishes it will over time become a scarce and crucial natural resource and this will impact on the water management practices, particularly for South African citizens, animals, agriculture (plantation), and industries as water is a major contributing factor for both survival and manufacturing purposes (eThekweni Municipality, 2018)

In South Africa, the eThekweni Municipality in KZN is no exception, as many households and businesses do not receive a regular continuous supply of water, resulting in poor water management practices (eThekweni Municipality, 2018). Section 27(1)(b) of the Constitution of the Republic of South Africa of 1996 states that “everyone has the right to have access to sufficient water”. Viljoen (2018) states that scarcity of water becomes an increasing problem and continues to escalate at an alarming rate as the supply of water to households and industries are restricted due to poor management of water practices and ineffective service delivery.

The study aimed to investigate the problem of water shortage and water loss and the impact on the water management practices within the eThekweni region, as measures to address water shortages in eThekweni are currently unknown. The researcher investigated the assessment of the current water management practices within the KwaZulu-Natal region and suggested tailor-made solutions as recommendations to improve the efficiency and effectiveness of the quality water management system.

1.4 Research Objectives

1. To explore the accessibility of water supply to consumers within the eThekweni region.
2. To explore the relationship between the supply of water and water restrictions within eThekweni Municipality.
3. To examine the amount of rainfall and water supplied to the eThekweni Municipality.
4. To evaluate the Quality Management System (QMS) on water management practices at eThekweni Municipality.
5. To provide recommendations for a more suitable water detection method which will reduce existing water loss.

1.5 Research Questions

1. How accessible is the water supply to consumers in the eThekweni region?
2. What is the relationship between the water supply and water restrictions within eThekweni Municipality?
3. What control measures are being put into place to monitor the amount of rainfall and water supplied to eThekweni Municipality?
4. How can the current Quality Management System on water management practices at the eThekweni Municipality be improved?
5. How effective is the current water management system on reducing water loss at the eThekweni Municipality?

1.6 Preliminary literature review

According to Majumder (2015: 1), water shortage can be defined as “the lack of sufficient water resources that is available to meet water needs within a region”. One of the objectives of this study was to investigate the problem of water shortages and water loss and the impact on water management practices within the eThekweni region, as measures to address water shortage in eThekweni are currently unknown. The focus was to investigate the current water management practices and the challenges experienced when trying to access water during erratic rainfall patterns. This study emphasised the importance, causes, impacts, imposed water restrictions, and the limited water supply that is affecting not only the KZN province but South Africa.

The eThekweni Municipality is addressing the water shortage by imposing restrictions on supply and increasing tariffs. These are short-term measures or stop-gap solutions. There are other external factors that water suppliers and the Municipality do not have under their direct control, such as the control of rainfall (eThekweni Municipality, 2016).

Considerable preventative measures are being undertaken such as building new dams or expanding existing dams and increasing the height of the current dam walls (eThekweni, 2018). This study provides recommendations to the eThekweni Municipality based on a newly developed water quality management system that will assist with the effectiveness and efficiency of the water management practices employed.

The shortage of water can be attributed to a reduced supply due to lower rainfall, loss of water through undetected leaks in pipes, and opportunistic use. According to the eThekweni region (2017), 35% of the city’s water is either stolen or lost through illegal connections. eThekweni Municipality statistics estimate that Durban is losing nearly R600m annually through water loss attributed to leaks and stolen water (Municipality, 2018). This is one of the factors affecting the shortage of water and the water supply to both businesses and households.

The reason for the selection of this topic is that water is becoming a scarce commodity in South Africa (Taylor et al, 2014). The effect of climate change is evident in erratic rainfall patterns as South Africa experienced drought conditions in the past decade in specific provinces. Measurements have shown that rainfall was below average and therefore, this has resulted in prolonged water shortages (Municipality, 2018).

The preliminary literature search was conducted using conventional content analysis. Themes were developed and research was based on categories and sub-categories. The research was conducted at the eThekweni Municipality and the University of KwaZulu-Natal’s libraries.

Various online resources were used namely, municipalities' websites, summit portfolios, and Google scholar. Keywords under respective categories were used to search for relevant literature and construct a preliminary concept matrix using the required guidelines such as the authority of the author, objectivity of the work, coverage of the work, and the currency of the published work (Bryman and Bell, 2015).

Due to the ongoing drought in South Africa, the eThekweni Municipality has implemented measures to limit the supply of potable water to all areas to prolong the available storage for as long as possible. To stabilize the water and ensure that the EMWS supply system able to function, the City is currently installing restrictors. This measure impacts on the reduction of water flow and pressure and implementing planned water shuts to all areas within the eThekweni region. The frequent draining and filling of the water supply system have resulted in prolonged interruptions to customers, mainly in higher-end areas. Through these prolonged interruptions, repeated burst pipes have been detected from the water mains. These interim interventions will assist in stabilizing the water supply system from the eThekweni Municipality and control the outflow from the reservoirs. The EMWS intention is to provide citizens with an uninterrupted supply of water once the desired saving of 5% is achieved.

In 2018 restrictions were placed on water usage due to the lack of water supply and possible water loss. The recent water restrictions that were imposed by the eThekweni Municipality has affected households, businesses, farming, agriculture, sanitation facilities, and healthcare

The literature review discusses factors of water loss and shortages and their impact on the current water management practices within the eThekweni Municipality region. A comparison to the United States of America made. This study attempted to show the link between a water quality management system and the current water management practices. Chapter two provides a discussion on these elements.

Figure 1 was developed by the researcher and the factors were drawn from literature review of the study. This model addressed the factors affecting the water management practices.

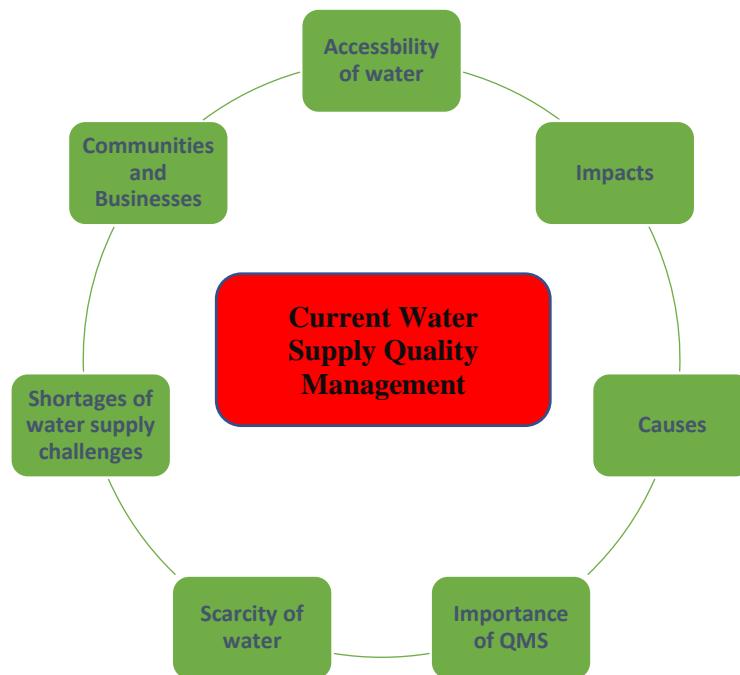


Figure 1: Factors affecting the Current Practices of Water Management.

Source: Author's construction

1.7 Aim of this study

The study investigated the water management practices within the KwaZulu- Natal Region. The researcher investigated the assessment of the current water management practices and addressed the concerning factors such as water shortage; water loss and their contributory impact on water management practices. Recommendations were provided to improve the efficiency and effectiveness of the water quality management system at the eThekwin Municipality.

1.8 Contribution of the Study

The study will contribute to, and target, the eThekwin Water and Sanitation Department in KwaZulu-Natal. It aims to contribute to the organization under study, providing possible findings and suggesting a long-term solution to ensure the efficiency and effectiveness of a

water quality management system at the eThekweni Municipality. This study will also benefit other municipalities by identifying ways to become more effective and efficient as a service provider as this natural resource is becoming a scarce commodity. Municipalities need to ensure that the environment benefits and becomes safer and healthier for consumers and communities.

1.9 Research Methodology

According to Saunders, Lewis, and Thornhill (2019), research methodology can be defined as methods of collecting, organising, and analysing data. The methodology is a framework of theories and principles upon which methods are based (Leedy and Ormrod, 2015). Sekaran (2016) defines research as a process of studying and analysing methods as a situational factor to find a solution to a research problem. Cairney and St Denney (2014) define the concept of research methodology as methods, research techniques, and required research procedures that can be used in the process of implementation of a research design. This study is based on a Water Supply Quality Management System while the impacts and causes of the existing water supply shortage and evaluation of the current water management practices will be investigated.

1.10 Research Design

The nature of this study led the researcher to an exploratory case study design. Sekaran (2016) defines a research design as the implementation of structures within a study. Qualitative and quantitative research methodologies can comprise three extensive classifications: descriptive, exploratory, and causal research designs.

Burns and Grove (2011) define exploratory research design as research conducted to attain new insights, ascertain innovative ideas, and increase the knowledge of a phenomenon. This approach enables researchers to enter the study field and collect data using observation, focus groups, and interviews.

The focal intention of the exploratory research is to determine the restriction of water supply within the eThekweni region. Therefore, the focus of exploratory research should address the problems, opportunities, or situations that are most probable to reside and to determine the key salient factors or variables that will be contributory factors and be relevant to the study (Van Wyk, 2013).

1.11 Research Approach

The main research approaches consist of qualitative and quantitative approaches (Creswell, 2014). Qualitative research refers to holistic, subjective methods that can be used to analyse, understand, and develop a theory (Leedy and Ormrod, 2015). The qualitative approach is associated with language, words, and past experiences as opposed to numbers, statistics, and measurements (Marshall and Rossman, 2011). This research approach can be described as dynamic and developmental (Leedy and Ormrod, 2015). It consists of narrative information that has been identified, collected, and analysed appropriately.

It has been determined that the most appropriate research paradigm for this study was qualitative research, as it will probe into deeper areas, while quantitative research methods may be too superficial (Hair, Celsi, Ortinau, and Bush, 2013). Hair et al. (2013) indicate the importance of using specific approaches to conduct deep research into certain areas. This is in line with this study which requires a thorough investigation into the causes and impacts of the scarcity of water.

1.12 Research Instrument

Research instruments for data collection include interviews, observations, surveys, questionnaires, and physical measurements (Edmonds and Kennedy, 2013). Interviews can be structured interviews, semi-structured interviews, and focus group interviews. Interviews are used and developed according to the research questions of this study. The face-to-face interview method was more suitable for this type of study, as it will be two-way communication between the researcher and the selected participant, where the information is presented to the researcher (Hair et al., 2015). Interviews will help to achieve a wide range of coverage and this will also add to the validity and reliability of the data (Sekaran and Bougie, 2013).

Face-to-face or direct interviews allow the researcher to adapt the questions were necessary. This assists the researcher by clarifying doubts and ensuring that responses are clearly understood. It enables the researcher to repeat or rephrase the questions to achieve a desired rich response. The researcher can observe nonverbal cues from the participants. Any discomfort, problems, or stress can be identified through facial expressions, nervous tapping,

and another body language that can be unconsciously exhibited by the interviewee (Sekaran et al, 2016).

When undertaking an exploratory study, it is more likely that the researcher would include in-depth or semi-structured interviews in their design. Similarly, the purpose of using an exploratory study is to use interviews which will help the researcher identify infer causal relationships between variables (Ghauri and Gronhang, 2011). Therefore, it was important for the researcher to understand the reasons for the selection of participants, the decisions made, and to understand the participant's opinions and attitudes. (Saunders et al., 2019).

Semi-structured and in-depth interviews allow the researcher the opportunity to probe a response, where the researcher wanted the participant to explain, elaborate, or build further on based upon their previous response. This became important as the researcher adopted an interpretivist philosophy, as the interviewer became concerned to understand the meaning of his participants and how they ascribed to the different types of phenomena (Saunders et al., 2019).

Therefore, face-to-face semi-structured interviews were the most appropriate research instrument for this study and were used during the data collection, as this study called for an exploratory case study approach. To be precise, this type of study required semi-structured interviews and achieve comprehensive research that provided a deeper understanding of how the Municipality assesses their water management practices when relating to the challenges of water supply and water shortage.

1.13 Study Site

eThekwini Water and Sanitation is a unit of the eThekwini Municipality and is responsible for the provision of water and sanitation services to all customers with the Municipality. The study site refers to the location where the study will be conducted. The study site for this research was the eThekwini Municipality Water and Sanitation Department in Durban, KwaZulu-Natal, 3 Prior Road, Durban. The study site was selected due to the implementation of its water management practices as well as the ease of access to information.

1.14 Sampling Procedure

In this study, the sample population that will be interviewed are managers and senior managers from the department who make strategic decisions for the city. These senior managers are from

the eThekwin Municipality Water and Sanitation Unit in KwaZulu-Natal. The target population and the sampling techniques are discussed in Sections 1.16 and 1.17.

1.15 Access to Sample

The researcher interviewed both managers and senior managers at the eThekwin Municipality Water and Sanitation Department. One of the major limitations of this study will be access to the participants who were available to assist the researcher with interviews. Only 9 of the 12 participants had responded positively to the request to participate in this study.

1.16 Sampling Technique

The sampling strategy that will be used in this study is non-probability based on purposive sampling. Sekaran and Bougie (2013) define purposive sampling as being confined to specific types of individuals with specific elements that can provide the desired information with a specific purpose. The sample elements are chosen specifically, according to participant characteristics. The purposive sampling technique was a deliberate choice of the researcher and the researcher selected participants based on the value of the qualities that he/she possesses.

1.17 Sample Size

With reference to Creswell and Creswell (2018), between 8 and 12 interviews may be sufficient before a point of saturation is reached. Although 12 requests were made for participation in the study, only 9 participants responded to undertake this study. The total number of people interviewed during the data collection was nine (9). These interviewees were managers and senior managers, as they would contribute to the credibility and trustworthiness of the study.

1.18 Data Quality Control

According to Sekaran et al. (2016), reliability and validity are critical in quantitative studies. However, in qualitative research, the four dimensions of trustworthiness by Lincoln and Guba (1985) are considered equivalent to reliability and validity in quantitative research. It is imperative to ensure the credibility and trustworthiness of a research study as they measure the quality of the study and the possibility for similar future studies. Broadly, both reliability and

validity contribute to the essential's criterion of quality research, trustworthiness (Lincoln and Guba, 1985). Reliability refers to the trustworthiness of observations or data and validity refers to the trustworthiness of the interpretations of conclusions. Although qualitative research does not draw a sharp conclusion between observations and interpretations, it becomes useful for the researcher to distinguish procedural trustworthiness from the criteria of judging the trustworthiness of interpretations (Stiles, 2013).

Therefore, it becomes difficult for the researcher to conduct qualitative research as the researcher does not know whether the research will be credible and trustworthy after conducting it. To ensure that the credibility of this qualitative research, the researcher considered the four-dimension criteria when conducting this type of research namely, transferability, confirmability, trustworthiness/credibility, and dependability (Lincoln and Guba, 1985). These will be discussed further in Chapter Three.

1.19 Ethical Considerations

Ethical clearance was obtained from the University of KwaZulu-Natal. It is a mandatory requirement that all researchers at the university should familiarise themselves with the necessary research ethics. A gatekeeper's letter was also issued by the eThekweni Municipality Water and Sanitation department. This permission was granted for the research to be conducted within the organisation as part of the Master of Commerce qualification in Supply Chain Management. The Municipality was assured that all information gained from the research would be treated with utmost circumspection and should the organisation request for the resulting outcome to be embargoed from the dissertation for an agreed time, this would be arranged with the researcher, supervisor, and relevant individuals within the Municipality. The research committed to adhering to anonymity and confidentiality of the participation from the eThekweni Municipality Water and Sanitation department and all participants.

Informed consent letters were given to each respondent before the interview process began, outlining the objectives and the aim of the study in detail. This allowed the participants to feel comfortable as their anonymity was guaranteed and their role in this research was discussed with them. Only when the researcher received full consent from the research participants could the researcher proceed with the interview.

During this research study, the research instrument that was utilised ensured the anonymity of

all participants. The research participants were not coerced into disclosing their personal information at any time. All information collected was utilised for research purposes only and the researcher ensured that privacy and confidentiality were not breached at any time. All participants were treated with the utmost respect and under no circumstance was the self-respect and self – esteem violated.

1.20 Data Analysis Technique

An inductive approach to data analysis, rather than a deductive approach was used (Hair et al., 2015). Since the study was based on a qualitative approach and not a quantitative approach, the study was expected to have close interaction with data from eThekweni Municipality.

NVivo is a qualitative analysis (QDA) computer software program designed for qualitative research. This programme assists qualitative researchers when working with complex text-based and/or multimedia information, where researchers require a deep analysis of small or large volumes of data (Saunders et al., 2019). NVivo assists researchers to organise and analyse non-numerical or unstructured data. The software allows users to arrange information, examining relationships with specific data, and combining analysis with linking, shaping, and searching required data.

The researcher can test theories, identify specific trends, and cross-examine information by identifying the correlation between relationships through search engines and query functions. Observations can be determined with NVivo software and the researcher can build a body of evidence to support his/her research (Braun and Clarke, 2006)

According to Sekaran and Bougie (2016), conventional content analysis is broken down into coding categories derived directly from the data collection. Thematic analysis was applied to the data in which the key themes and patterns were identified through NVivo software and the researcher was able to analyse the data using categories and codes. From this, the themes were identified, and categories and sub-categories were created (Sekaran et al. 2016).

1.21 Limitations

The limitations faced during research were as follows:

1. A lack of available company information: eThekwini Municipality may not be able or willing to disclose corporate information due to contractual constraints that could be leaked to other municipalities.
2. Limited access to departments within eThekwini Municipality.
3. Water supply shortages were identified through the literature review and research conducted at eThekwini Municipality in KwaZulu-Natal only. The implication is that not all impacts and causes may have been identified, with the study focusing on one Municipality only.
4. Given the sensitivity of face to face interviews, the researcher was given consent to conduct interviews at the eThekwini Municipality but consent for audio recording the interviews were not granted due to the sensitivity of the information and the confidentiality of the participant. The participants felt uncomfortable as they feared that this information would be leaked if it was recorded, which would impact the status of the employment.
5. Prior research has not been done on this area of study on the eThekwini Municipality. Furthermore, there was very little literature that was available concerning the water crisis, water shortage, water supply, and eThekwini Municipality 's water management practices from a South African context.

1.22 Delimitations

1. The main delimitation for this study was the selection of one Municipality only. However, the eThekwini Municipality is the largest within KwaZulu-Natal. This research was based in the Durban Metro area region and does not consider other municipalities outside of KwaZulu-Natal
2. The research problem was current and relevant to the 21st century. The data control measures of transferability will enable a better study outcome as this research topic was applicable to situations faced by other municipalities and countries.
3. The researcher ensured that proper fieldwork was conducted and ensured that the participants had a deep understanding of the objective of the study and allowed for

- comparison from their current situation before findings and conclusions were made.
4. The researcher ensured that semi-structured interviews will be voice recorded in future studies to ensure that the researcher receives the full benefit of the interviews. This will help the researcher with detailed accurate findings as the responses will be transcribed verbatim and NVivo software will generate detailed themes, sub-themes, and codes.

1.23 Chapter Outline

Chapter 1: Introduction

This chapter introduces the study and discusses the relevance within the South African context. It also highlights the water management concerns experienced by the eThekweni Municipality and contextualises the topic in terms of the need for the research study. Based on the need of this research, research objectives and correlating questions were identified to ensure that that problem statement could be achieved with possible recommendations. This chapter further outlines the preliminary literature review, research methodology, limitations, delimitations, and what the researcher aims to investigate and achieve from the study.

Chapter 2: Literature Review

This chapter establishes the context and provides the theoretical framework for this specific study, by examining previous and current literature on the eThekweni's Municipality and other countries which are experiencing challenges with water management practices. A detailed discussion of the contributory factors towards water management practices is provided. From this understanding, the contributory factors such as water loss, water shortages, and relevant factors will be discussed, within the context of South Africa, then compared to other countries. The Service Gap model will be used as the theoretical framework underpinning the literature. From this, the process approach will be used and discussed as an extension to the theoretical framework and proposed as an approach underpinning the study.

Chapter 3: Case Study Overview of eThekweni Municipality

Chapter Three presents an overview of the eThekweni Municipality. The relevance of choosing this specific study site will also be discussed regarding the Municipality's water management practices.

Chapter 4: Research Methodology

This chapter presents the various research approaches, methodologies, and analysis tools used in conducting this research study, motivating for the selection made.

Chapter 5: Data Analysis

Chapter Five covers the analysis of the data and the presentation of the results for this study. This analysis was done using NVivo software as a tool for thematic analysis. Diagrams, tables, and reference to statistics are central to the presentation of results.

Chapter 6: Discussion of Findings

This chapter discusses the results and findings that were presented in the previous chapter. This is critically analysed against the literature, the study's theoretical framework as well as the research objectives of this study.

Chapter 7: Recommendations and Conclusions

The last chapter concludes the study by determining whether if the research questions have been answered and research objectives achieved. It provides the conclusions based on the analysis from the previous chapter. Recommendations are identified, discussed in detail and customised per research objective, together with possible recommendations on future studies.

1.24 Conclusion

Chapter One has provided the structure and outline for this research study. The following terms pertaining to this study was also discussed: the problem statement, research questions, and research objectives. The research methodology has been highlighted in the introductory chapter and will be discussed in the detail in Chapter Four. The next chapters will provide a literature review on knowledge of the Water Management Practices and the challenges of water loss and water supply. Possible recommendations for the focal area of this research study will also be provided.

Chapter Two

Literature Review and Conceptual Framework

2.1 Introduction

This Chapter provides a discussion on the water management practices and the concept of Quality Management System in the automatic control or instrumentation of large water supply systems at present. Automatic control remains a secondary or selective component of overall waterworks facilities. This literature review will be confined to the current situation in the eThekweni Municipality region with possible recommendations for future developments.

While the Department of Water and Sanitation is trying its best to encourage South African citizens to use water sparingly in the face of the calamitous drought that is affecting the country as a whole (Schoeman, 2015). There seems to be a growing perception that the government is not doing enough to harness and save floodwaters that often wash away roads, riverbanks, and bridges.

This perception is opposed to the reality of the situation. The department is managing 211 dams across the country to ensure that as much water as possible is collected to ensure that our taps never run dry. The argument, therefore, that to have abundant water municipalities must ensure the construction of new dams, is an unsustainable one (Sunderland, 2014)

One of the factors that must be taken into consideration is that South Africa remains a water-scarce country (Malunga, 2017). Accordingly, patterns of water consumption today are key to whether there will be enough for tomorrow. The department is the custodian of the country's water resources and has an important obligation in making sure that the citizens have access to this life-giving resource (Mckenzie and Wegelin, 2019).

2.2 Three types of Water Supplier Losses

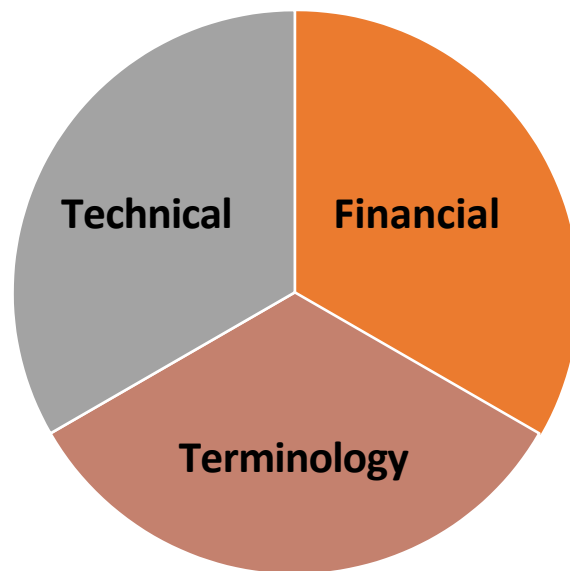


Figure 2.1: Problems identified for water and revenue losses

Source: Thornton (2002)

According to Thornton (2002), the problems of water and revenue losses are as follows:

1. Technical: Not all water supplied by a water utility reaches the customer.
2. Financial: Not all the water that reached the end user is properly measured or paid for.
3. Terminology: Standardised definitions of water and revenue losses are lacking.

The International Water Association (IWA) defines two major categories under which all types of supplier water loss occurrences fall:

1. Real losses are the physical escape of water from the distribution system and include leakage and overflow before the point of end-use.
2. Apparent losses are essential “paper” losses and consist of customer use which is not recorded due to metering error, incorrect assumptions of unmeasured use, or unauthorised consumption.

While these two definitions can be distinguished by a stark physical differentiation, a dramatic economic difference also exists on a marginal cost basis. Real losses, mostly through leakage, are typically valued at a marginal production cost of the water. Apparent losses, which occur at the customer destination, penalise the water supplier at the retail cost (Vemersch, 2016: 11). While the marginal costs are only short-term costs, long-term costs must also be assessed. The implications of the costs of the real and apparent losses require a careful assessment of each to design the most appropriate water loss optimisation program (Ociepa, 2019: 4).

2.3 Why Real (Leakage) Losses Occur

A water supplier's real losses are not losses at all, since these losses (leakage) do not represent water that is destroyed but the water that is usually returned to the watershed. Apparent losses include no physical impropriety, as the water has reached the destination of an end-user. However, this successful supply function lacks either a full and accurate accounting and revenue capture, or the use of the water was unauthorised (Ncube, 2018). Van Zyl (2014) states that leakage is the most common form of real loss for water suppliers and occurs for several reasons. Below are the factors that affect water suppliers when dealing with real losses, the factors contribute to the increase in real water loss.



Figure 2.2: Real losses for water suppliers

Source (Thorton, 2002)

With reference to Figure 2.2, the most recognisable examples of reported leaks is dramatic pipe bursts. Due to their damage-causing nature, dramatic pipe bursts are usually quickly reported, responded to, and contained.

Unreported leaks - often running at a small rate of flow on underground pipes - frequently escape the attention of the water supplier and the public (Ncube, 2018). However, they account for larger amounts of lost water since they run undetected for long periods.

A significant finding of leakage efforts over the past decade has been a large amount of water loss occurring on the customer service piping branching from the water main and supplying water to single or multiple users' premises (Van Zyl, 2014). For many systems, leaks on these small-diameter pipes represent the greatest number of leaks encountered in water supply operations. Often, supplier policies require customers to own their service lines and to execute repairs or replacement when necessary (Vermersch, 2016).

Unfortunately, many customers are often unaware of their responsibilities and, when advised to repair known leaks, are neither timely nor effective in getting relatively expensive repairs executed. Consequently, customer service piping leaks can run for considerable periods, even after being reported and account for substantial water loss (Van Zyl, 2014).

A severe drought in England in the mid-1990s resulted in emergency regulations that required some water suppliers to implement repairs on leaking customer service lines (Farley and Trow, 2013). The resulting savings in lost water were found to be so significant and the repair methods so efficient that national regulations were soon established, requiring all water companies to implement policies for company-executed customer service line leak repairs.

Two other notable aspects of these regulations are that customers retained their ownership of the lines and once high initial backlogs of customer leaks were repaired, the rate of occurrence of new leaks was sufficiently low that the repair policies for the water companies were found to be manageable and cost-effective (Farley and Trow, 2013). This experience dramatically demonstrates the principle that leakage losses depend on two primary variables: rate of flow and time permitted to run (Ociepa, 2019). Both parameters must be considered in developing a leakage management strategy. Too often, water suppliers lose track of small-volume leaks, allowing indefinite leak time to occur and losses to mount (Allwood and Hall, 2017).

Another technique employed in recent times by progressive leakage management programs around the world is the science of pressure management. In designing water infrastructure, engineers have frequently specified distribution system pressure levels with the primary

objective of providing service above a minimum requirement, without considering the impact of the “excessive” pressure (Farley and Trow, 2013).

2.3.1 The Apparent reasons for the occurring of losses

Apparent losses become significant mainly in two ways:

- Inappropriate assessment of the apparent loss often results in real losses being overstated in water audits. This becomes a misleading factor for water loss, resulting in optimisation planning which can negatively impact the inordinate emphasis on the leakage, while potential revenue recovery is unattended (Ociepa, 2019).
- Relative to real losses, apparent losses have a typically greater short-run marginal cost effect, since they negatively impact revenue at a retailer customer rate (Thornton 2002).

According to Thornton (2002), there are three ways that apparent losses can be perceived by water:

1. Unauthorised usage
2. Errors in water flow measurement
3. Errors in water accounting

Before discussing the specifics of these water losses, it is imperative to review the typical metering and analyse the billing structure, used by water suppliers. In the last 150 years, most of the world’s water supply systems have come into existence, while the earth’s population has quadrupled (Ociepa, 2019). Therefore, the need for water supply has multiplied to serve the increased population. This has required considerable infrastructure, pumping facilities, pipelines, water detection methods, and treatment plants (Thornton, 2002).

Many households are establishing modern indoor plumbing. Customers have noticed that their service pipes have been tapered, which has directly impacted the local water pipes or the mains, resulting in a direct water supply into consumer households (Pradhikaran, 2012).

In South Africa, many water suppliers have chosen to manufacture water meters which are installed at consumer end-user premises. This type of meter helps to gather regular readings for the person’s billing per unit volume of water used (Malunga, 2017). Customer water prepaid systems are meters that allow consumers to monitor their usage and provide the option to

restrict themselves from excessive water usage and identify wastage (Thornton, 2002).

2.3.2 Traditional and Progressive Approaches to Water Loss

Allwood and Hall (2017), state that many utilities ignore the factor of water losses around the world. This is due to the lack of resources and perceived burden which results in other priorities of the operation of a system. Other countries have downplayed their losses which has resulted in a negative impact and public resentment. This is mainly due to concerns from customers who are requested to conserve their water utility or pay higher water tariffs or rates (Tirado, 2016). In some countries, areas with limited water supply restrict water allocation. In those areas, where limited water audit exists, municipalities often eliminate their water losses on paper by using “pencil” audits that are not scrutinised by other departments and stakeholders (Allwood and Hall, 2017). It can be said that most of these practices reflect the lack of both a national and a regional agenda for water loss.

Many developing countries and developed countries have opted for systems that cannot provide consumers with a continuous supply of water on a 24-hour basis, especially during the scarcity of rain. Other countries are faced with systems that are becoming an increased cost factor for new innovative water sources, due to peak holiday periods and tourist trade (Van Zyl, 2014). These innovative systems require major funding and significant funds for the implementation and installation of costly water sources (Thornton, 2002).

In other systems initiating or accelerating a successful water loss optimisation program, the cost of loans for capital investment will be deferred, which in turn provides a very positive return on investment. A comparison between South Africa and the US is formed as the US is regarded as a first world country, which is considered a benchmark for SA to adapt to. This will assist SA to implement and adapt to processes and technologies that could be appropriate to conditions of water practices to enhance quality management practices of effective water service delivery.

2.3.3 Water Loss is viewed from a United States perspective.

The United States is blessed with bountiful natural resources and forms the ideal example of the recognition of water loss as a major issue. Water is a primary resource that has been continuously developed to help grow the country to the level of strength and prosperity that it enjoys today. Unfortunately, water availability during the country’s early history may have

been a factor that contributed to the water supply infrastructure and an American psyche that now tolerates significant water loss.

Coupled with the general lack of awareness of water scarcity by the public and many other supply professionals in the United States, the state of water loss is cause for concern as many water systems face the challenges of growing populations and resulting in limited natural resources in the future (Thornton, 2002).

The term 'water accountability' has been using very casually in the United States for the last few decades. It is used to label a variety of activities that have affected the service delivery efficiency of water utilities (Adeosun, 2014). Water accountability, however, exists more as an art than science, due to its methods often generating as much confusion as to the explanation in interpreting water loss conditions. Symptomatically, the confusion stems from inconsistent terminology, unreliable percentage measures, and a lack of procedures to evaluate and compare the performance of water loss (Pradhikaran, 2012). On a broader scale, however, water accountability is a weak discipline due to the lack of knowledge and awareness about the extent of water loss in the United States. Lacking the knowledge concern for this problem becomes a critical issue as this leads to the non-existence of a national agenda for the reduction of water loss for the suppliers (Thornton, 2002).

Conversely, in the United States, the field of water conservation is structured effectively and efficiently to achieve success in limiting unnecessary water usage. This gives attention to the arid and semi-arid regions of the country, where the population growth is increasing and where water is both expensive and limited (Allwood and Hall, 2017). Water conservation focuses mainly on water wastage reduction by the consumer by ensuring that the usage efficiency is improved. It has achieved recognition at the national level with legislation that sets requirements for household water appliances and other water uses (Adeosun, 2014). Unfortunately, supply-side source losses occur due to leakage and poor accounting management principles by water utilities. The losses that occur are likely to be greater than the end-user savings achieved through conservation (Thornton, 2002).

High water loss in the United States occurs for many varied and complex reasons. Some of the reasons will be discussed next.

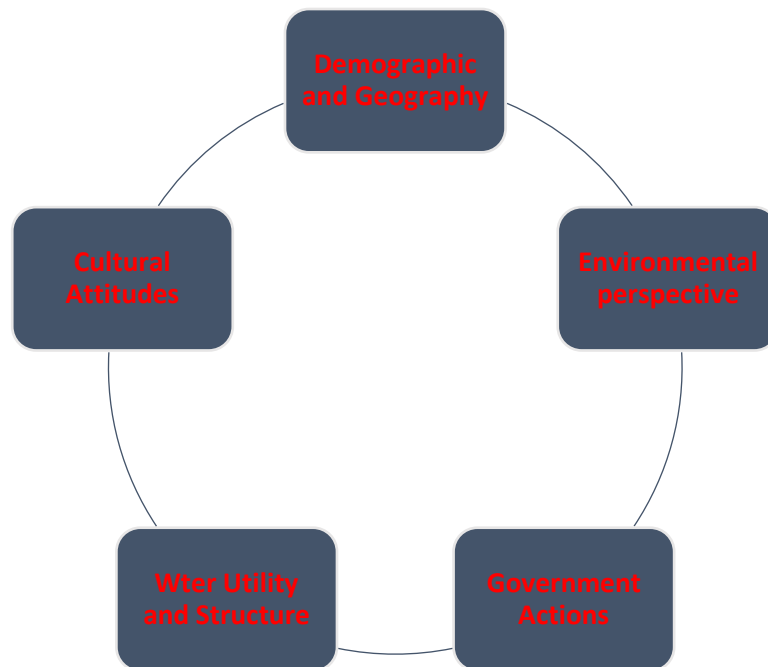


Figure 2.3: Reasons for high water losses in the USA

Source: Author's construction

2.3.3.1 Cultural Attitudes

Americans are the world's consumers. This consumption includes water, with a relatively high per capita usage compared to many other industrialised countries and nations. When using the term 'conserving', it is sometimes referred to as "doing with less". This is a notion that runs contrary to the way Americans think, as they are often geared towards development, building, and focusing on resource exploitation. In many parts of the world, water is undervalued due to the intentional suppression of social and political reasons.

2.3.3.2 Water Utility Organisations and Structures.

In rural areas of the United States, 55-thousand water suppliers have small utilities, with a relatively small number of medium and large systems. The organisational and management structure of water utilities tends to vary widely, with many systems being operated and influenced by municipalities and local authorities.

2.3.3.3 Environmental Perspective

In the United States, environmental consciousness has grown rapidly over several decades and is now a balancing force with planning and development decisions that will impact the country. The Environment Protection Agency (EPA) confirmed the establishment of the consideration environmental decision-making process as a sustainable practice to ensure that ISO 1400 standard is achieved. This assists with effective management measures to achieve water conservation and minimise water loss.

High losses indirectly require oversized infrastructure, excessive energy usage, and unneeded withdrawals from water supplier sources, all of which have a negative impact on the environment.

2.4 Challenges in South Africa

Most rural areas within South Africa are experiencing several challenges to access water services because they cannot afford municipal services. The Department of Water Affairs has entrusted the Water Service Authorities (WSA) and the Water Services Provider (WSP) with the task of ensuring that all citizens within South Africa, including poor households who cannot afford to pay for the municipal service, have access to water. The Department of Water Affairs had instructed that the WSA and WSP provide a basic level of service at no cost (25 liters of water per person per day). It is acknowledged that most municipalities within South Africa struggle to service rural communities as they face several challenges in supplying these communities with even the basic level of service.

Challenges identified in KwaZulu-Natal include the availability of water sources, administrative challenges, issues that relate to policy, and political interference. For many rural communities within the KwaZulu-Natal region, water sources and infrastructure are available,

but they are not maintained and become unusable and non-operational.

In South Africa, the resource of water is a basic human right as stated in our constitution and therefore the government has introduced several measures to ensure that all citizens within South Africa have access to a basic level of service at no cost. In terms of the Water Act and the Free Basic Water Policy, municipalities must provide at least 6000 litres of water to each household for free (25 litres per person). To facilitate this process of supplying water to households and businesses, municipalities receive an annual grant to compensate for the cost for the underprivileged. The government provides these grants as support to ensure that all small municipalities can provide the necessary services and to ensure that service delivery is operational.

2.5 Challenges for water supply in KwaZulu- Natal

2.5.1 Lack of capacity and skills at municipalities

In most rural communities, water supply is a major concern. This concern escalates in some communities where weeks would pass amid a disrupted water supply. This problem is caused by several factors which include the availability of water operators and municipal officials who are responsible for operations and management activities. To illustrate, regarding one of the projects in the KZN region, a site had boreholes but had not been functional for more than two years. Through discussions with municipal officials, it was highlighted that this project deteriorated due to a lack of communication between the various officials responsible for the project site. In some cases, water operators become not available because infrastructure is broken and requires immediate repairs. In this case, it had taken longer to fix, and this impacted the operational time. In situations like this, the water supply becomes more inconsistent and, especially in rural areas, people face challenges in purchasing water and are forced to turn to unsafe/untreated water sources such as wells, nearby rivers, and lakes. By consuming this water, citizens are prone to waterborne diseases.

2.5.2 Poor operation and maintenance of infrastructure

Within the KZN region, almost all project sites had some infrastructure in place, and some that required further development. This type of infrastructure included reservoirs, reticulation pumps, dams,

borehole pumps, water operation centers, street taps (Mnisi, 2019).

Investigation of selected sites showed that most infrastructure was poorly maintained. Infrastructure problems included water leakages (reservoirs, burst pipes, and leaking taps) caused either through aging or damage (Mnisi, 2019).

To ensure a continuous and effective water supply, infrastructure needs to be supported by appropriate pipes and valves at the borehole. To protect the quality of water, the supply infrastructure should be as important as source and distribution. According to Khatri and Vairavamoorthy (2007:9), water supply systems that are poorly managed can be linked to insufficient financial resources, lack of training and development, and poor management. Therefore, insufficient financial resources lead to the deterioration of water infrastructure, and the quality and reliability of water services are threatened.

2.5.3 Illegal connections

One major challenge to the supply of water in rural areas is illegal connections. These affect the pressure of water within the pipelines, either to or from the Umgeni Reservoir, as piped water from or to the reservoir is lost along the way. For example, in some areas within the eThekweni Municipality illegal connections resulted in challenges to the feeder/supply of water pipes to the various reservoirs, which affected the filling of the reservoir (Johnson, Leenders, and Flynn, 2011).

It was highlighted through discussions that illegal connections were one of the biggest challenges in the eThekweni Municipality. Community mobilisation patterns were identified as a possible effective measure to educate the community about illegal connections and bring awareness of the negative impact on water supply services. However, feedback and reports by municipal officials indicated that community participation in roadshows and awareness campaigns was very low (eThekweni Municipality, 2018).

2.5.4 Political interferences

Political interference in the eThekweni Municipality's water operations and the development of water infrastructure is seen as a further operational issue, affecting the delivery of the water supply infrastructure (Franks and Cleaver, 2007). It can lead to funds not being appropriately spent, and decelerating services to various communities.

In one example, community members had decided that various areas within the community

would not get a water supply if the entire community did not get water services. This becomes a challenge as the eThekweni Municipality cannot service the entire community if a budget has not been granted to cover all areas, as revenue generation is very minimal in poor rural communities. Studies have shown that decision-making on public funds utilisation is based on political processes. As a result, in rural areas, investment in water services is not seen as a high priority (Franks and Cleaver, 2007). Studies have highlighted that staff is appointed mainly on political grounds and not on their professional credentials. This poses a high risk in developing countries.

2.6 Equipment and Techniques

When evaluating losses from water systems or facilities, it is important to use a hands-on approach and collect data from the field as the result will be accurate, reliable, and valid. To collect this data, portable, temporary equipment can be used to prepare for the installation of new equipment or rehabilitate old infrastructure and the use of data recorders to collect time-based pattern trends. This assists with the analysis of the actual dynamic situation.

2.6.1 Portable equipment

There are various types of flow measurement equipment on the market that can be used to detect water leaks. To utilise leak detection equipment, water operators must provide proper training and development to ensure the equipment is utilised effectively and efficiently and that the required work is of high quality. The use of test equipment with uncertain credibility will only result in confusion.

The reason for measuring the flow of water is often to try and identify the cause of a problem why a master meter is overreading, what is the cause of the leakage. This can create added uncertainty in selecting the appropriate test equipment.

2.6.2 Portable Insertion Meters

One of the most effective and commonly used portable flow meters is the insertion-type meter. Insertion comes in different types and from various manufacturers, with their own strong and weak points. Proper training, excellent customer service, good technical support, calibration,

and maintenance will ensure a high-quality job.

Some common insertion meters that are used today include:

1. The turbine insertion meter
2. The heat meters
3. The pilot rods
4. The vortex shedding insertion meter
5. The turbine insertion meter

2.7 The Role of Environmental Analysis in a Service Organisation

To ensure success within an organisation, there three organisational roles that contribute to the environmental analysis of an eThekwini Municipality.

2.7.1 Policy-oriented role

The main purpose of a policy-oriented environmental analysis is to improve the organisational performance by keeping top management informed and updating them about the major trends emerging in the environment (Certo, 2019). Those who conduct and perform the environmental analysis within the EMWS department should focus on the entire eThekwini Municipality and have direct access to top management authority. Policy-oriented allows for early detection of water loss and mismanagement of water practices by top management, as this level of management can react to broad strategic issues of the Municipality such as attitudes, norms, laws, and mismanagement of organisational practices that are likely to affect eThekwini Municipality as a whole. Therefore, the environmental analysis of the eThekwini Municipality is policy-oriented and is normally unstructured, as this type of relationship between the environmental analysis process and the formal organisational planning is indirect and informal.

2.7.2 The Integrated Strategic Role

The main purpose of this kind of environmental analysis role is to improve the organisational performance by making the top and divisional managers aware of issues that arise within the firm's environment and by having a direct impact on planning, and by linking both corporate

and divisional planning together (Certo, 2019). The EMWS department operates within the divisional level and reports to the “Strategic and Planning” unit, as this unit reports directly to the City Manager. Normally this type of analysis system has a specific task to perform within the strategic water management practice process. Within the Municipality, this task includes preparing environmental forecasts to generate basic assumptions about strategic planning and to provide more information about specific areas of the environment as specific municipalities plans tend to materialise.

2.7.3 Functional- oriented role

The purpose of this role is to improve organisational performance by providing environmental information concerning the effective performance of a specific organisational structure (Certo, 2019). The eThekwini Municipality uses this type of environmental analysis to enhance the performance of the Municipality of a particular function or a major Municipality activity at both municipal and divisional level. Such functions can be very broad (improving eThekwini’s Municipality water management practices) and specific (complying with government regulations within specific periods). The ENWS staff who perform these tasks, normally focus very narrowly on specific environmental segments that are related to the Municipality 's function. The water management practices which are normally used, are integrated with the strategic planning process for the eThekwini municipalities function.

2.8 Environmental scanning of water management practices

Smith (2015), states that environmental scanning is the process of gathering information about events and their relationships within an organisation’s internal and external environments. The purpose of all this gathered information is to help management determine the future direction of the organisation. Within the eThekwini Municipality, environmental scanning systems exist in many different forms. The most widely accepted methods which are accepted by the EMWS department are divided into three types:

2.8.1 Regular scanning systems

This system revolves around a specific regular review of the eThekwini region environment.

This review is done annually by the EMWS department. As this scan is done, it is perceived as decision-oriented: top management review these results during the decision-making process for future strategic goals implementation. The focus of this system is primarily retrospective, but the Municipality has some thoughts as to future condition assumptions that will evolve within the eThekwini region (eThekwini, 2018).

2.8.2 Irregular scanning systems

This system largely consists of ad hoc environmental studies. The eThekwini Municipality normally activates these systems when there is an environmental crisis, such as a water shortage. The EMWS department focuses mainly on the past to identify crises that have already taken place. When eThekwini Municipality emphasizes immediate or short reactions to the crisis, irregular scanning is undertaken is normally taken as it pays little attention to future environmental events (eThekwini, 2018).

2.8.3 Continuous scanning system

These systems constantly monitor components of the Municipality 's environment. Such scanning is an ongoing activity that is implemented by the strategic and planning unit (Taylor, 2016). The implementation of a continuous scanning system within the eThekwini Municipality tends to be more future-oriented than either irregular or regular systems (eThekwini, 2018).

2.9 Conceptual Framework

A conceptual was developed as the researcher was of the opinion that a combination of elements from various frameworks was important as it supported the objective of improving water practices and enhancing the water quality management practices at eThekweni Municipality. The Service Quality Gap Model can be used to explain the effectiveness and efficiency of the Quality Management System and how service delivery can be used to enhance continuous improvement with respect to the ISO 9001.

Figure 2.4 explains the effectiveness and efficiency of integrating the service gap model into the Quality Management System to ensure continuous improvement.

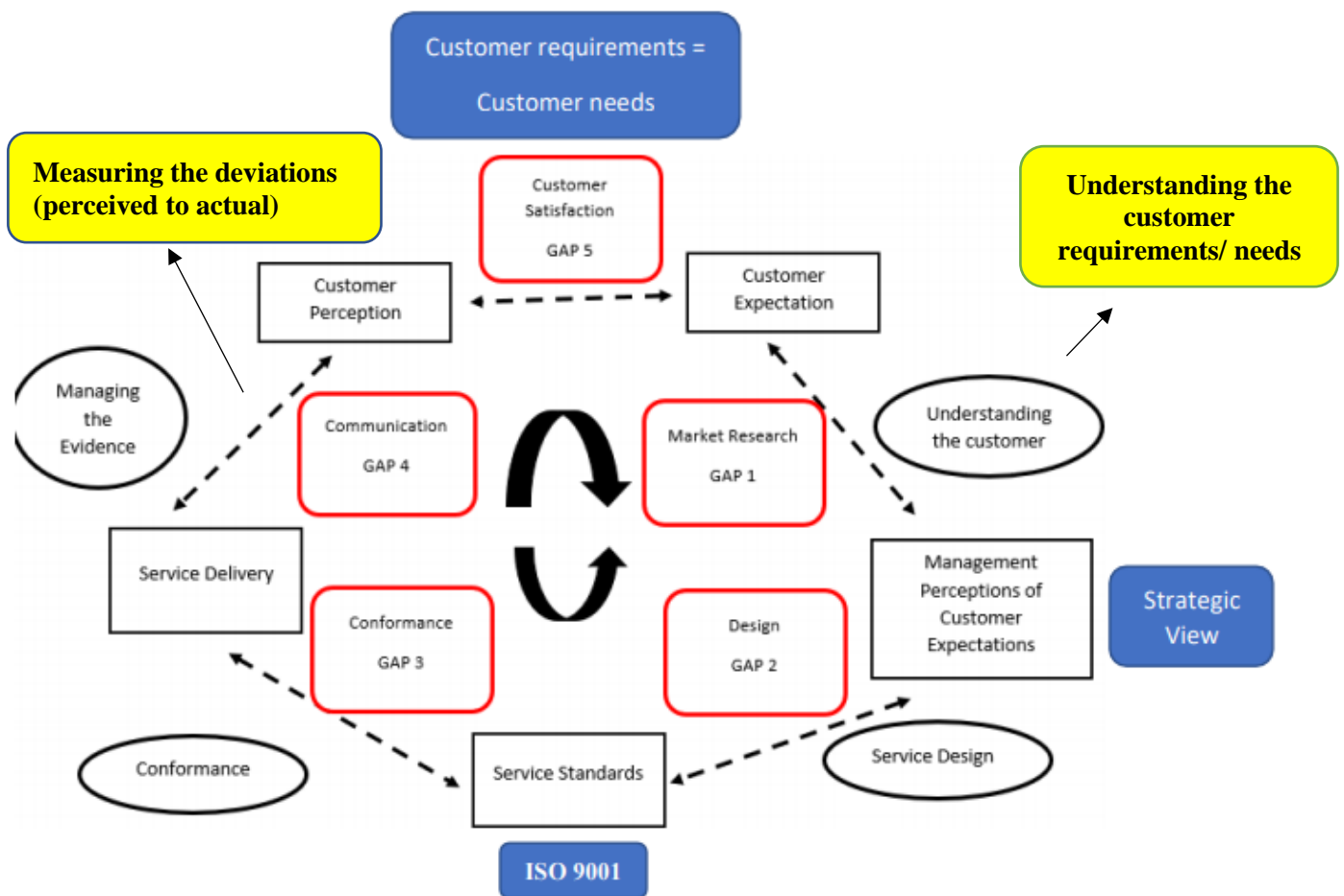


Figure 2.4: Service Quality Gap Model

Source: Author's construction

The gap between the two factors - customer expectations and perceptions - is defined as GAP 5. The factor - customer satisfaction - is dependent on minimising gaps 1 through to 4, associated with service delivery. GAP 1 - Market Research - is the discrepancy between customer expectations and management perceptions of these two expectations (Buttle, 2004). GAP 1 arises from the management's lack of a full understanding of how customers must formulate their expectations based on various sources (Klibi, Martel, and Guitouni, 2010).

Strategies for closing the gap include improving marketing research, fostering better communication between managers and their contact employees, and reducing the number of management levels (Bharwana, Bashir and Mohsin, 2013).

The service design gap results from management's inability to formulate and implement service quality target levels that will be able to meet perceptions of customer expectations and to translate this into realistic and achievable workable specifications (Bharwana et al., 2013).

GAP 2 results from a lack of commitment from management to quality specifications or perceptions of the unfeasibility of meeting customer expectations (Brink and Berndt, 2004). Setting specific, measurable, achievable, and realistic standardized goals of service delivery will assist in closing the gap (Ivanauskiene and Volungenaite, 2014). The conformance gap occurs due to the factor that the actual delivery of the service does not meet the expectations and specifications of management. GAP 3 arises for various reasons, including a lack of teamwork, poor employee selection, and inadequate training and development. Customer expectations of the service provider are formed by communication tools (Berry, Parasuraman, and Zeithaml, 1994). GAP 4 is the discrepancy between the factors of service delivery and external communications in the form of a lack of communication to the appropriate personnel and exaggerated promises that cannot be fulfilled (Bharwana et al., 2013).

The generality of developing countries is the focus on customer orientation, as the common theme for every effort is the reform of modernising public administration. EThekwini Municipality acknowledges the need to involve their customers such as businesses and consumers in their service design and service evaluation. Given the fact that the eThekwini Municipality is the service provider, this allows the Municipality to be in close contact with its customers and this allows them to serve their customers with their required needs. Consequently, as recognised in the service quality approach, the customer evaluation of eThekwini Municipality's services is seen as primarily linked to aspects such as service setting, the performance of frontline employees, and other non-human elements of service delivery.

Collecting customer feedback on such determinants assists the EMWS department as this is an essential guide for improvement and the achievement of higher degree excellence.

Few studies have compared the perspectives of customers and employees concerning the expectations of service quality or perception of the level of desired service quality. The researcher intends to contribute to and address this gap. For the eThekweni Municipality to capture the perceptions of the frontline employee, this becomes a strong justifiable and critical role for service delivery. This role includes listening to customers, understand and interpreting the customer requirements, and performing appropriate tasks to the quality service standards that have been set (eThekweni, 2019). The eThekweni Municipality must have alignment between their customers' and frontline employees' perceptions as this is a major element to avoid many service quality gaps.

2.10 The Deming Cycle

The Deming cycle was necessary as this process enhances quality improvement in an organisation. The researcher found this process to be useful as the current water management practices at eThekweni Municipality needed to enhance their quality improvements and implement appropriate water quality management standards to improve the service delivery to consumers and businesses.

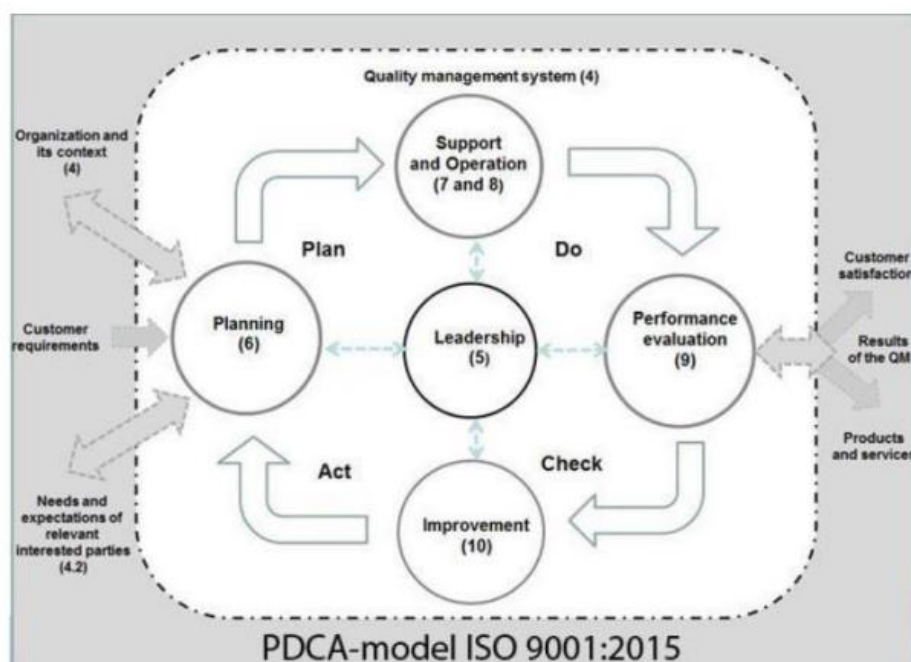


Figure 2.5: Deming cycle in the process of quality improvement

Source (Dale, Boaden and Lascelles, 1990)

2.10.1 The 'Plan' Phase

The planning stage focuses on the concept of changes in quality improvement, derived from the Deming cycle traditional model. In the planning stage, quality characteristics are identified and improved based on the possible improvement methods, measurement instruments, and acceptance criteria for testing the success of the improvement required. The primary challenges in the planning stage are correct identification of the change and improvement measures to achieve the best opportunities (Juran, 1988). It is imperative to achieve a wide-scale buy-in from all employees based on previous successes. For example, converting a manufacturing process to use new machinery with tighter tolerances, or changes in training and development to reduce errors (Sokovic, Pavletic and Pipan, 2010).

<p>Plan Identifying the problem (What?)</p>	<ul style="list-style-type: none">• Identify and examine the problem.• Formulate a specific problem statement to identify the cause and effect of the problem.• Ensure measurable, attainable, and achievable goals.• Develop communication channels with necessary stakeholders to gain approval.
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<p>Plan</p> <p>Analyse the problem</p> <p>(Why?)</p>	<ul style="list-style-type: none"> • Break down the overall system into individual processes - allowing for a mapping process to be conducted. • Brainstorm and map potential causes for the problem identified. • Collect and analyse appropriate data to validate the root cause of the problem identified. • Formulate hypothesis according to the problem. • Ensure that the problem statement is verified and revised to obtain the optimal result.
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Figure 2.6: Planning component of the Deming Cycle

Source: (Jilcha, Beshah and Kitaw, 2014)

2.10.2 The ‘Do’ Phase

The second phase of the Deming cycle is performing the implementation of the experimental changes to measure the different effects of the changes on the Quality Management System. Tests are performed during the implementation of small-scale experiments as this strengthens the accuracy of the results. Large-scale tests have restrictions and limitations due to long duration which impacts the accuracy of findings. In either case, it is critical to understand the primary purpose of the experiment - to test and gather data on the effectiveness of the proposed experimental changes. The biggest challenge in the “Do” phase is the correction of the implementation of experiments. Therefore, careful planning from the previous stage is vitally important to ensure that effectiveness and efficiency are accomplished. From the earlier example, this phase might consist of a pilot production run with the implementation of new machinery or the training and development of a small cohort of employees utilising the new methods implemented from the experimental changes (Sokovic et al., 2010).

2.10.3 The ‘Check’ Phase

The third stage of the Deming cycle is determined by the measurement of the results obtained from the experiments. This stage also determines whether the results will impact a change in the quality or on a large scale as the implementation of change will still be required. The main challenge in this stage is obtaining inconclusive results. Implementing proper measures into the experiments in the previous stages will assure continuous improvement (Jilcha, Beshah, and Kitaw, 2014). From the example, error rates can change when comparing yields between the utilisation of old and new manufacturing processes, as employees may require different types of training when using machinery that they are not familiar with (Sokovic et al., 2010).

2.10.4 The ‘Act’ Phase

The Act phase comprises the fourth stage in the Deming cycle. This stage consists of the large-scale rollout of the measurement changes or the decision that maintains the status quo. In either case, the Deming cycle returns to stage one - the Planning stage - as new improvements are considered for the Quality Management System to be more efficient and effective (Jilcha et al., 2014). The primary challenge in the Act phase is ensuring employee buy-in to the specific changes that have been implemented. Collecting conclusive data from the Do phase can help simplify and resolve the problem identified. From the above example, it would be could be resolved with the purchasing of new machines, and the roll-out into the manufacturing process. The retraining of employees will be important to assist with the increased productivity levels of each employee (Sokovic et al., 2010).

Each stage of the process requires different types of employees who have various skills and weaknesses as this is dependent on the success of the previous stage. Initially, this start-up process may be challenging but continuous improvement will make future processes much more effective and efficient.

2.11 Dr. Edwards Deming’s 14 points of quality management

Dr. Edwards Deming’s 14 points of quality management provide a solid foundation for good water management practices which can assist the eThekweni Municipality with their processes and ensuring the continuous improvement of service delivery to consumers.

2.11.1 Description of a need from an overall business perspective

1. Create constancy of purpose toward continuous improvement of product and service quality, to become more competitive, to stay in business, and to provide job creation within the economy.

In today's economy, many companies are experiencing challenges to remain within the business environment. It would be easy for eThekweni Municipality to stay wrapped up in its problems as water demand is ever-increasing. Forecasting and constancy are two factors that become important in determining the purpose and dedication of water supply throughout the KwaZulu-Natal region. Strategic decisions need to be made around cultivating innovation, funding research, and education as this will assist in continuous improvement in the supply of water and service delivery (Caruana, 2002).

2.11.2 Leadership for change

2. Adopting a new philosophy into practice and the Municipality is in a new economic age.

The water and sanitation department must awaken to new challenges, learn their responsibilities, and take on new leadership that can assist in change for continuous improvement.

2.11.3 Training and Development

Proper training and development with employee participation need to be enforced as effective training can assist in understanding their job portfolio more effectively and efficiently. Supervision must be provided to employees to help with training as employees will be free to ask for assistance when they do not understand certain duties. EMWS team management must be rooted within the Municipality and not job-hop from one position to the next within the Municipality.

2.11.4 Management must stop their common practice of inspecting quality in a product.

3. To achieve quality, ceasing dependence on quality inspection is imperative. Inspection should be eliminated in mass production and quality should be built into the product in the first place.

Random inspection is ineffective and costly as the product or service is already produced. It

becomes difficult for quality inspectors to react to product quality when the product reaches customers (Oakland, 1992). Quality does not come from inspection but rather from creating value and improving the entire production process.

2.11.5 Additional activities that should be incorporated as part of the business practice.

4. eThekweni Municipality's supply chain management team needs to end the practice of awarding businesses and contractors based on the price tag. To improve the Quality Management System, the minimisation of total cost needs to be implemented. Long-term relationships of loyalty and trust need to be developed by the organisation as moving to a single supplier or two will result in a more effective and efficient water supply.

There is a direct correlation between price and quality. Decreasing the price of a purchased product or service without involving the aspect of quality can drive good suppliers and good customer service out of business (Dale et al., 1990). Therefore, having a single-source supplier can result in many desirable outcomes. For example, Umgeni Water can create innovation and develop an economy in line with the production process of water supply that can only result from a long-term relationship with the EMWS department as the purchaser.

5. To constantly improve the system of production and service, to improve quality and productivity, constantly decreasing costs.

There is a need for constant improvement in possible test methods. This will help with a better understanding of the utilisation of water and prevent the misuse of water. For example, continuous improvement in the manufacturing process means that continuous work needs to be done with suppliers to improve the entire manufacturing process.

6. Institute training and development on the job.

The EMWS department needs to have adequate training to be knowledgeable on all aspects of the water supply process, water quality specifications, and customer needs, as well as the impact on the process variation done within the Municipality.

To improve the Quality Management System, the management team needs to identify and understand the problem experienced by employees when performing their duties satisfactorily. A large challenge exists in the training and leadership phase if there are flexible standards for acceptable work (Oakland, 1992).

2.12 Process approach

The process approach is a key aspect of an effective Quality Management System. This approach states that every operation of the company must be observed as a process. This means that the department should identify all inputs, key resources, documents, operational activities, and all outputs from each operation. Once the Quality Management System is set up and is in alignment with the required processes, quality inspectors can monitor and measure the system processes (Fawcett, Magnan, and McCarter, 2008). This will help measure the effectiveness and efficiency of the improvement and any other detail relating to the required standards. For the Quality Management System to be effective, a process map needs to be implemented, which will include all the processes within the Municipality and the required interconnections (Croxtan, Lambert, García-Dastugue and Rogers, 2008). For example, the delivery process of water cannot be done before the purification and sales process and the purification of water cannot be done without adequate rainfall.

2.13 Context of the organisation

2.13.1.1 Understanding the organisation and its context.

This type of clause is about understanding the new requirements that can be used in practice, compared to the 2008 version of the ISO 9001 standard. This clause also requires the organisation to determine all factors of internal and external issues that are relevant to the success of the Quality Management System.

2.13.1.2 Understanding the needs and expectations of all interested parties.

It's important to understand the type of contribution that interested parties will provide to the organisation in terms of quality for both products and services, as this can help in improving customer satisfaction and standards of the Quality Management System (Harris, 2002).

2.13.1.3 Determining the scope of the Quality Management System

Determining the QMS scope is one of the main objectives in the implementation stage. Therefore, the scope needs to be examined and defined according to both internal and external issues, customer needs, and expectations, as well as taking into consideration legal and

regulatory compliance obligations. Additional considerations that are required for the QMS scope are product and service quality, organisational size, nature, and complexity. The QMS information scope and justified exclusions must be identified and documented as this can help with future decisions relating to the Quality Management System (Dale et al., 1990).

2.13.1.4 Quality Management System and the different processes

The eThekweni Municipality Water and Sanitation department needs to establish, implement, maintain and implement a QMS model, including the various processes needed within the department as these changes will need to be in accordance with the requirements of the ISO 9001 standard (Fenton, 2019).

The process approach is seen as effective because the EMWS department will need to determine their inputs and outputs of the processes, the sequence, and the different interactions between the processes, responsibilities, and resources needed. It is also imperative that the EMWS department maintains the necessary documents to support the operational processes and keep records of each process to ensure that all processes were implemented accordingly to what was planned.

2.14 Leadership

2.14.1 Leadership and Commitment

The Quality Management System implementation is a strategic decision that demonstrates the commitment to development and the application of the QMS model (Fenton, 2019). The QMS aims to ensure continual improvement of its effectiveness. This type of commitment must be carried out and demonstrated through employees by informing the organisation about the importance of meeting customer requirements and customer satisfaction, compliance with legal requirements, setting quality objectives and a Quality Policy, providing the required resources, and conducting management reviews when needed (Dale et al., 1990).

2.14.2 Quality Policy

The Quality Policy is a high-level document that entails the general direction of the organisation, its quality commitment, and success at meeting customer satisfaction (Brink and

Berndt, 2004). It is a type of framework to achieve quality objectives and a key element to meet the compliance and regulatory requirements (Hult, Ketchen, and Arrfelt, 2007). The quality policy must provide a commitment toward continuous improvement (Johnston, 2004). It must be maintained, and all information must be documented and communicated to all employees within the organisation (Fenton, 2019).

2.15 Conclusion

In conclusion, this chapter has highlighted and presented the literature review as well as the conceptual framework for this study. South Africa was used as a benchmark in comparison to the US, as the US has implemented appropriate measures to improve their water management practices especially the concept of water loss. The challenges of the current water practices in SA was also discussed and the challenges for water supply was also presented. Environmental scanning of water management practices was seen as an important aspect for discussion as this impact on the current water management practices within eThekweni Municipality. The conceptual framework was discussed with reference of the three aspects: service quality gap model; the demining cycle as well as the appropriate points of the ‘demining 14 points’ and the process approach. The literature and the conceptual framework contributed towards the investigation of this study. A case study overview of eThekweni Municipality will be discussed in the next chapter.

Chapter Three

Case Study Overview of eThekweni Municipality

The eThekweni Municipality is one of South Africa's most competent municipalities, offering many examples of excellent public services. The eThekweni Water & Sanitation department within the Municipality has demonstrated progressive management and innovative methods that have impacted other departments positively across the region and country. The Constitution of South Africa allocates the responsibility for providing water services and setting tariffs to local governments. The regulatory framework is set out by the Water Services Act (108 of 1997) and describes the different water services institutions that will need to be established.

The water service provider (WSP) is the entity that provides water supply and sanitation services physically to consumers, however, the water service authority (WSA) is the responsible Municipality (eThekweni Municipality, 2016). Thus, the eThekweni Municipality is the water service authority and the eThekweni Municipality water and sanitation department is the water service provider. The water service provider is responsible for providing water and sanitation services to more than 3.6 million people living in both rural and urban areas (eThekweni Municipality, 2017). The government policy states that free sanitation and access to free basic water are provided for indigent households. The challenge in providing these water and sanitation services is assisted with the following:

- Ensure effective conflict management between different users and different catchments.
- Provide access to those consumers who are still without services.
- Maintain and ensure sustainable continuous improvement in services that have been supplied.
- Assist consumers who cannot afford normal service charges and
- Provide water services in support of all forms of economic development.

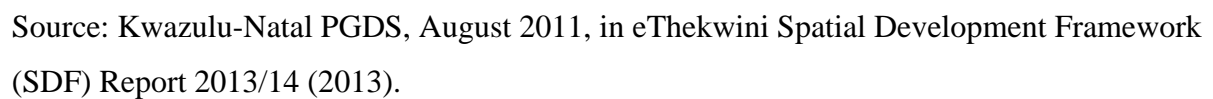
The period 2020/2021 marks a significant milestone in the development of Local Government in South Africa, after 20 years of transformation within the city. The eThekweni Municipality has made significant progress in the past 20 years to ensure that the city deepens its democracy, radically transform economic development, and continue to deliver the efficient provision of basic services to all citizens within the city (eThekweni Municipality 2016). Amongst the various challenges and impacts experienced as a Municipality by the Covid 19

pandemic, the city aims to continue and deliver on its mandate. The pandemic has offered the Municipality opportunities to find new and innovative ways of improving its service delivery and strengthening multi-stakeholder collaboration (Makhari, 2016).

The Integrated Development Plan remains a key strategic driver for the Municipal budget, the enterprise risk, and the performance management system. These strategic drivers encourage the City's performances against target details in the IDP document. EThekwini Municipality is proud to announce that they are a City that continues to positively influence the policy, strategic decisions at a global level, national, provincial, and local government levels (eThekwini Municipality, 2018). Through these engagements, it has assisted with the shaping of the city's strategy.

eThekwini Municipality was demarcated as a category A (Metropolitan) Municipality in South Africa, comprising a total area of 2297 square kilometers. A few existing apartheid local governments, former black dormitory townships, and traditional areas were considered and included in the development of the new metropolitan area. The aim of this was to be included in the boundaries, which citizens would relate to functionally (eThekwini Municipality, 2017). The first municipal democratic was held in December 2000 and the first five- year term of office was aimed at the council to amalgamate the existing administrative jurisdictions, hence, the creation of single policies became effective as they were required to be in line with the new constitution and the municipal dispensation (eThekwini Municipality 2017).

Label: Map indicating the different provinces in KwaZulu- Natal



The eThekweni Municipality is divided into 103 wards and, because wards are roughly equally distributed in terms of the number of voters, most wards are concentrated near the City Centre (see map below)



Figure 3.1: Different wards within the eThekweni Municipality region

Source: Municipal Demarcation Board, eThekweni Municipality 2011 Municipal Boundary

eThekweni Municipality comprises approximately 45% of rural land, while 30% is peri-urban and 25% urban (eThekweni Municipality, 2019). Whilst the whole Municipality is divided into ward sections, which is elected by the ward councilors, about 90% of the rural areas have traditional leadership which comprises land that falls under communal ownership (eThekweni Municipality, 2016). The coastline and beaches have been a significant sight for tourist attraction and accommodation, commercial, and entertainment.

3.1 The role of the eThekweni Water and Sanitation Department (EMWS) in the eThekweni Municipality

The eThekweni water and sanitation department aims to provide all citizens within the eThekweni region access to the appropriate, acceptable, affordable, and safe basic water supply of sanitation services. The EMWS department has played a significant leading role in shaping South Africa's water and sanitation policy. The department has received several international

and national awards for best practice in service delivery of water and sanitation (eThekwini Municipality, 2018).

However, civil society groups and community members have argued that the eThekwini Municipality does not adequately support consumers “right to water” which is enshrined in the South African Constitution. The eThekwini and Sanitation department ensures that they execute and refine their strategies to enhance engagement, improving dialogue with and disseminating information to and from consumers (eThekwini Municipality, 2019). The department holds a strong belief that they will strengthen their partnerships and relations with consumers, businesses, and relevant stakeholders to improve their service delivery.

3.2 Conclusion

This chapter provided an overview of the eThekwini Municipality as well as the role of the EMWS department within the eThekwini Municipality. The next chapter will present the research methodology of this study.

Chapter Four

Research Methodology

4.1 Introduction

This chapter discusses the research methodology used in this study and provides clarification pertaining to the selected methods. It provides a discussion of specific data sources and illustrates the significance of using appropriate data collection methods. The chapter also identifies the appropriate methods that were used for this study.

The research methodology focal area of the study must be planned well. This will result in accurate findings and ensure that both results and findings are reliable and valid for future expansion of this topic. This chapter covers the various sections of research design; study site, target population; sampling method; the purpose of non- probability sampling; sample size; sample; data collection instruments; data collection process; data quality control; data analysis, and ethical considerations.

4.2 Research Design

The purpose of a research design is to provide a framework for the collection of data and its analysis (Bryman and Bell, 2004: 210). It guides the planning and implementation of a study to ensure that the question of interest is answered adequately (Polit and Beck, 2008: 158).

A research design reveals how the study prioritises the range of dimensions of the research process (Bryman and Bell, 2004: 210). According to Cooper and Schindler (2008: 140), a research design can be identified as an activity and time-based plan, which is derived from research questions. It is a method of selecting the appropriate sources and seeking relevant information (Welman, Kruger, and Mitchell, 2008).

The research onion was developed by Saunders et al. (2019). The different stages are illustrated by Figure 4.1 and must be considered when developing a research strategy. When the research onion diagram is viewed from the outside, each layer of the onion provides a detailed

description of each stage of the process. The research onion provides an effective progression of the research methodology which can be designed. The relevance of the research onion becomes beneficial in the adaptability of almost any type of research, which can be used in a variety of contexts (Bryman, 2015). The research diagram will be examined and the description of each stage and concepts relevant to this study will be explained.

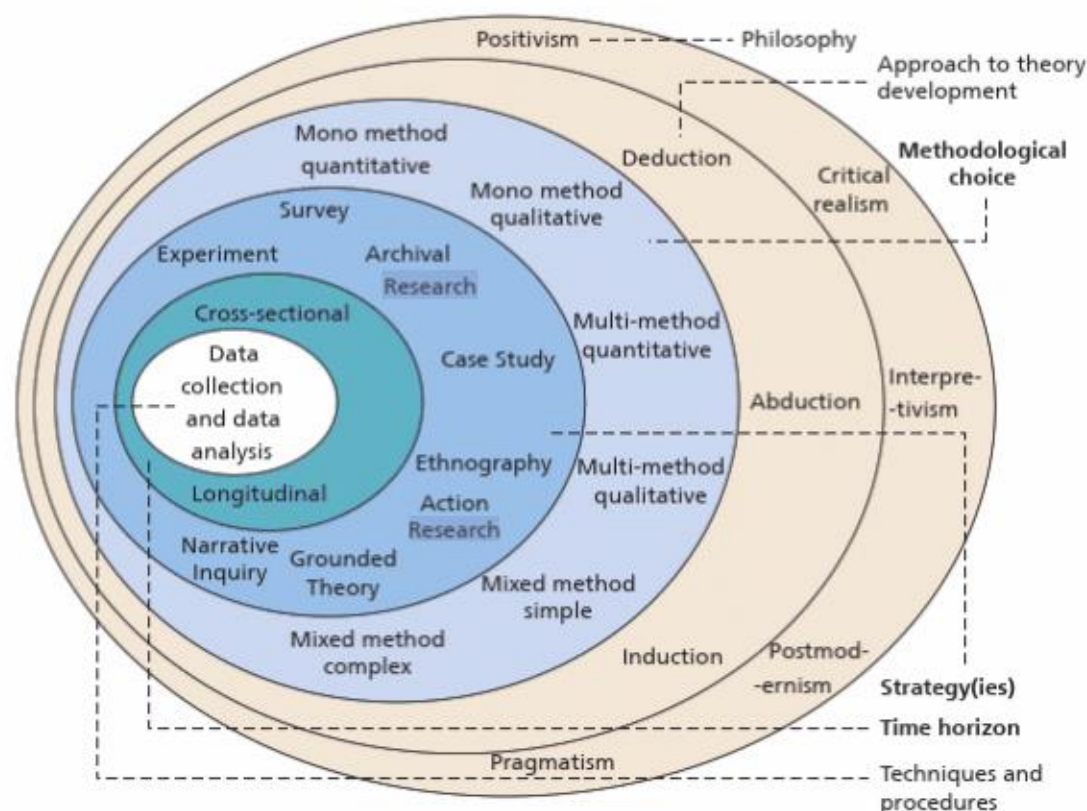


Figure 4.1: The Research Onion

Source: Saunders, Lewis, Thornhill (2019)

4.2.1 Philosophy

The interpretivist paradigm was deemed appropriate to this study as it focused on a social phenomenon within the natural environment. Interpretivism argues that truth and knowledge are subjective, culturally, and historically situated based on lived experiences and understanding of them, hence when conducting this research, the study focused on people rather than on objects, opting to understand and identify with the participants of the research. The purpose of interpretative research is to create new rich meaningful content and interpretations of the social world. Therefore, the researcher explored the organisation from the perspective of

different groups of people. This allowed for an understanding of the social world which was derived from the participants' perceptions. The data collection and analysis involved using primarily qualitative data, which was conducted through face-to-face semi-structured interviews as this study required in-depth responses.

4.2.2 Approach to Theory Development

An inductive approach was used when conducting this research study, which allowed for the creation of a new theory rather than adopting a pre-existing one as in the deductive approach. In this approach, no theory initially informs the data collection and the research framework can be formed after the data has been collected (Flick, 2011). The researcher does not start with a theoretical framework; this approach allows the researcher to look at a specific problem from a specific angle. The inductive approach is commonly used for qualitative research. Interviews are carried out to address specific phenomena, which are then examined for patterns between the participants (Flick, 2011).

4.2.3 Methodological choice

Quantitative research can be defined as a method of “testing object theories by examining the relationship amongst variables which can be measured on instruments, so numbered data can be analysed using statistical procedures” (Creswell, 2014: 4). A quantitative inquiry is rooted in the positivist paradigm which applies scientific and various logical methods to understand the phenomenon of interest and the data is to be analysed statistically. A quantitative approach focuses on the strategies of objective and systematic approach (Hahn and Kuhn, 2012). This means the researcher focuses on various steps and progresses logically through a series of steps, according to a pre-specified plan of action required (Sekaran and Bougie, 2013: 390; Brink, Van der Walt, and Van Rensburg, 2006: 78). Quantitative research can show relationships that exist between two or more variables (Bryman, 2008).

“Qualitative research allows for a deeper understanding of consumer feelings by probing deeper into areas that quantitative research may be too superficial to access” (Hair et al., 2013: 79). “Qualitative methods are governed by several rules and offers a method of exploring issues which cannot be categorised by a number” (Greener and Martelli, 2015: 10). Within the Science and Business research context, the qualitative method becomes the preferred method of choice as it is increasingly accepted that this area of inquiry “differentiates its method from a scientific positivist paradigm” (Greener and Martelli, 2015: 101). Human behavior and constantly

changing organisations become difficult to measure in isolation as they “can offer different dimensions of themselves to different audiences” (Greener and Martelli, 2015: 101).

This research adopted a qualitative approach as the study explores aspects of the eThekwini Water Department through senior managers and managers. “Qualitative research allows for a deeper understanding of consumer feelings by probing deeper into areas that quantitative research may be too superficial to access” (Hair et al., 2013: 79). Greener and Martelli (2015:101) state that the qualitative approach is more beneficial for some problems than the quantitative approach, based on the various challenges and issues in an organisation or group of individuals (Ghauri, Gronhaug and Kristianslund, 1995). Therefore, extensive explanation and reasoning were needed, hence the reason for the methodology. A qualitative methodology has various strengths; however, researchers need to understand the level of difficulty in collecting, analysing, and categorising data.

4.2.4 Research Strategy

The nature of this study suggested the use of an exploratory case study design. Sekaran et al. (2016) define exploratory design as a study where little or no information or knowledge is available on the phenomenon under investigation, or new ideas being investigated. The aim of the exploratory design to explore the full nature of the phenomenon, bringing clarity to concepts, identifying different types of priorities, cultivating different operation definitions, and improving the overall research design (Cooper and Schindler, 2008: 145).

Case studies are often used in exploratory research. The case study method allows for the generation of new research that can be tested and evaluated and produce in-depth for possible use by other similar cases. Also, case studies provide valuable insight into the illustration and development of theories and existing models demonstrating the relationship between the different variables.

The exploratory case study allowed the researcher to examine the data thoroughly within certain limits, which concluded that a case study approach allowed for the selection of a small geographical area or a limited number of participants for the focus of the study.

The case study approach was appropriate to conduct this study as the researcher was provided access to a specific organization “eThekwini Municipality Water and Sanitation department”. This approach will assist with the investigation of a contemporary phenomenon in-depth and

within the real-world context, especially when boundaries between the phenomenon and context may not be evident. The researcher adopted this approach as he wanted to understand a real-world case and not assume an understanding that is more likely to involve important contextual conditions pertinent to the eThekweni Municipality.

Furthermore, this research strategy was relevant to this study because of the impact on the water management practices and the causes of the limited water supply that are affecting not only the KZN province but South Africa. In this context, an exploratory case study design was preferred to explore the full nature of the phenomenon, while understanding the current underlying issues in the eThekweni water region.

4.2.5 Time Horizon

The study involved a cross-sectional design as the data was gathered at the same time. The researcher adopted this perspective design primarily on the basis that it was not the stated intention of the research to assess changes in particular variables over a period.

A cross-sectional study is a type of observational study design, which allows the researcher to measure the outcome and the exposures of the research participants at the same time. Consequently, it was considered unnecessary to interview these same participants some months later to track any variations. The participants for a cross-sectional study are selected on the inclusion and exclusion criteria set for the study. Once the participants were selected, the researcher followed the study to assess the exposures and the outcomes. The analysis was involved from different information collected from a subset of a large population, who were knowledgeable in the area of the study. As previously stated, the qualitative approach was used and semi-structured, face-to-face interviews were used. NVivo was used to analyse the responses and selection of themes, sub-themes and codes were derived from this software (thematic analysis).

4.2.6 Techniques and procedures

4.2.6.1 The Data Collection Instrument

The data collection instrument used was a semi-structured, face-to-face interview schedule. This interview schedule can be found in Appendix D. The interview schedule consists of an introduction, the interview questions, and a conclusion.

4.2.6.2 The Interviews

4.2.6.2.1 Interview Process and Procedures

As discussed previously, the researcher used a qualitative approach, semi-structured face-to-face interviews were adopted as the primary data collection instrument to collect data from the participants.

The interview dates and locations were set and communicated in advance by the researcher. The researcher set interview dates according to the availability of the participant.

All participants were given reminders either by email or telephone a few days before the interviews took place. A variety of different venues such as offices and boardrooms were used to conduct the interview, this was dependent on the suitability and convenience of the participant at that specific time. Each interview lasted approximately 90 to 120 minutes. It was difficult for the researcher to have advanced knowledge of how many respondents would be required for this specific study to reach a point of saturation (Glaser & Strauss, 1967). However, in the end, a total of 12 participants were willing to participate, but only 9 participants finally agreed and were available during the interview schedule dates.

At the start of each interview, the researcher introduced himself to the participant and provided a brief description of the study and key information that was important for the participant to know before the interview. The researcher assured each participant from the start that their responses would remain anonymous and confidential. Also, the researcher reiterated to each participant that their involvement in this research was voluntary and the participant had the right to terminate the interview at any given time should they feel necessary to do so.

Permission to audio record the interview was requested from each participant but participants did not grant consent to record due to the sensitivity of the information and the confidentiality and identity of themselves. The participants felt uncomfortable as they feared that this information would be leaked if recorded and this would impact the status of their employment. It was thus decided to forego the audio recording of the interviews and to make detailed notes of the participants' responses instead.

The purpose of the interviews was to ask each participant to share their knowledge and experiences within the eThekweni Municipality Water and Sanitation department, as they knew the current water management practices.

4.2.6.3 Confidentiality and Anonymity

From the start of the interview, all interview data were treated in the strictest of confidence. The researcher has not disclosed any participants names within any documents or findings within the presentation of this dissertation. Each participant was allocated a code for identification ease and these codes were in the transcripts as a mechanism tool to ensure the anonymity of the participants.

4.3 Study Site

Simons (2009) identifies a research study site as a physical place where the research study will be conducted to collect the required data. The eThekwini Water and Sanitation is a unit of the eThekwini Municipality and is responsible for the provision of water and sanitation services to all customers in the Municipality.

Therefore, the study site was conducted at eThekwini Municipality Water and Sanitation department, 3 Prior Road, KwaZulu- Natal, Durban. The EMWS department is located in the central business district (CBD) of Durban. This study site was chosen as this department is experiencing challenges with water management practices and the researcher found that staff in this department were appropriate as they had first-hand information on these challenges.

4.4 Target Population

Target Population can be defined as “the entire group of people, individuals, events, or conditions that researchers are interested in generalising the conclusion to (Sekaran and Bougie, 2013: 394). Naidoo (2011: 113) suggests that a research problem relates to a specific population that has been identified for investigation. However, it becomes impossible and expensive, as this involves all the required members of the population. Therefore, the researcher becomes dependent on the data that has been obtained from the sample (Lopez and Whitehead, 2016).

The population selected for this study were senior managers and managers of the eThekwini Municipality Water and Sanitation department. These participants were targeted because of their roles and direct involvement in the formulation and implementation of the Water Quality Management strategies as they tackle and analyse water scarcity and water loss.

The researcher would have appreciated if all 20 participants contributed during the data

collection period, However, only 12 participants had given consent to participate in this study. At the time of the data collection period, only 9 participants were available to conduct semi-structured interviews. There was a total of 5 managers and 4 senior managers who committed to participate in this study, and their valuable input was required for this study.

4.5 Sampling Method

A sample can be identified through probability or non-probability sampling (Sekaran and Bougie, 2013: 98). Battaglia (2011: 523) says “sampling involves the selection of a portion of the finite populate under a study”. Non-probability sampling is a method that does not attempt to “select a random sample from the required population, instead, the subjective methods are utilised and to decide which elements are required and needed by the sample” (Battaglia, 2011: 523). Sekaran and Bougie (2016: 130) state that it “is where the elements in the population do not have any probabilities that are associated with being selected as sample subjects”. Authors also suggest that some units in the population become more likely to be selected over others (Lopez and Whitehead, 2016). Non-probability sampling was used. This type of sampling includes purposive sampling, quota sampling, snowball sampling, judgmental sampling, and convenience sampling (Vehovar, 2016). Due to a few senior managers and managers having specific conceptual knowledge on water management practices in the EMWS department, these individuals were targeted.

4.6 The Purpose of non-probability sampling

The purpose of non-probability sampling is described in Figure 4.2, which illustrates the various types of non-probability sampling together with its characteristics.

Quota sampling	Bryman and Bell (2004: 112) “Development of a sample that mirrors a population in terms of different relative proportions of members within different socio-economic, demographic, and geographic groups”.
Judgmental sampling	Cooper and Schindler (2008: 397) “Used when a researcher is conformed to sample set criteria”

Convenience sampling	Bryman and Bell (2004: 105) “The purpose of convenience sampling is when the sample is available immediately to the researcher as a result of immediate accessibility.”
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Table 4.1: Different non-probability sampling techniques

In purposive sampling, there is judgmental and quota sampling. Purposive sampling is a method synonymous with qualitative research (Palys 2008: 697). This study used non-probability sampling, where the elements of this sampling technique in the population do not have any probabilities associated with being selected as sample subjects (Sekaran and Bougie, 2013: 132).

This study adopted a purposive convenience sampling technique, which involved selecting specific participants that were accessible at the time of the research and were in the best position to provide the required information or data on the aspect of water management practices.

Purposive sampling aims to produce a sample that can represent the target population (Battaglia, 2011: 524). Therefore the “selection of a purposive sample is about the application of expert knowledge of the population (Etikan, 2016), that will enable a non-probability manner, that will represent a cross-section of the population (Battaglia, 2011: 524).

Purposive sampling was more appropriate than a systematic approach because it was not easy to access some participants due to shifts and some employees’ functions are situated at more than one division (Palinkas, 2015). The purposive sampling possesses quality choices for the researcher to use (Saunders et al., 2016). This sampling is a non-random method that does not require theories to support it. The researcher had full decision-making on the selection of the participants based on the criteria of knowledge and skills imperative for this type of study (Saunders et al., 2016).

Senior managers and managers were selected based on their employment positions and years of service. The criterion used was based on 5 years or more of service. The participants were selected from a list of long service employees at the EMWS department and were selected as the researcher’s target population of which 20 were purposively chosen but only 9 agreed to participate in the study.

4.7 Sample Size

Sekaran and Bougie (2016, 241) state “a sample is a subset of a population, where particular elements or numbers of elements are selected from the population”. Therefore, the definition of sample size is the process of selecting the number of units in a study, based on the representation of the larger population (Dermatol, 2016).

The determination of a sample design is based on the level of precision and confidence desired in estimating the population parameters, also taking into consideration the variability of the population (Sekaran and Bougie, 2016: 249). With reference to Creswell and Creswell (2018), between 8 and 12 interviews may be sufficient before a point of saturation is reached. Although 20 requests were made for participation in the study, only 9 participants responded to undertake this study. Therefore, the total number of people interviewed during the data collection was nine (9) participants.

4.8 Sample

Sekaran and Bougie (2013: 241) define a sample as “a subset of the population and comprises of some of the selected participants but not all”. As the sample is a subgroup or subset of the target population, by selecting and studying the sample size, the researcher should generalise and conclude the population of interest (Sekaran and Bougie, 2013: 241).

A small sample of individuals, events, or groups are consistently chosen for investigation due to the in-depth nature of a qualitative study (Sekaran and Bougie, 2013: 296). Sekaran and Bougie (2013: 242-243) say that “in research investigations involving several hundred and even thousands of elements it becomes practically impossible to collect data from or test or examine every element”. Even if this had been possible, it would be prohibitive in terms of time, cost, and other human resources. The study of a sample rather than the entire population is also sometimes likely to produce more reliable results (Martinez- Mesa, 2014). This is mostly because fatigue is reduced and fewer errors, therefore, result in collecting data, especially when a larger number of elements is involved. Therefore, qualitative studies consist of a small sample size which results in generalised findings, which are highly restricted (Sekaran and Bougie, 2013: 296).

4.9 Data Collection Instruments

The data collection method employed in this study was face-to-face semi-structured interviews, where information was required from participants from the outset. Sekaran and Bougie (2013: 118) suggests that unstructured interviews are useful to bring preliminary issues to the surface, and help the researcher determine which factors are imperative for in-depth investigation (Neuman, 2011). According to the type of study and the complexity of the issue being investigated, structured interviews may either be conducted face-to-face, by computer or telephonically, while unstructured interviews can be conducted face-to-face based on business research. (Sekaran and Bougie, 2016).

The advantage of using interviews include participants being able to use their interpersonal skills to cooperate and gain deeper information. Sekaran and Bougie (2013) suggest that there is a higher response rate to interviews compared to questionnaires.

Interviews can also assist in the clarification of terms or questions, and clear up uncertainty and doubts (Sandelowski, 2000b). Participants can also use visual aids to clarify focal points (Hair et al., 2013). Considering the type and title of this study, the researcher used interviews to obtain data based on the knowledge required to understand the phenomena in the study.

The researcher prepared a list of questions that were asked to the participants during a face-to-face interview. Sekaran and Bougie (2016) suggest that each respondent should be asked the same questions. As the questions were answered by the participant, the researcher simultaneously took down word-for- word answers.

4.10 Access to participants and Data Collection Process

The researcher approached the deputy head of the eThekweni Municipality Water and Sanitation department and explained the objective of the study. He was then advised to approach the Human Resource department and requested permission to conduct research. An appointment was provided by the HR Senior manager, the researcher explained the objective of the study and the HR Senior manager advised that an official letter of request for permission was required and needed to be sent to the HR department. After the HR department received the letter of request, the HR department requested permission to conduct research within the EMWS Department. The Head of the EMWS department provided a letter of approval to the

researcher granting permission to conduct research. Thereafter, ethical clearance was requested from the University of KwaZulu-Natal's research office, once the ethical committee had met and accepted the application, permission was granted to undertake the study.

The data collection process began after securing ethical clearance approval from the University Ethics Board and obtaining gatekeeper permission from the eThekweni Water and Sanitation Department. The Head of the department granted permission to the participants to conduct the necessary research. The sampling technique for this study was purposive sampling. Hence, the researcher selected potential participants based on the value of quality that he/she possesses and the criterion of five years of managerial level experience from the list of long service at the EMWS department.

Once the participants were selected; the researcher provided the objective and a detailed overview of the study. He set two weeks for the participants to decide whether they would participate in the study. Thereafter, twelve consent forms were sent to the relevant voluntarily participants who agreed to participate in the study. Once the consent forms were signed and sent back to the researcher, face-to-face interviews were scheduled according to the availability of the participants. Location was discussed and participants chose a variety of venues such as offices and boardrooms at the eThekweni Water and Sanitation department, 3 Prior Road, Durban. The interviews were conducted during the period of 4 March 2019 to the 15 March 2019 and had a duration of approximately 90 to 120 minutes each.

According to Greener and Martelli (2015: 113), the preparation of critical questions is important, as this will help researchers to achieve their research outcomes and to be professional and consistent during interviews. The researcher (interviewer) should be knowledgeable about the concepts of the study and should be able to control the questions and follow the "directions suggested by the interviewee (Sandelowski, 2000b)". Therefore, the interview questions must be guided by the research questions.

During the interview, direct responses were provided to most of the questions, but some participants required clarification to answer the question. Since the participants did not provide consent to audio record the interviews because of the sensitivity of the information, the researcher took a word for word response from each participant during the interview. After the interview was completed with each participant, the researcher went through each question and response with the participant to ensure that appropriate answers were relevant to each interview

guide question. Thereafter, the researcher provided the participants with a copy of the transcribed notes that were taken during the interview, this enabled the participants to review their interview responses and verify interpretive accuracy. Once all interviews were done, the researcher began the process of data analysis by exporting all transcriptions into NVivo 12 software for subsequent coding and analysis.

Saunders et al (2019) define the pre-test as a small- scale test aspect of research. The researcher a limited number of participants and did not want to use up a participant on a pre-test of the interview. Instead, the researcher gained input from his supervisors and experienced researchers. Their valuable feedback and suggestions were incorporated into the interview guide to ensure that the quality of the interview guide was appropriate for this study.

4.11 Data Quality Control

It is imperative to ensure the reliability and validity of a research study as they measure the quality of the study. Hair et al. (2013: 78) suggest that qualitative research data and analysis are cautious and rigorous. Most research practitioners regard qualitative research as less reliable than quantitative research (Saunders et al., 2016). However, most researchers prefer to use qualitative research as this type of research requires and provides deeper knowledge (Saunders et al., 2013). Consequently, qualitative research helps researchers understand their participants instead of predetermining categories with the answers, as this restricts the explanation of responses (Hair et al., 2013: 78).

To ensure reliability and validity in qualitative research, the examination of trustworthiness is crucial. Lincoln and Guba (1985), while establishing good quality of qualitative studies through reliability and validity, state that the trustworthiness of a research report lies at the heart of issues conventionally discussed as reliability and validity. Strauss and Corbin (1990) also suggested that the “usual canons of “good science” require redefinition to fit the qualitative research realities. Therefore, “Qualitative research allows for a deeper understanding of consumer feelings by probing deeper into areas that quantitative research may be too superficial to access” (Hair et al., 2013).

Qualitative research discovers unanticipated findings and reactions, while some research experts mention that qualitative research becomes less reliable than quantitative research (Hair

et al., 2013). Gibbs (2007) states that qualitative validity means that the researcher checks the accuracy of the findings, by employing certain protocols and procedures, whereas qualitative reliability indicates that the researcher must be consistent with his/her approach amongst other researchers and other projects. Golafshani (2003: 598) contends that “validity and reliability are two factors which any qualitative researcher should be concerned about while designing a study, analysing results and judging the quality of the study”.

This research study used the framework of trustworthiness by Lincoln and Guba (1985), to assess the data quality. Trustworthiness replaces reliability and validity as these two terms are deemed relevant and are treated separately in quantitative research, while in a qualitative study, reliability, and validity are not viewed separately but are categorised as a pair. Instead these two terms are referred together as transferability, trustworthiness, and credibility (Golafshani, 2003).

According to Lincoln and Guba (1985), there are four dimensions of trustworthiness:

2.15.1 Credibility (Internal validity)

2.15.2 Dependability (Reliability)

2.15.3 Transferability (External validity and generalisability)

2.15.4 Confirmability (Objectivity)

Trustworthiness refers to a degree of confidence, interpretation, and methods used to ensure the quality of the study (Pilot and Beck, 2014). When conducting research, the researcher must establish the different protocols and procedures necessary for that specific study and consider them worthy of consideration by the readers (Amankwaa, 2016). Although many research experts agree that trustworthiness is necessary for qualitative research, debates have been waged in literature as to what constitutes trustworthiness (Leung, 2015). The terms validity and reliability in qualitative research are not viewed as separate terms but can be categorised as pair terms, and instead, these two terminologies are encompassed together as transferability, trustworthiness, and credibility (Golafshani, 2003).

4.11.1 Credibility

Lincoln and Guba (1985) stated that the credibility of the study is determined when the co-researcher or reader is confronted with the experience and they can recognise it. The concept

of credibility addresses the term “fit” between the participant's views and the researcher’s representation of them (Tobin & Begley, 2004). Lincoln and Guba (1985) provided several techniques to address the concept of credibility. These activities include prolonged engagement; persistent observation; data collection triangulation and researcher triangulation. These authors also recommended peer debriefing to provide an overview of the external check of the research process; examine referential adequacy to check preliminary findings and interpret against the raw data, both may increase the value of credibility (Lincoln & Guba, 1985).

Shenton (2004) cites Lincoln and Guba (1985) that to ensure trustworthiness, credibility is a vital contributing factor. Both authors have made the following provisions to enhance the research study by promoting confidence in the credibility of the study: a) the adoption of research methods well established in a qualitative investigation in general; b) the development of an early familiarity with the culture of participating organisations; c) random sampling of individuals to serve as informants; d) triangulation; e) tactics to help ensure honesty in informants; f) iterative questioning; g) negative case analysis; h) frequent debriefing sessions; i) peer scrutiny of the research project; j) the researcher’s “reflective commentary”; k) background, qualifications, and experience of the investigator; l) member checks; m) thick description of the phenomenon under scrutiny, and n) examination of previous research findings. Consequently, the researcher adopted these provisions to ensure that credibility was always guaranteed.

As a “tactic to help ensure honesty in informants” when contributing data, the researcher gave each participant approached an opportunity to refuse participation and to ensure that the data collection sessions only involved willing and prepared participants who provided consent to offer data freely (Shenton, 2004).

According to Shenton (2004, 68), the provision of “Background, qualifications, and experience of the investigator” was relevant as it assisted the credibility of the researcher, as the researcher is the major instrument of the data collection and analysis (Patton, 1990). Credibility was enhanced as the researcher is qualified, experienced, and is knowledgeable about the study.

The provision of “member checks” ensured credibility (Shenton, 2004: 68), as the researcher provided the participants with a copy of the transcribed notes that was taken during the

interview, this enabled the participants to review their interview responses and verify interpretive accuracy; consequently this increased the credibility of the study. (Golafshani, 2003). The researcher also adopted the provision of “iterative questioning”, this was relevant as this study probed to elicit detailed data, as some matters previously raised from the participant were important and the researcher returned to extract related data through rephrased questions (Shenton, 2004: 67).

The provision of a “thick description of the phenomenon under scrutiny” was relevant as the researcher provided a detailed description of the study site to ensure that the reader is knowledgeable about the phenomenon under study. This allowed the reader to determine the extent to which the overall findings were made, by comparing his/her situation to the study (Shenton, 2004).

4.11.2 Dependability

Lincoln and Guba (1985) assert that dependability aims to replace reliability, which requires the researcher to replicate the study, and should achieve the same results. As this is not expected in a qualitative setting, alternative criteria are general understandability, the flow of argument and logic. The researcher must ensure that the process and the product are consistent throughout. Tobin and Begley (2004), states that the research process must be logical, traceable, and documented to achieve dependability. Another way to ensure that the research study demonstrates dependability is to ensure that the process is audited (Lincoln and Guba, 1985).

According to (Lincoln and Guba, 1985), dependability includes the aspect of consistency, hence, the researcher ensured that the analysis process was in line with the accepted standards for this study. He ensured that the interpretation was not based on his preference and viewpoints but was grounded in the data. For the audit trail, the researcher took responsibility and provided a complete set of notes on the decisions that were made during the research process, reflective thoughts, sampling, research materials adopted, the emergence of the findings, and information about data management. Another way that dependability was achieved, was that the researcher provided the participants with a copy of the transcribed notes that were taken during the interview. This enabled the participants to review their interview responses and verify interpretive accuracy, consequently this increased the dependability of the study.

4.11.3 Transferability

The concept of transferability refers to the generalisability of the inquiry, this concern only refers to a case-to-case transfer within qualitative research (Tobin & Begley, 2004). The researcher may not know the sites that require the transfer of findings, hence, the researcher is responsible for providing a detailed description, so that other researchers who seek to transfer the findings to their own site can judge the concept of transferability (Lincoln & Guba, 1985). Trochim (2006) also argues that transferability corresponds to external validity, i.e. generalising a research study's results, hence, transferability can be achieved thoroughly by the description of the research context and the underlying assumptions. By providing the required information, the research results may be transferred from the original research situation to a similar situation.

Since the findings of a qualitative study are specific to a small number of participants from a specific environment, it becomes difficult for the researcher to demonstrate that the findings and conclusions become pertinent to other relevant situations and populations (Shenton, 2004). Lincoln and Guba (1985) and Firestone (1993) both share a similar argument that the researcher must take full responsibility and ensure that there is adequate contextual information about their fieldwork sites, to allow the qualitative research project reader to make the transfer.

According to Shenton (2004: 70), before any transference is made, the following factors must be given at the outset: a) the number of organisations that confirmed participation in the study and their location of business; b) any restrictions with the type of people that contributed to the data; c) the number of participants involved with the fieldwork; d) the various data collection methods that were adopted; e) the number and the time frame of the data collection sessions and f) the duration in which the data was collected. The researcher acknowledged all these factors and has provided sufficient detail of the context for other researchers to consider the possibility of transferability.

4.11.4 Confirmability

Tobin and Begley (2004) state that confirmability is a concern with the establishment of the researcher's interpretations and findings which are derived from the data. This is required from the researcher, to demonstrate how the conclusions and interpretations have been reached. According to Lincoln and Guba (1985), the state instead of general objectivity in quantitative

research, the researcher is required to his/her interpretation of neutrality of the research. This can be achieved by a confirmability audit, which includes an audit trail of raw data, analysis notes, reconstruction as well as preliminary developmental information. Therefore, both these authors have argued that confirmability can only be established when transferability, credibility, and dependability are all achieved. The concept of confirmability is the qualitative equivalent of objectivity (Shenton, 2004:71). Steps need to be taken to ensure that the findings of the study are “the results of the experiences and ideas” of the participants rather than “the characteristics and preferences of the researcher”.

Confirmability was maintained in this study as an audit trail was created and can be checked if necessary. The researcher provided a detailed process of the data collection, data analysis, and interpretation of the data. Due to the participants not providing consent to record the interview because of the sensitivity of information if spoken freely, the researcher instead took word for word responses during the interview to ensure confirmability.

4.11.5 Reflexivity

Palaganas et al., (2017: 426) confirm that a “qualitative researcher needs to acknowledge the importance of being self-aware and reflexive about their personal role in the process of collecting, analysing and interpreting the data as well as the preconceived assumptions that the researcher brings to his or her study”. Therefore, the researcher must ensure that their interviews, observations, focus group discussions and all analysis must be supplemented with their reflexive notes (Lincoln and Guba, 1985).

4.12 Data Analysis

Data analysis occurs once the collection of data is done to interpret the results (Collis and Hussey, 2003). For this study, qualitative data was analysed using thematic analysis.

According to Thomas and Harden (2008), thematic analysis is a technique used to examine data of primary qualitative research. Braun and Clarke (2006: 3) stated that “thematic analysis is a poorly demarcated, rarely acknowledged and yet widely-used qualitative analytic method”, whereas Nowell, Norris, White, and Moules (2017) suggest that thematic analysis seeks to pinpoint, look for patterns and examine for recurring themes in the collected data. NVivo 12 was employed as the software tool for thematic analysis for this qualitative study.

The thematic analysis consists of six steps according to Braun and Clarke (2006) and these steps were followed:

- Step 1: Getting familiar with the data,
- Step 2: Generating the first set of codes,
- Step 3: Searching for themes in the coded data,
- Step 4: Reviewing the themes,
- Step 5: Redefining the themes and naming the themes
- Step 6: Producing the final report.

During the process of data analysis, the researcher went through each transcript and became familiar with the data by ensuring it was correct, consistent, and useable. The researcher looked for spelling and language errors within the data and corrected the errors while processing to ensure clean data. After this process was done, the researcher captured and exported the data into NVivo 12 software for subsequent coding and analysis. After data was exported into NVivo 12 software, the researcher was able to identify themes, patterns, and categories as they started to emerge.

According to Braun and Clarke (2006: 78), it can be concluded that “thematic analysis provides a flexible and useful research technique that can be used to provide a rich and detailed outcome that can help researchers when analysing complex data.

4.13 Ethical Consideration

Ethical clearance was obtained from the University of KwaZulu-Natal. It is a mandatory requirement that all researchers at the university should familiarise themselves with the necessary research ethics. The research ethic applies to two main groups of individuals. Firstly, the researcher who is undertaking the research study should already be conscious of his/her responsibilities, obligations, and the research subject matter. This allows the researcher to protect his/her basic rights. The second group of individuals is the participants who will be used during the data collection period. These individuals are normally selected through various techniques to ensure the credibility and trustworthiness of the findings.

During this research study, the research instrument that was utilised ensured the anonymity of all participants. The research participants were not coerced into disclosing their personal

information at any time. All information collected was utilised for research purposes only and the researcher ensured that the privacy and confidentiality were not breached at any time, Informed consent letters were given to each respondent before the interview process began, outlining the objectives of the study in detail. This allowed the participants to feel comfortable as their anonymity was guaranteed and their role in this research was discussed with them. Only once the researcher received full consent from the research participants could the researcher proceed with the interview.

A gatekeeper's letter was also issued by the eThekweni Municipality Water and Sanitation department. This granted permission for the research to be conducted within the organisation as part of the Master of Commerce qualification in Supply Chain Management. The Municipality was assured that all information gained from the research would be treated with utmost circumspection and should the organisation request for the resulting outcome to be embargoed from the dissertation for an agreed time, this would be arranged with the researcher, supervisor, and relevant individuals within the Municipality. The research committed to adhering to anonymity and confidentiality of the participation from the eThekweni Municipality Water and Sanitation department and all participants.

4.14 Conclusion

In conclusion, this chapter has highlighted and presented the importance of the research methodology that pertains to this investigation. The necessary procedures were implemented according to the study research design which is exploratory. This research design has allowed for the collection of the primary data and the steps required for this study. The vital techniques of the sampling process were also presented in this chapter. This allowed the researcher to use purposive sampling to identify the selection of appropriate employees that would be required for the study. The study also illustrated the use of non-probability purposive convenience sampling after taking into consideration the constraints that had been mentioned.

Chapter Five

Data Presentation and Analysis

5.1 Introduction

This chapter presents the analysis of the interviews conducted and provides discussions of the findings of the study. The primary instrument used to collect data for this study was interviews with senior managers and managers from the eThekweni Municipality Water and Sanitation Department.

This chapter is focused on the presentation of data and analysis of the data using computer-aided data analysis software - NVIVO 12 and thematic analysis. The thematic analysis highlights patterns, pinpoints, and examines data for recurring themes. The thematic analysis followed the Braun & Clark (2006) six steps.

1. Getting familiar with the data,
2. Generating the first set of codes,
3. Searching for themes in the coded data,
4. Reviewing the themes,
5. Redefining the themes and naming the themes and
6. Producing the final report.

5.1.1 Process steps of analysis

The process step started with transcribing the interviews and importing them into the NVIVO 12 software. After exporting to NVIVO 12, the first set of coding was done using the questions as the main themes, the participants' responses and non-responses formed the sub-themes. An in-depth review to search for recurring patterns, themes, and consistencies, revealed responses which also gave rise to other sets of themes. The research objectives will be recapped and used to frame the discussion.

5.1.2 Structure of analysis

This research study is aimed at assessing water management practices within the KwaZulu-Natal region: A case study of the eThekweni Municipality. The following research objectives were designed:

- To explore the accessibility of water supply to consumers within the eThekweni Municipality
- To explore the relationship between the supply of water and water restrictions within eThekweni Municipality
- To examine the amount of rainfall and water supplied to the eThekweni Municipality.
- To evaluate the Quality Management System (QMS) on water management practices at eThekweni Municipality.
- To provide recommendations for a more suitable water detection method to which will reduce existing water loss.

The interview questions were divided into six sections

Section a: *Water supply*,

Section b: *Accessibility of water supply*,

Section c: *Correlation between water supply and water restrictions*,

Section d: *Examining the amount of rainfall*,

Section e: *Quality management system*, and

Section f: *Water detection method*.

The outcomes of the analysis were then displayed in models to visualize the themes and relationships. The results of the data analysis will be presented in a model per question to show the responses from the participants. This is to display and understand the results in detail.

5.1.3 Response rate

The researcher would have appreciated if all 20 participants contributed during the data collection period, However, only 12 participants had given consent to participate in this study. At the time of the data collection period, only 9 participants were available to conduct semi-

structured interviews. Therefore, a response rate of 45% was obtained.

5.2 Presentation of Data Analysis

5.2.1 Research Objective One

Objective 1: To explore the accessibility of water supply to consumers within the eThekweni Municipality

Section A: Question 1

What do you understand by the term ‘water supply’?

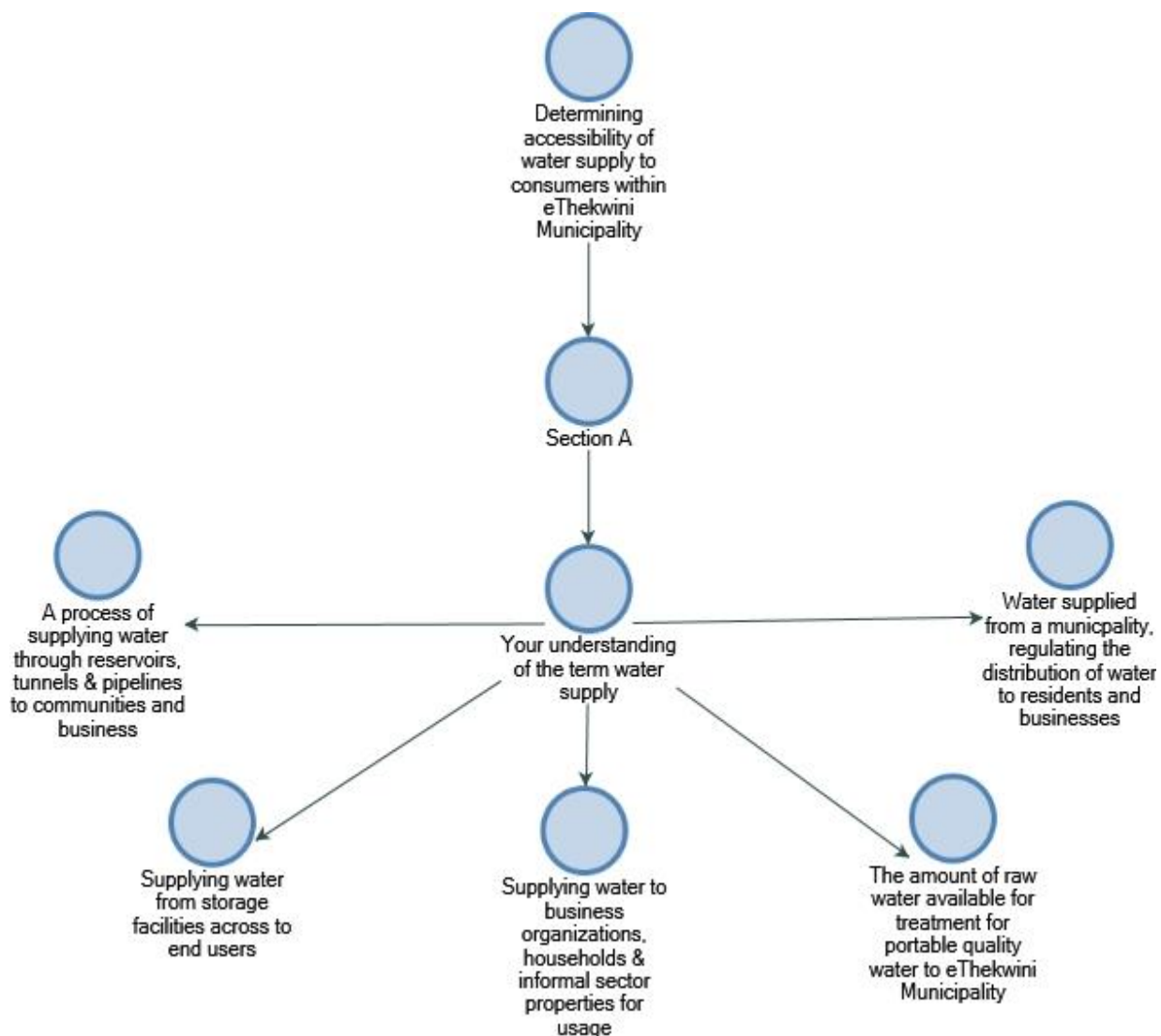


Figure 5.1. The model shows participants understanding of the term ‘water supply’

Interpretation: This question aimed to gain insight into each research participant’s interpretation of the term water supply.

The general perception gained from participants was “*Supplying water from storage facilities across to end-users; Supplying water to business organizations, households and informal sector properties for usage; Water supplied from a Municipality , regulating the distribution of water to residents and businesses; The amount of raw water available for treatment for portable quality water to eThekweni Municipality ; and A process of supplying water through reservoirs tunnels and pipelines to communities and businesses.*”

Conclusion/themes: The summation of the findings shows the participants have a clear understanding of the term ‘water supply’.

Themes:

- Storage
- Customer supply processes
- Management regulations.

Participants 1 and 2 stated that water supply is a process of supplying water from storage. Participants: 1, 3, 4, and 6 described the water supply as a process to customers. Participants 3, 6, 8, and 9 perspectives of water supply were seen as management service, and participants stated that management regulations were required and needed to be followed.

Question 2: How has your department contributed, in terms of strategies, towards the mitigation/alleviation regarding the shortage of the water supply?

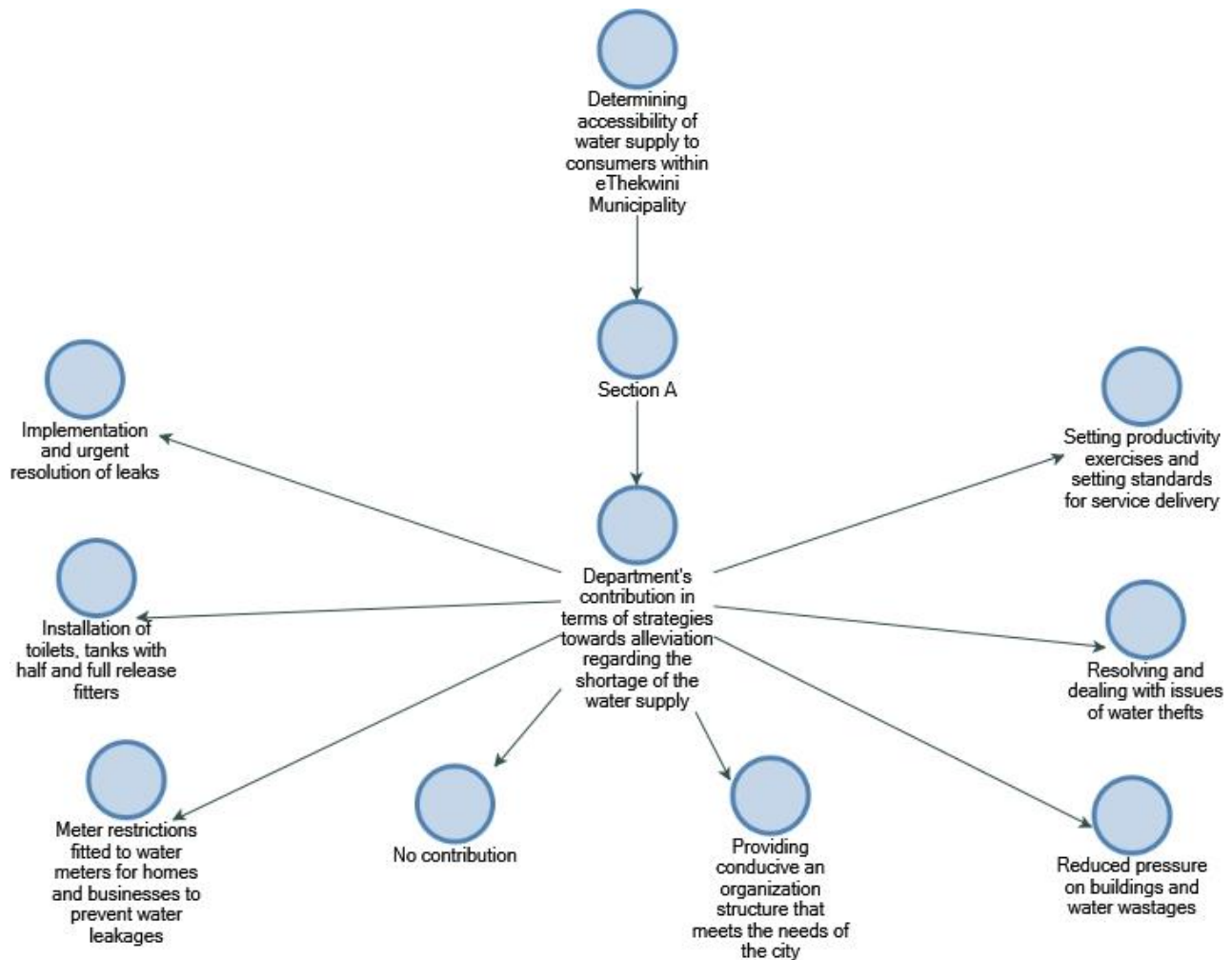


Figure 5.2. Participants' response to the question on the department's contribution in terms of strategies for water supply

Interpretation: The purpose of this question was to establish the extent of managerial contribution towards developing strategies of mitigation/alleviation to prevent further water shortages.

The responses include “*Meter restrictions fitted to water for homes and businesses to prevent water leakages, reduced pressure on buildings and water wastages, installation of toilets, tanks with half and full release fitters, implementation and urgent resolution of leaks, resolving and*

dealing with issues of water thefts, setting productivity exercises and setting standards for service delivery and providing conducive organization structure that meets the needs of the city, no contribution”.

Conclusion/themes: The findings showed that EMWS was responsive to any water supply leakages and detection.

- Water metering infrastructures
- Water management structures
- Leakage prevention measures

Participants 2, 6, and 8 believed that water metering infrastructures was necessary for mitigation of water shortage. Participants 3, 5, 6, and 7 highlighted water management structures as their main contribution towards the alleviation of water shortage. Participants 3, 6, 7, 8, and 9 touched on leak preventions that could assist with mitigation measures for the shortage of water supply.

Question 3: How is the shortage of water supply being affected by your department?

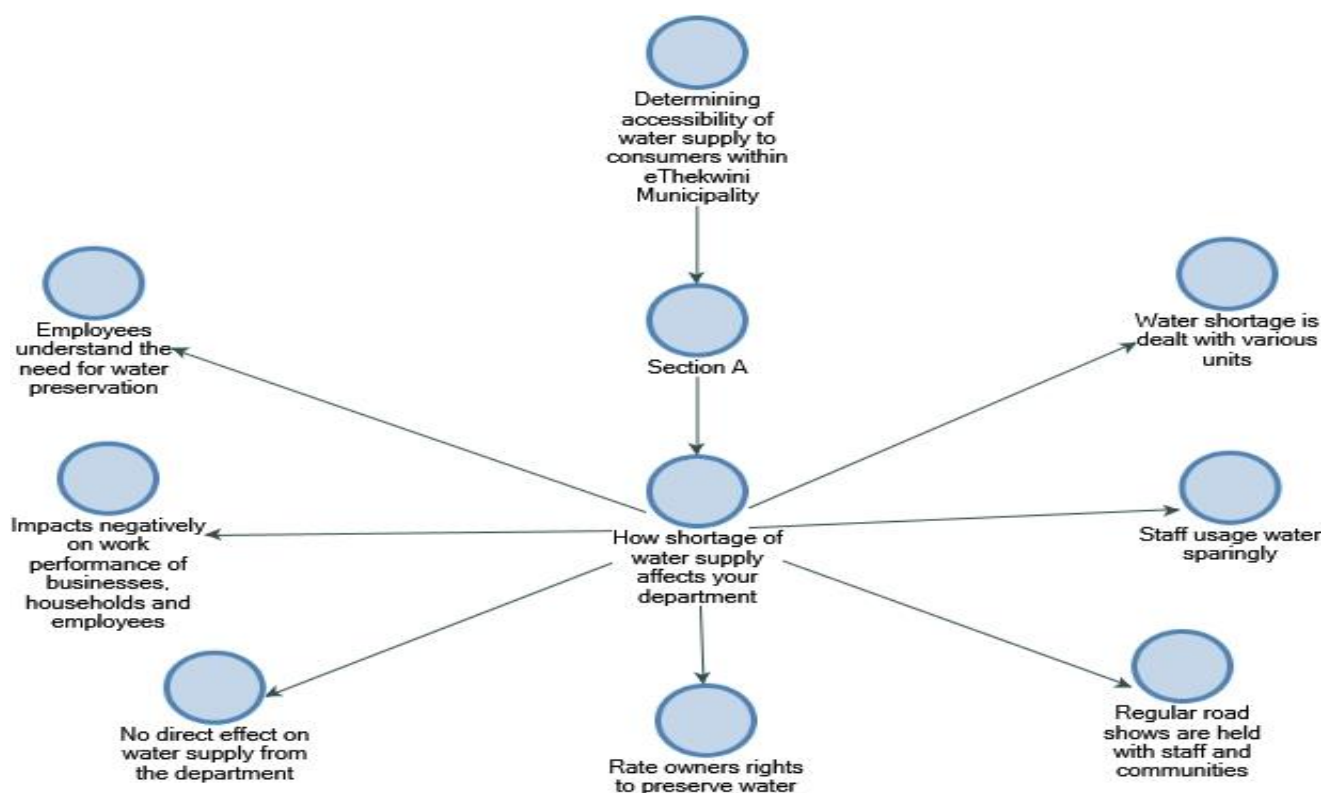


Figure 5.3. How water supply shortage affects their department

Interpretation: Departmental information sharing was imperative therefore, the researcher aimed to identify whether the participants portrayed adequate information for the development of strategies.

Their responses to the question were: *“Water shortage is dealt with from various units; employees understand the need for water preservation; staff usage of water sparingly; regular roadshows are held with staff and communities; rate owners’ rights to preserve water; no direct effect on water supply from the department; impacts negatively on work performance, businesses, households, and employees”*.

Conclusion/themes: The findings from participants shows that the department staff were aware of the water shortage and made efforts to minimize the usage and preserve it, although some of them confirmed it negatively impacted work performance. Themes include:

- Water preservation measures
- Water awareness programs
- Impact on performance

Participants 2, 4, 6, 8, and 9 all described at least one of the above as a sign of staff awareness of water shortages and efforts to minimize it.

Question 4: In your opinion, do you think that the shortage of water supply will be a concern in the next 10 years?

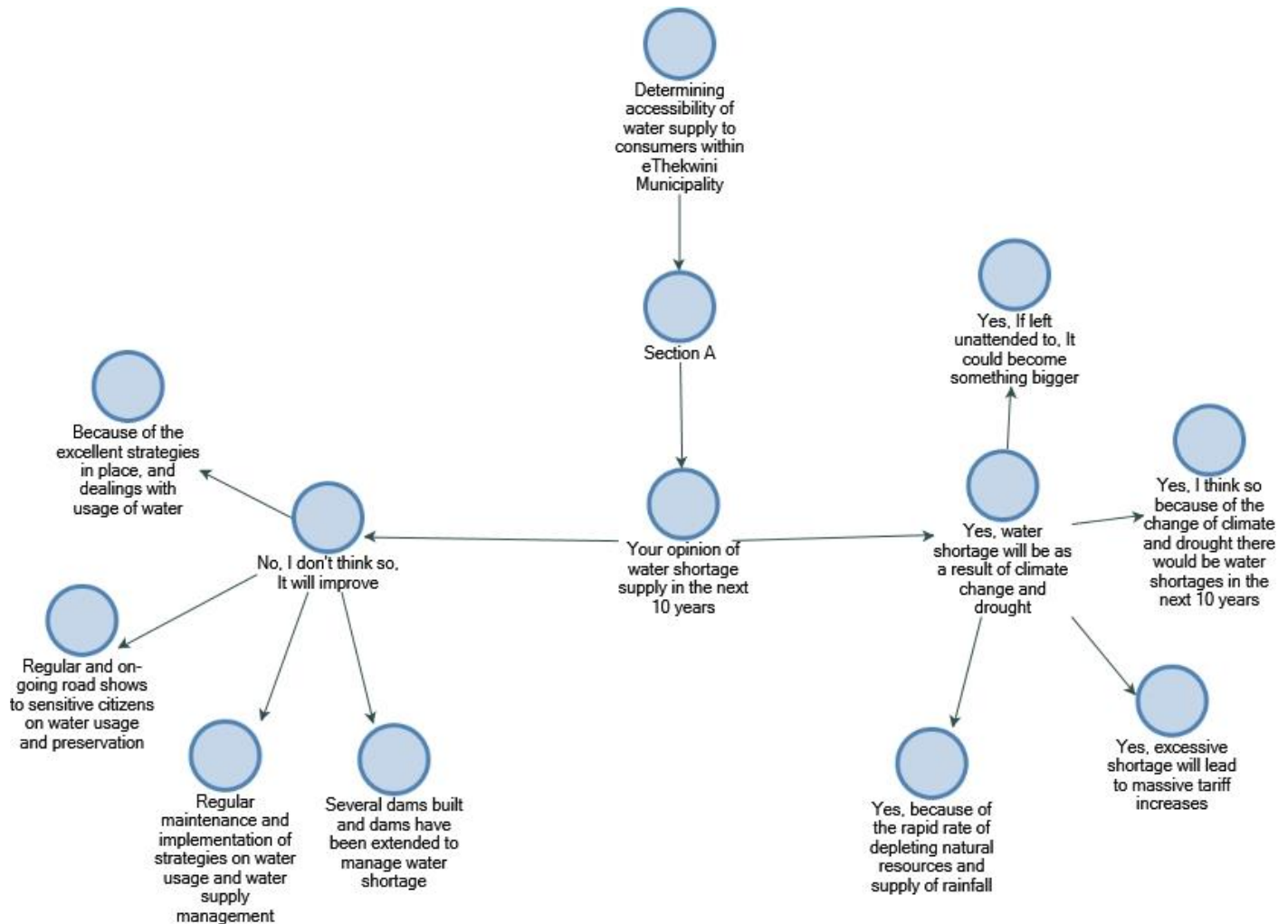


Figure 5.4. Participants' opinion on water shortage supply in the next 10 years

Interpretations: The researcher found it fitting to ask the selected participants about their opinion on the growing concern of water shortage as they would be knowledgeable about the current water demand patterns.

Their responses were two-fold. Some stated that “*Yes water shortage will be as a result of climate change and drought*”. Other participants disagreed, stating that “*No, I do not think so, it will improve*”.

“Yes, water shortage will be as a result of climate change and drought: Yes, the excessive shortage will lead to massive tariff increases. Yes, if left unattended, it could become something

bigger. Yes, I think so, because of the change of climate and drought, there would be water shortages in the next 10 years”.

“No, I don’t think so. It will improve Regular maintenance and implementation of strategies on water usage and water supply management. Several dams were built, and dams extended to manage water shortage. Regular and on-going roadshows to sensitize citizens on water usage and preservation. Because of the excellent strategies in place and dealing with the usage of water”.

Conclusion/themes: The responses expressed fear about the water shortage crisis and alternatively, some expressed optimism that there will be no water shortage in 10 years. One can conclude that there were some improvements in tackling water shortage, but there is room for improvement. Themes include:

- Water shortage strategies
- Water savings awareness
- Dam maintenance strategies.

Participants 1, 2, 8, and 9 listed water shortage strategies as necessary for the next 10 years. Water savings awareness was more of the focus for participants 2, 5, 6, and 7. Participants 2, and 8 believed dam maintenance strategies were necessary to adapt to climate change, as the weather patterns were changing and appropriate dam maintenance strategies were needed for this change.

Question 5: Do you think that KZN is heading for a major water crisis? Please explain, in your opinion, why or why not, water scarcity is becoming a major crisis in South Africa?

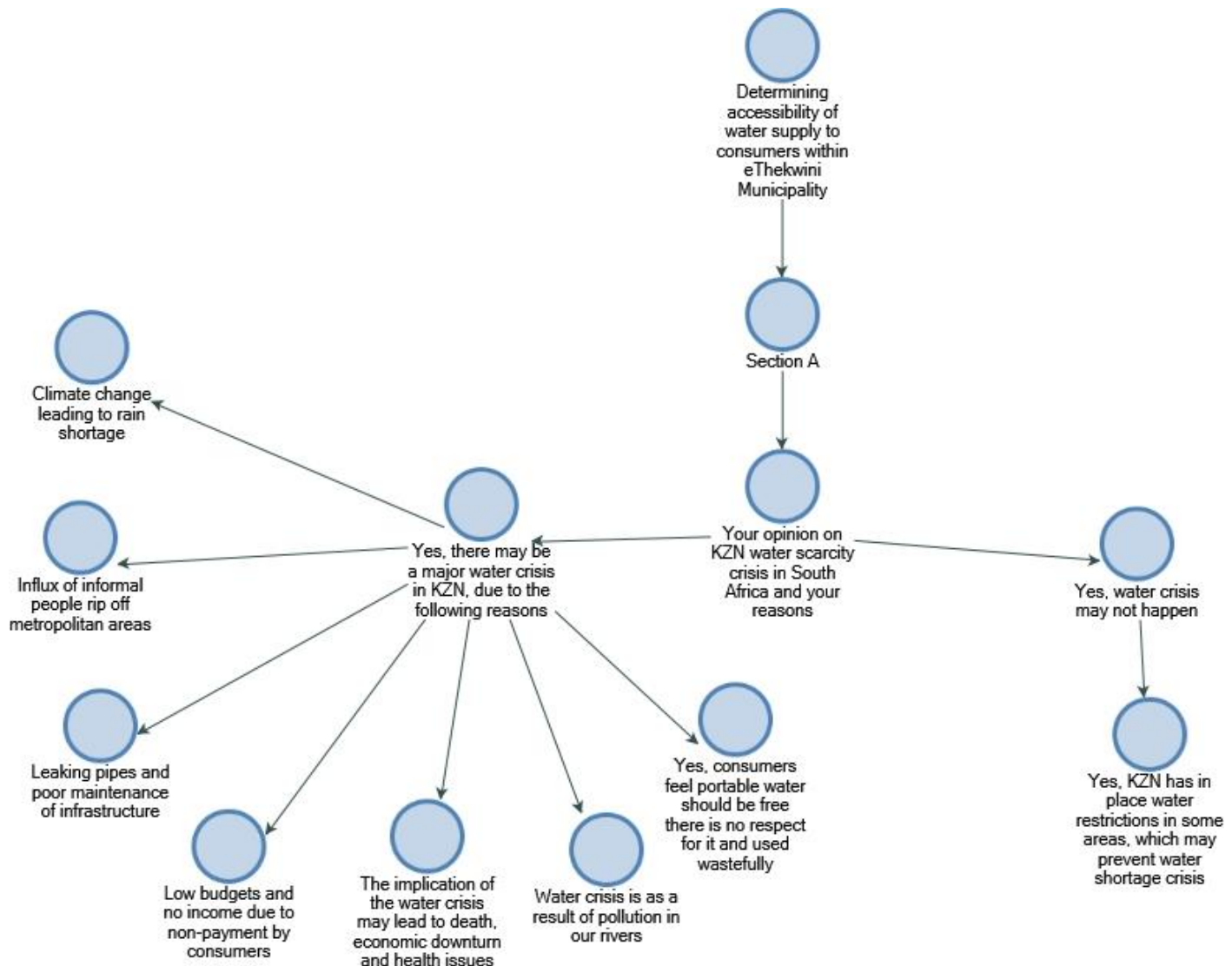


Figure 5.5. Participants' opinions and reasons for KZN water scarcity crisis

Interpretation: The purpose of this question was to determine the level of concern experienced by the participants and how KZN will be affected by the crisis as a whole in the near future. The responses were two-fold: “*Yes, there may be a major water crisis in KZN, due to the following reasons*” and a few participants who said, “*Yes, water crisis may not happen*”.

“Yes, there may be a major water crisis in KZN, due to the following reasons: consumers feel portable water should be free, there is no respect for it and used wastefully. The implication of the water crisis may lead to death, economic downturn, and health issues. Low budgets and no

income due to non-payment by consumers. Leaking pipes and poor maintenance of infrastructure. The influx of informal people rips off metropolitan areas. Climate change leading to rain shortage. The water crisis is a result of pollution in our rivers”.

*“Yes, **water crisis may not happen**: Yes, because KZN has water restrictions in place some areas which may prevent water shortage crisis”.*

Conclusion/themes: The findings showed that several participants believed that the water crisis is inevitable, given the issues raised above. However, only a few of the participants expressed a positive view that with the present water restrictions KZN water crisis may not happen. Themes include:

- Climate change impacts
- Ineffective management of water infrastructures.
- Water restrictions.

Participants 3, 6, 7, and 8 described climate change as one of the main causes of the water crisis. Participants 1, 2, and 7, believes it is majorly about the ineffective management of infrastructures. While participants 4, 5, and 9 posits that it was necessary for the implementation of water restrictions.

Question 6: Are you experiencing water shortages in the area where you live?

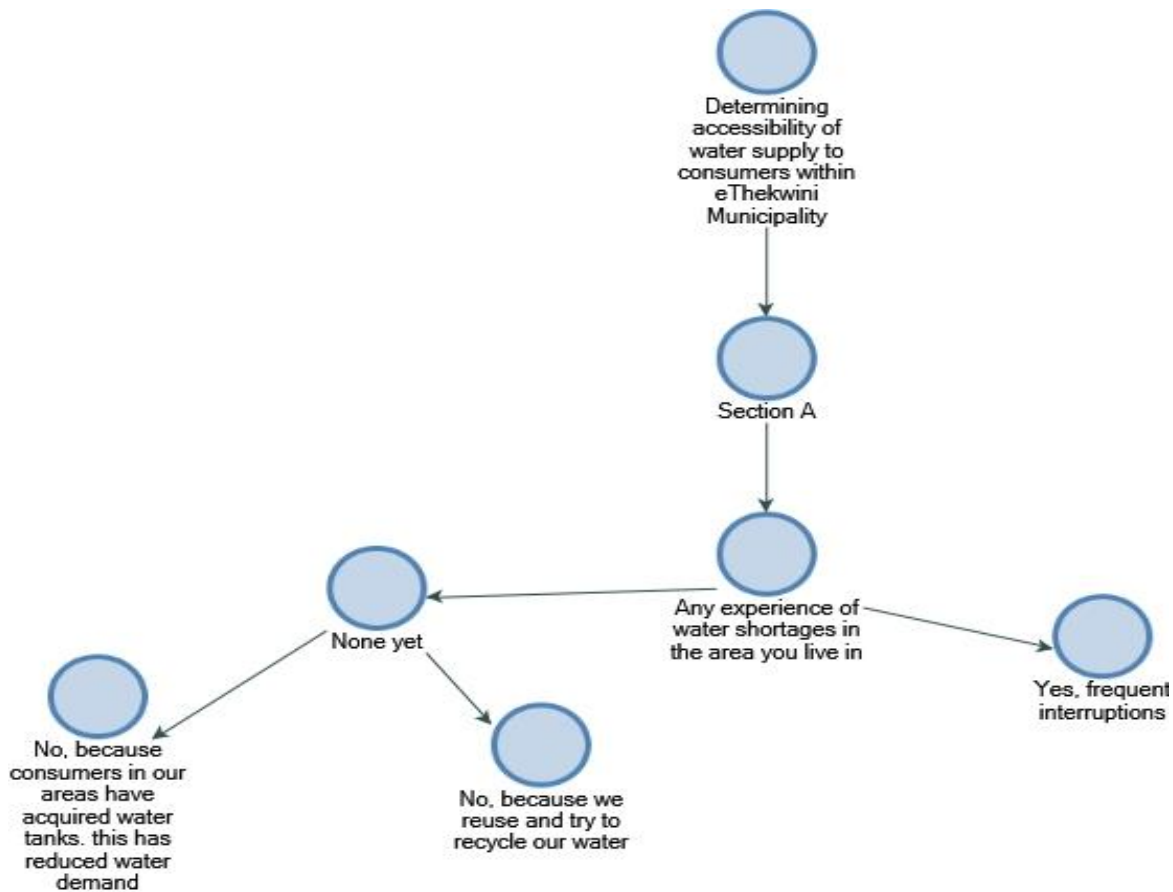


Figure 5.6. Participants' perspectives and experience on water shortages in their area

Interpretations: This question aimed to determine whether the selected participants are experiencing water shortages in their area where they live. Their responses: *"Yes, frequent interruptions"*. Several participants also stated, *"None yet: No because we reuse and try to recycle our water. No, because consumers in our areas have acquired water tanks. This has reduced water demand"*.

Conclusion/themes: The findings revealed that several of the participants did not experience any water shortage due to their established water savings habits. Themes:

- Water supply disruptions,
- Water rates,
- Recycling water.

Participants 2, 3, 6, and 9 all stated in the affirmative that water supply, water rates, and

recycling water were habits to cultivate the curb of water shortages.

Question 7: Are you aware of any significant water pollution in the area where you live? If yes, what are the causes of pollution?

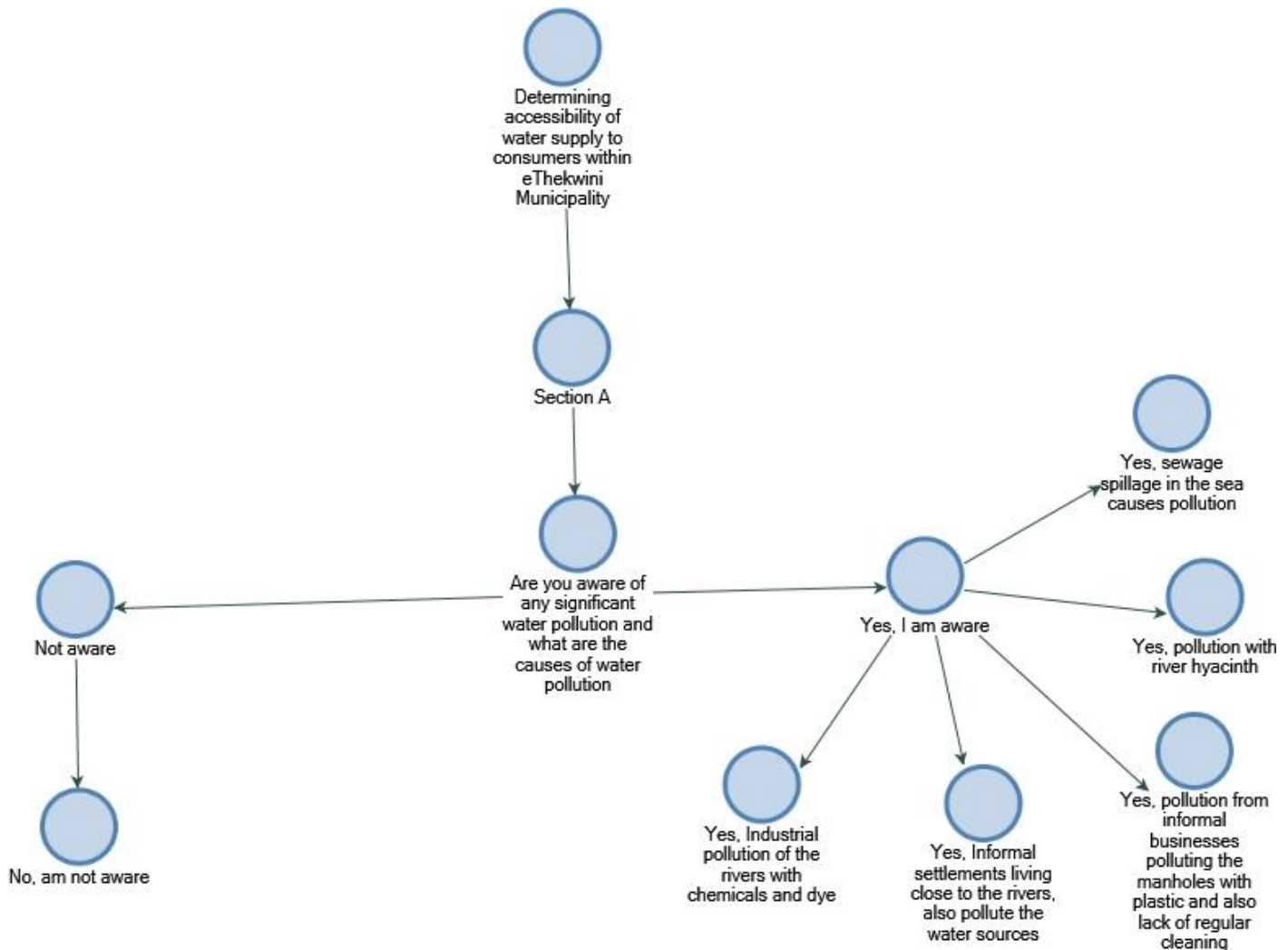


Figure 5.7. Participants' awareness of any significant water pollution and the causes of water pollution

Interpretation: This question was intended to provide the researcher with an understanding of the respondents' opinions as to what concerning factors are contributing to the current water pollution crisis. The responses are: "Not aware" and "Yes, I am aware".

"Not aware: No, am not aware". **"Yes, I am aware:** Yes, sewage spillage in the sea causes pollution. Yes, pollution with river hyacinth. Yes, Industrial pollution of the rivers with chemicals and dye. Yes, pollution from informal businesses polluting the manholes with plastic and lack of regular cleaning. Yes, Informal settlements living close to the rivers, also pollute

the water sources.

Conclusion/ themes: The findings revealed that almost all the participants showed awareness of the causes of water pollution. Only a few of the participants showed unawareness of the causes. Themes include:

- Water pollution sources
- Water source maintenance.

Participants 1, 2, 3,5, and 8 described water pollution and water source maintenance as the most prevalent sign of the causes of a water crisis.

The above themes generated from the questions under section A indicated that water accessibility may be possible if customers and water service providers are aware of all issues that relate to the water supply. These issues include understanding the sources, storage and management, leakage preventions, climate change concerns, water supply structures, water preservation strategies, water pollution sources, water supply disruptions, water rates, and water structure maintenance. If all these issues are considered and taken into perspective, water supply accessibility will improve.

Objective 1: To explore the accessibility of water supply to consumers with the eThekweni region.

Section B: Question 1: Describe the relationship that eThekweni has with their water supplier, Umgeni Reservoir?

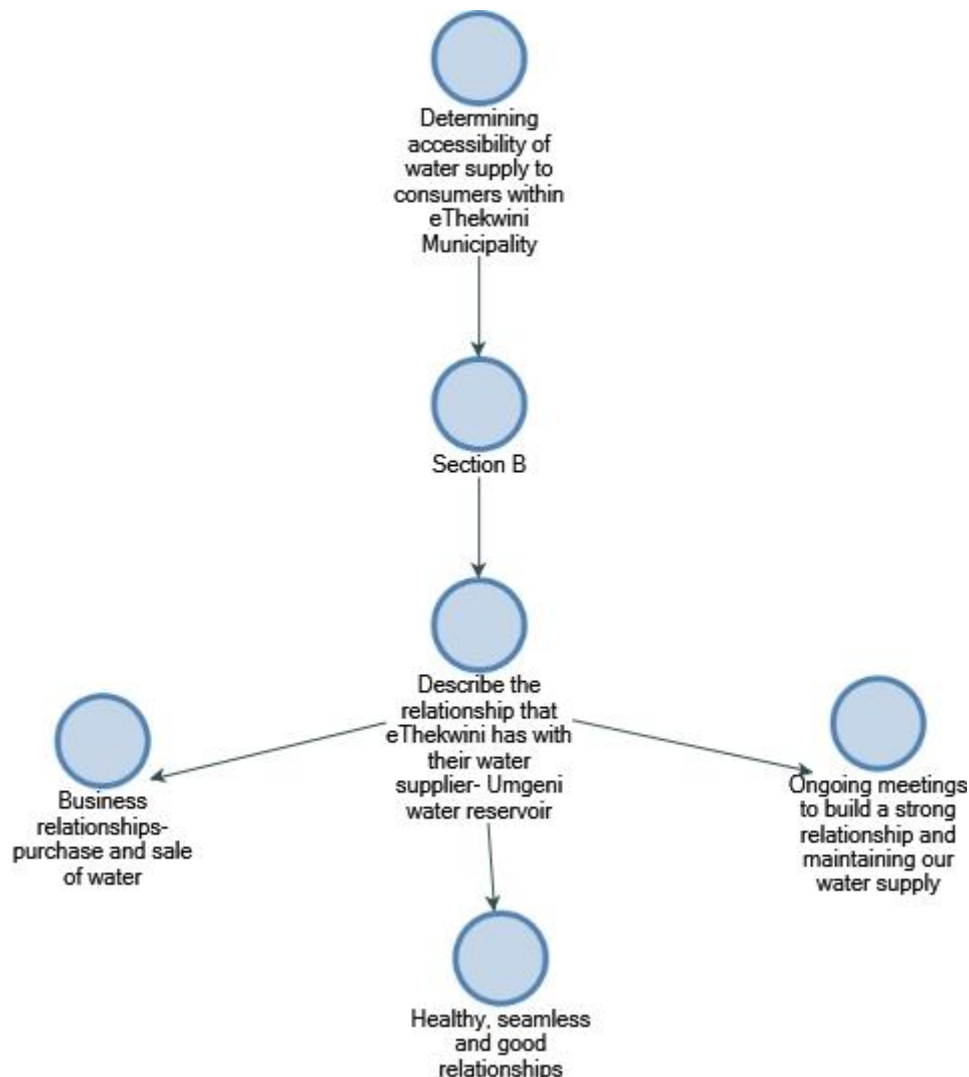


Figure 5.8. Participants' description of the relationship that eThekweni Municipality has with water supplier, - Umgeni water reservoir

Interpretations: This section relates to the relationship between the EMWS department and Umgeni Reservoir and water quantity purchased. Participants' responses include “*Healthy, seamless and good relationships; On-going meetings to build a strong relationship and*

maintaining our water supply; business relationships, purchase and sale of water”.

Conclusion/themes: The findings have indicated that there is a healthy and good business relationship with the Umgeni water reservoir. The seamless relationship also guarantees a regular supply of water that prevents water shortage. Themes include:

- Seamless business relationship
- Sustaining water supply

Participants 1, 2, 3,5, 6, 8, and 9 all alluded that the existing relationships between a supplier and buyer will help to sustain water supply for longer periods.

Question 2: In terms of water quantity, how much water does eThekwini purchase from Umgeni water in a year?

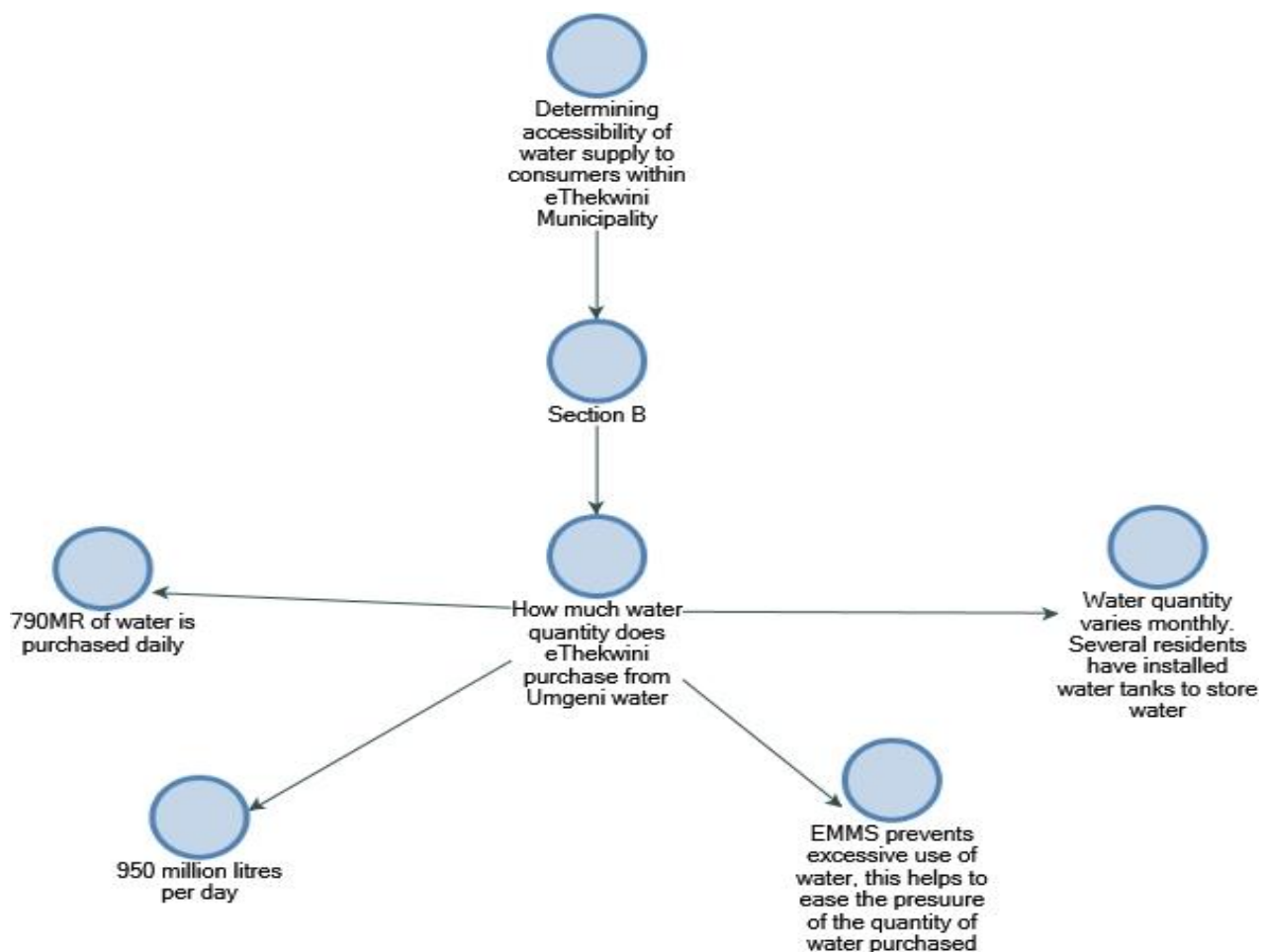


Figure 5.9. Participants views on how much quantity of water does eThekwini Municipality purchase from Umgeni water

Interpretations: This question aimed to determine the quantity of water purchased from Umgeni Water. This question was proposed as the researcher wanted to gain a deeper understanding of the amount of water purchased monthly. The responses include “790 MR of water purchased daily; water quantity varies monthly. Several residents have installed water tanks to store water; EMMS prevents excessive use of water, this helps to ease the pressure of the quantity of water purchased; 950 million liters per day”.

Conclusion/themes: The findings revealed that the daily water supply is 790-MR liters or sometimes at 950 million liters daily. Points to note include: “daily supply got up to 790MR; prevention of excessive use of water”.

Question 3: Have water supply trends changed in the past five years?

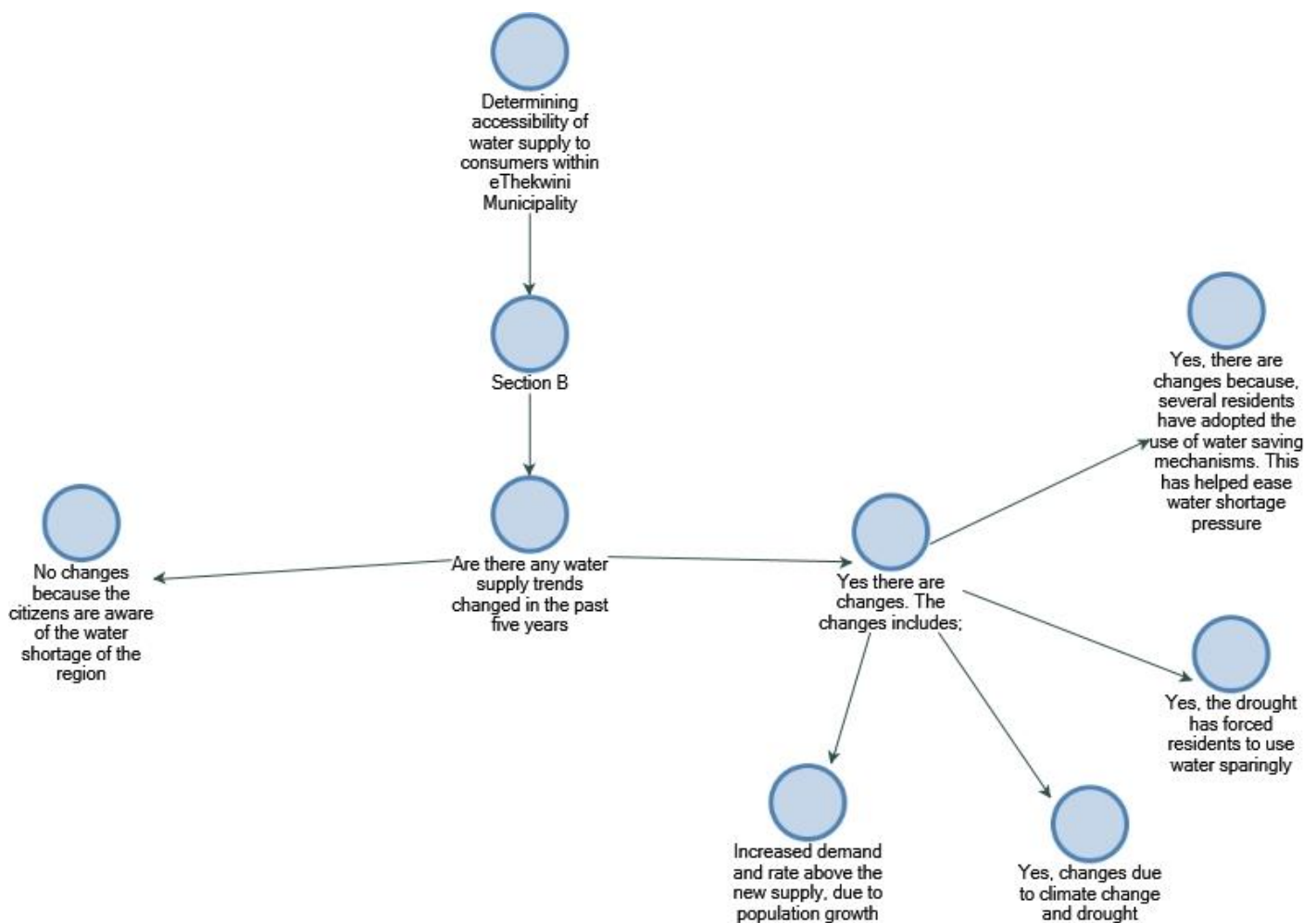


Figure 5.10. Participants’ views on water supply trends and changes in the past five years

Interpretation: The researcher wanted to identify if there had been a decline in water supply trends. The responses include “*No changes because the citizens are aware of the water shortage of the region*”. “*Yes, there are changes. The changes include: Yes, changes due to climate change and drought; Increased demand and rate above the new supply, due to population growth; Yes, the drought has forced residents to water sparingly; Yes, there are changes because several residents have adopted the use of water-saving mechanisms. This has helped ease water shortage pressure*”.

Conclusion/themes: The findings have revealed an increase in water shortage and a corresponding increase in the adoption of water savings mechanisms. The findings also attribute the changing trends to climate change. Themes include:

- Water-saving strategies
- Water demand fluctuations.

Participants 1, 2, 5, 6, 8, and 9 all concluded that there have been several trends and changes over the years. Participants 2 and 4 stated that water-saving strategies were necessary to preserve the existing water supply, whilst participants 5, 6, and 9 stated that there were water demand fluctuations in the past five years due to the increased population and increased consumption of consumers.

Question 4: What measures are put into place to ensure that water is supplied to citizens within the eThekweni region?

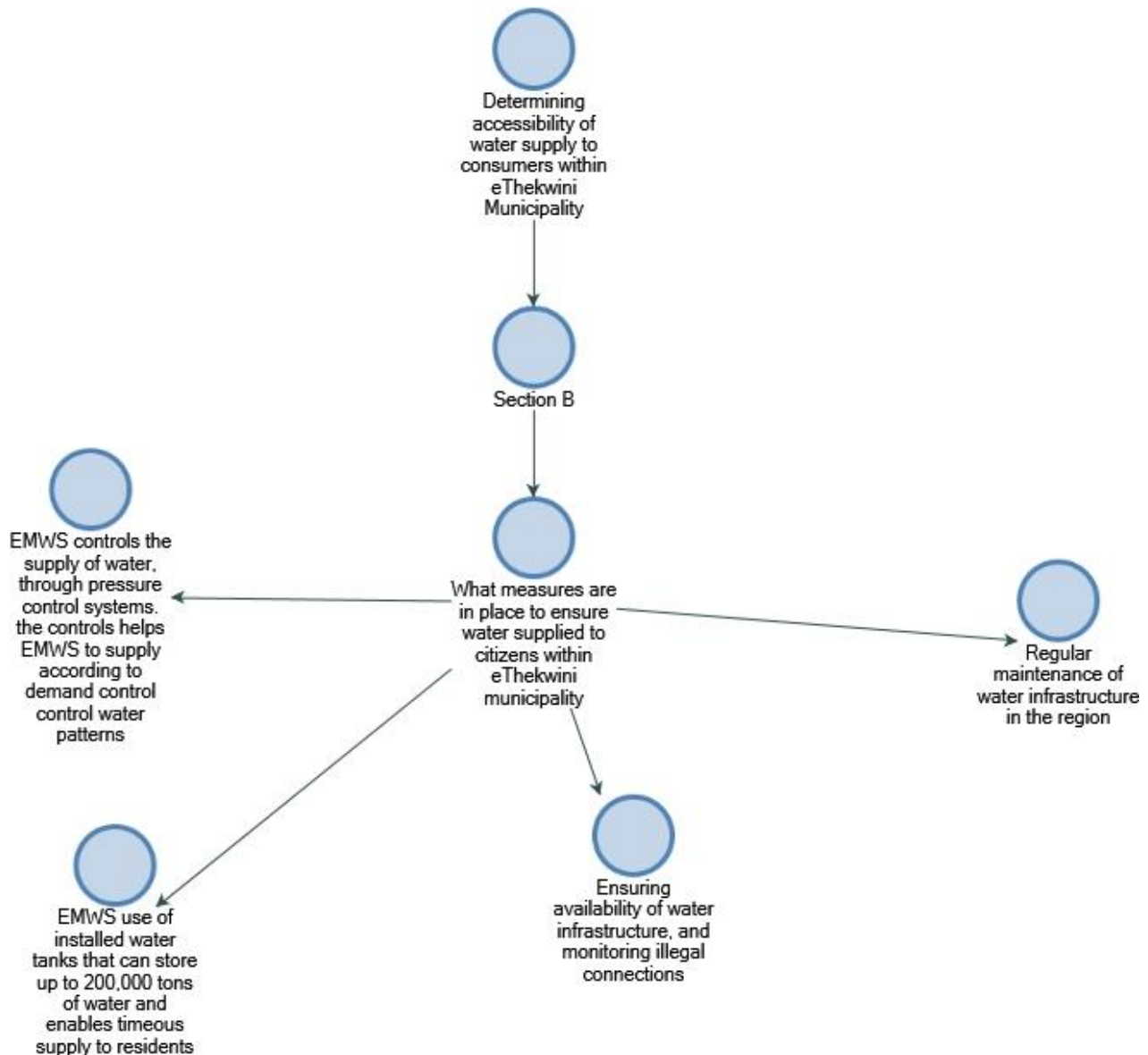


Figure 5.11. Measures used to ensure water supplied to citizens within eThekweni Municipality

Interpretations: The purpose of this question was to establish the various measures that can be used to assist the EMWS department. This will ensure effective and efficient water supply to all citizens within the eThekweni region.

Their responses include “*EMWS’s use of installed water tanks that can store up to 200,000 tons and enables the timeous supply of water to residents; regular maintenance of water*

infrastructure in the region; ensuring the availability of water infrastructure and monitoring illegal connections; EMWS controls the supply of water, through pressure control systems. The controls help EMWS to supply according to demand control, control water patterns”.

Conclusion/themes: The findings indicate several measures are already in place. The measures include regular maintenance of water infrastructure, water tanks for preservation and timeous supply, monitoring illegal water connections and water management processes. Themes include:

- Monitoring water connections
- Storage
- Maintenance of water infrastructures.

Participants 1, 2, 6, 8, and 9 believed monitoring water connections were important measures that were needed to be in place. Participants 2, 6, and 7 advocated for storage facilities as measures. While participants 1, 2, 4, 7, 8, and 9 also advocated for maintenance measures to tackle the efficient water service of their existing water infrastructures.

Question 5: What challenges are experienced during the supply of water?

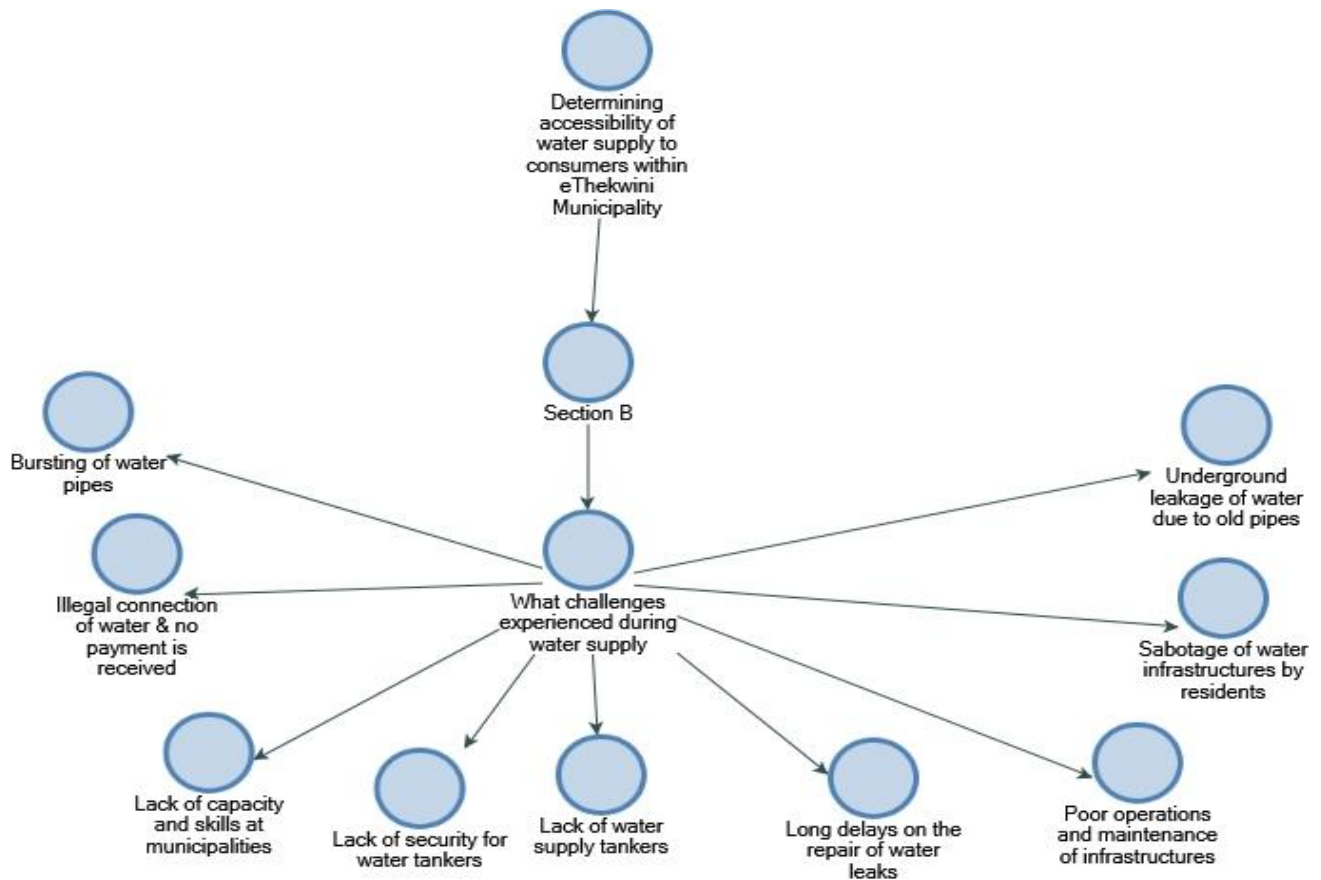


Figure 5.12. Participants' views on the challenges experienced during water supply

Interpretations: This question attempts to show the perceptions by participants on the common challenges experienced during the supply of water.

Their responses include: *“Bursting of water pipes; Underground leakage of water due to old pipes; long delays on the repair of water leaks; illegal connection of water and no payment is received; sabotage of water infrastructures by residents; lack of water supply tankers; lack of security for water tanks; lack of capacity and skills at municipalities and poor operations and maintenance of infrastructures”*.

Conclusion/themes: The findings indicate different kinds of service and capacity challenges when it comes to supplying water to consumers. Themes include:

- Capacity building
- Water supply disruptions
- Maintenance problems

Participants 3, and 6 stated a lack of capacity as one of their challenges. Participants 1, 2, 3, 7, 8, and 9 all described water supply and maintenance problems as the major challenges of water supply.

Question 6: How does practice ensure active, free, and meaningful participation with the consumer?

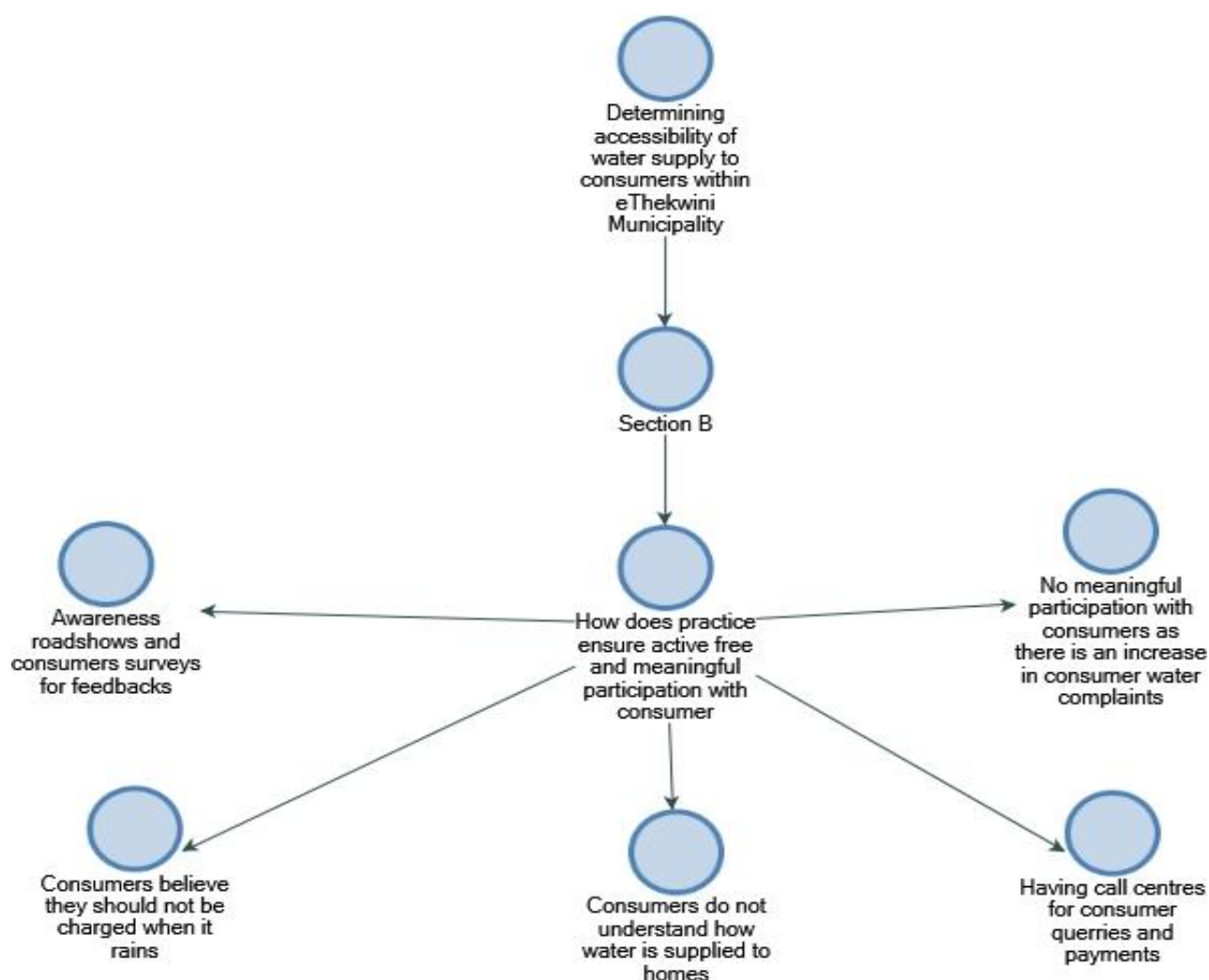


Figure 5.13: Model showing how practice ensure active free and meaningful participation with consumers

Interpretations: This question aimed to determine the various practices that can assist with maximum consumer participation. Participants responses include “No, meaningful participation with consumers as there is an increase in consumer water complaints; consumers believe they should not be charged when it rains; consumers do not understand how water is

supplied to homes; having call centers for consumer queries and payments and awareness roadshows and consumer surveyed ”.

Conclusion/themes: The findings revealed that consumers are still very ignorant of the process of supplying water to them. There are deliberate efforts to resolve all water issues and complaints and make them aware of the water supply processes. The themes was services delivery issues.

Participants 1, 3, 4, 5, 6, 7, 8, and 9 all confirmed that customer delivery issues are germane to the issue of water supply at eThekwini.

The themes generated from section B seems to be focused on the **operational structures** from the service provider, these issues will make water supply very much accessible and possible to implement. The operational structures include “seamless business relationships, water-saving strategies, water demand fluctuations, storage, monitoring water connections, water infrastructure maintenance, capacity building, water supply disruptions, and service delivery issues”.

5.2.2 Research Objective Two

Objective 2: To explore the relationship between the supply of water and water restrictions within the eThekweni Municipality.

Question 1: What are the perspectives of the eThekweni water management department on the issue of water shortage and water restrictions?

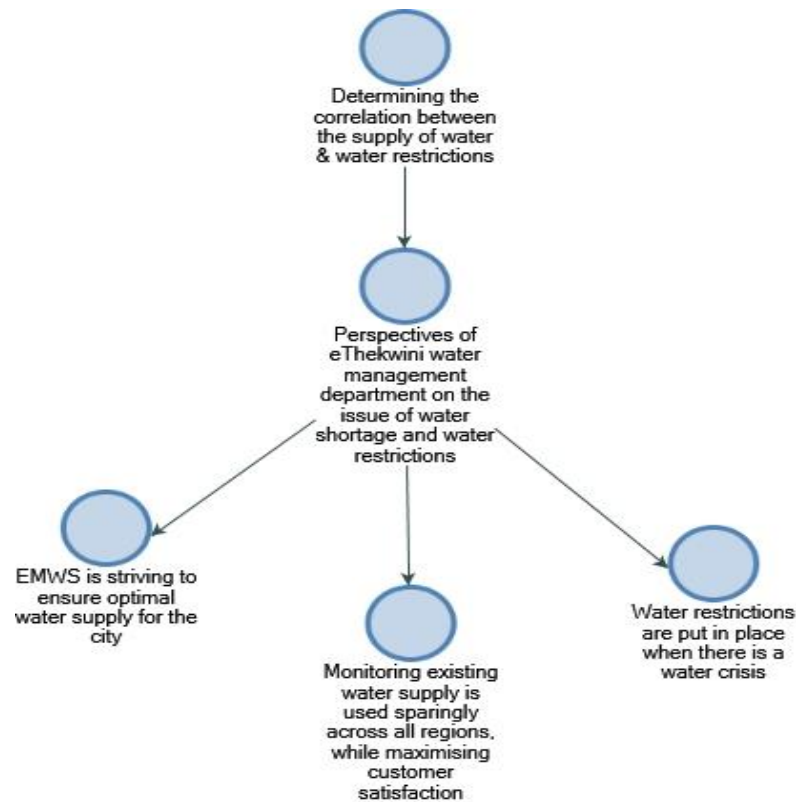


Figure 5.14. Model showing participants perspectives of eThekweni Municipality water management department on the issue of water shortage and water restrictions

Interpretations: This section focuses on the correlation between water supply and water restrictions. The researcher aimed to gain a deeper understanding of the implementation of water restrictions and the related effect on the current water supply.

The purpose of this question was to understand from the EMWS department's perspective whether there was a growing concern about water shortage and imposing water restrictions based on the crisis. The responses include *“Water restrictions are put in place when there is water crisis; EMWS is striving to ensure optimum water supply for the city, and monitoring existing water supply is used sparingly across all regions while maximizing customer satisfaction”*.

Conclusion/themes: The findings indicate the measures EMWS implements whenever there is a water crisis. The evident themes include:

- Water restrictions
- Water shortage crisis
- Consistent water supply.

Participants 1, 2, 6, 8, and 9 indicated that water restrictions are necessary to be put in place. Participants 8, and 2 stated that water restrictions were currently in place, while participants 4, 8, and 9 indicate consistent water supply to mitigate the water crisis.

Question 2: Do you think, there is a correlation/relationship between the supply of water and water restrictions?

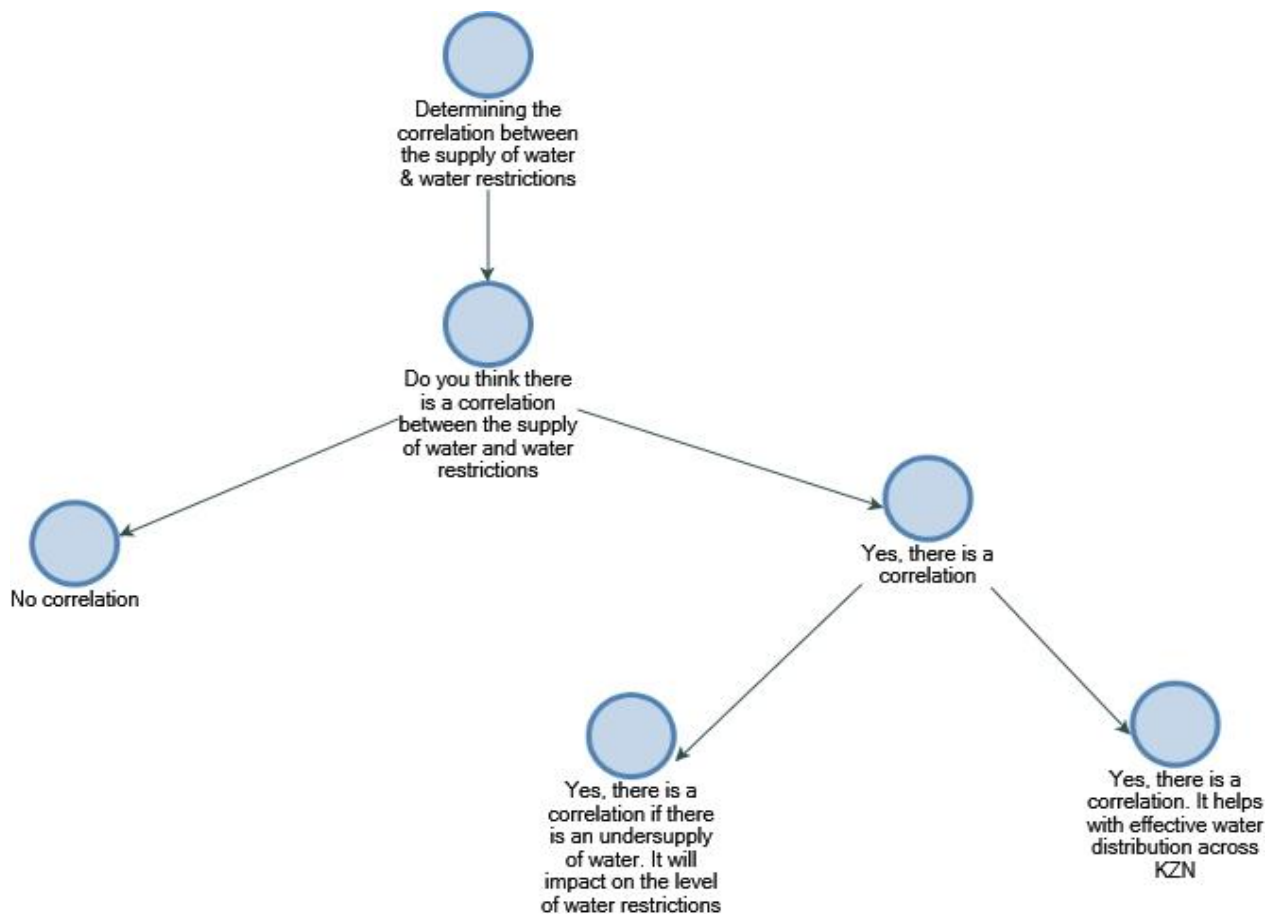


Figure 5.15. Participants views on the relationship between water supply and water restrictions

Interpretations: The purpose of this question was to ascertain how flexible the EMWS

department is when imposing water restrictions. Participants' responses include A few of the participants stated there is “No correlation”.

However, the majority of the participants stated “Yes, there is a correlation.” They also went ahead to give reasons for their positive response. “Yes, there is a correlation: Yes, there is a correlation if there is an undersupply of water. It will impact on the level of water restrictions.”

Conclusion/themes: The findings show EMWS is flexible and they implement water restrictions based on the level of water supply. Themes include:

- Flexible water restrictions
- Efficient water distribution.

Participants 2, 4, 5, 6, 7, 8, and 9 all alluded that there was a correlation on water supply. Participant 9, 8, 6, 5, 4, advocated for flexible water restrictions and efficient water distribution as measures.

Question 3: What is the importance of placing water restrictions?

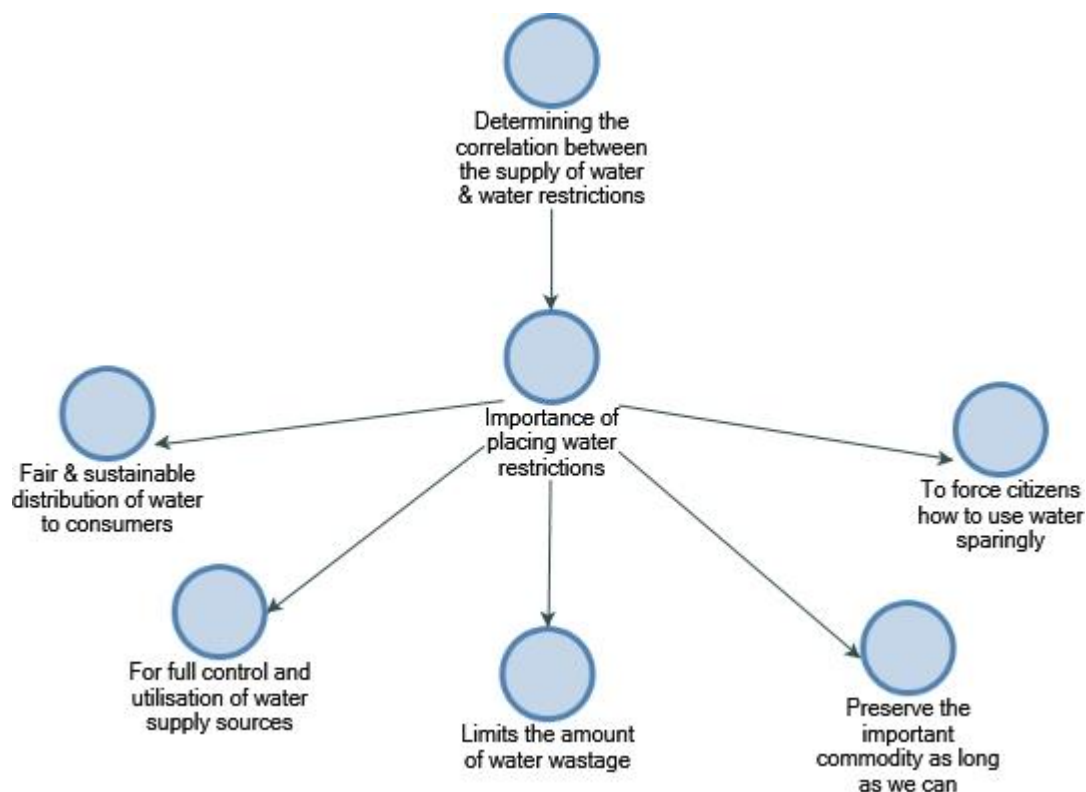


Figure 5.16. Participants' views on the importance of placing water restrictions

Interpretations: The aim of this question was to determine the need, and how organisations such as the EMWS department enforce water restrictions throughout the organisation and in the KwaZulu-Natal region.

Participants response include: *“Limits the amount of water wastage; To force citizens how to use water sparingly; Fair and sustainable distribution of water to consumers; Preserve the important commodity as long as we can; For full control and utilisation of water supply sources”*.

Conclusion/themes: The findings show that water restrictions are very necessary for water supply and needed to curb the water crisis in KZN. The theme was water control and restrictions.

Participants 1, 2, 3, 4, 6, and 9 focused on water restrictions and control, as participants experienced that water restrictions and controls will assist in preserving water supply for longer periods.

Question 4: Briefly describe the effectiveness of enforcing water restrictions in high consumption areas?

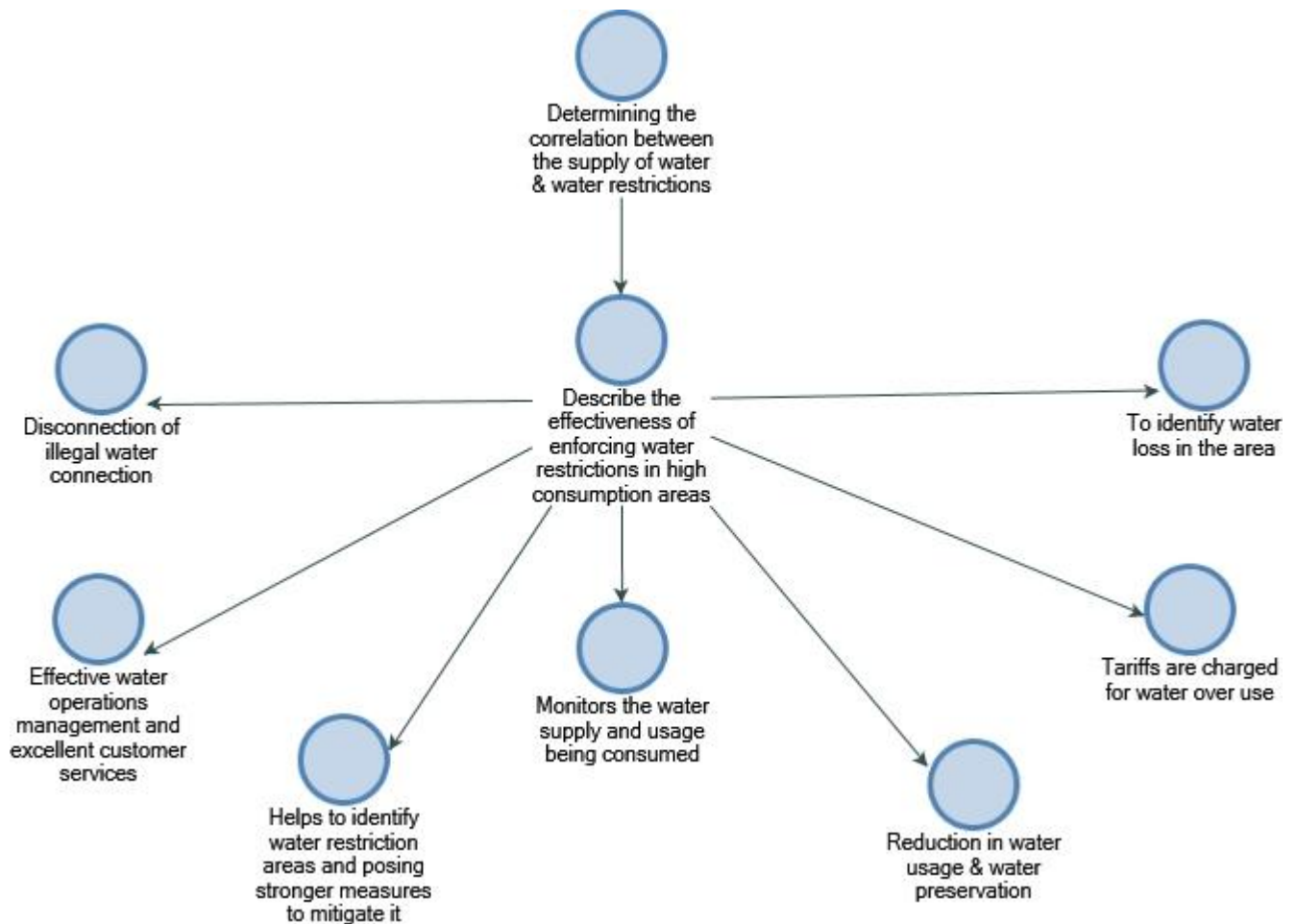


Figure 5.17. Participants' description of the effectiveness of enforcing water restrictions in high consumption areas

Interpretations: The purpose of this question was to determine the success of imposing water restrictions in high consumption areas during a water crisis, especially when the demand for water is high.

The responses from participants include “*Monitors the water supply and usage being consumed; To identify the water loss in the area; Reduction in water usage and water preservation; Tariffs are charged for water overuse; Disconnection of illegal connections; Helps to identify water restriction areas and posing stronger measures to mitigate it, and Effective water operations management and excellent customer services*”.

Conclusion/themes: The findings indicate that effective water management (main goal) of water supply was achieved. Themes include:

- Customer servicing issues
- Water preservation
- Monitoring water supply and usage.

Participants 1, 2, 4, 5, 8, and 9 alluded that customer issues are prevalent. While participants 1, 2, 3, 4, 6, 7, 8, and 9 all indicated that water preservation and water supply usage monitoring as their main themes for the question.

Question 5: Within eThekweni, which region is the highest consumption area?

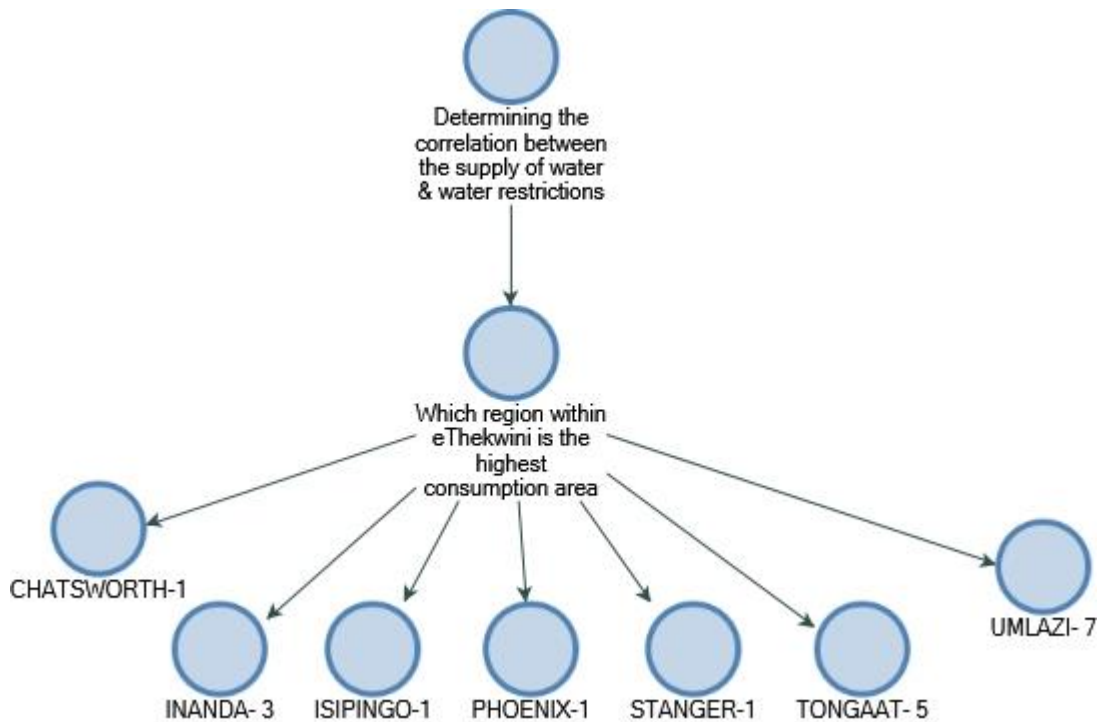


Figure 5.18. Participants' views on which region in eThekweni has the highest water consumption rate

Interpretations: This question aims to gain a deeper understanding of eThekweni's highest consumption areas in terms of water supply. The responses from participants are inserted in

Table 5.1.

Table 5.1: Consumption frequency relating to different eThekweni regions

eThekweni regions	Umlazi	Inanda	Tongaat	Isipingo	Stanger	Chatsworth	Phoenix
Consumption Frequency	7	3	5	1	1	1	1

Conclusion/themes: The findings illustrated in table 4.1 indicate that **Umlazi** and **Tongaat** regions at the eThekweni Municipality had the current highest and second highest water supply consumption. This information will surely help in implementing water restriction measures and water storage awareness when it comes to the water shortage crisis.

Question 6: Please explain the type of criteria that is used, in the implementation of water restrictions to specific areas.

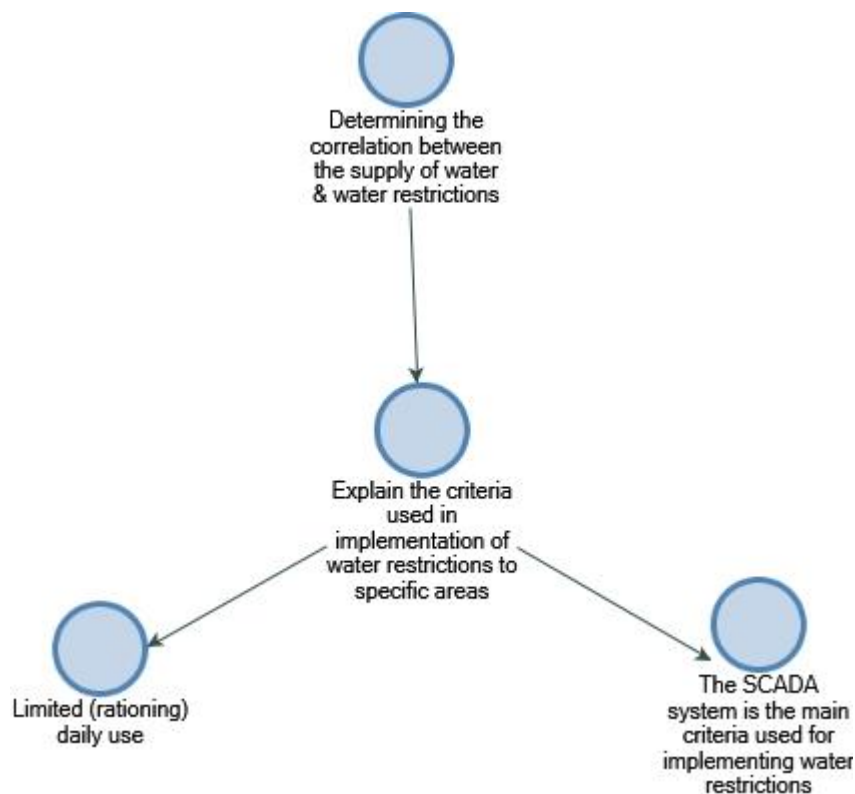


Figure 4.19. Participants explanation with the criteria used in implementing water restrictions to specific areas

Interpretations: The purpose of this question is to determine a deeper understanding of the factors that contribute to the criteria when implementing water restrictions. The participant's responses provided below are that *“The SCADA system is the main criteria used for implementing water restrictions and Limited (rationing) daily use”*.

Conclusion/themes: The findings revealed SCADA is the only criterion used in implementing water restrictions at the eThekweni Municipality. Themes include:

- SCADA
- Water restrictions.

All participants from 1 to 9 were involved in the affirmation of SCADA and advocated for water restrictions for the study. The themes generated from the above objective indicated that there is a strong correlation between water supply and water restrictions (change in water supply= water restrictions). The themes showed several ways water restrictions can be implemented, the tools that can be used, and how it can influence water supply.

5.2.3 Research Objective Three

Objective 3: To examine the amount of rainfall and water supplied to the eThekwini Municipality.

Question 1: What control measures are being put into place to monitor the amount of rainfall and water supplied to the eThekwini Municipality?

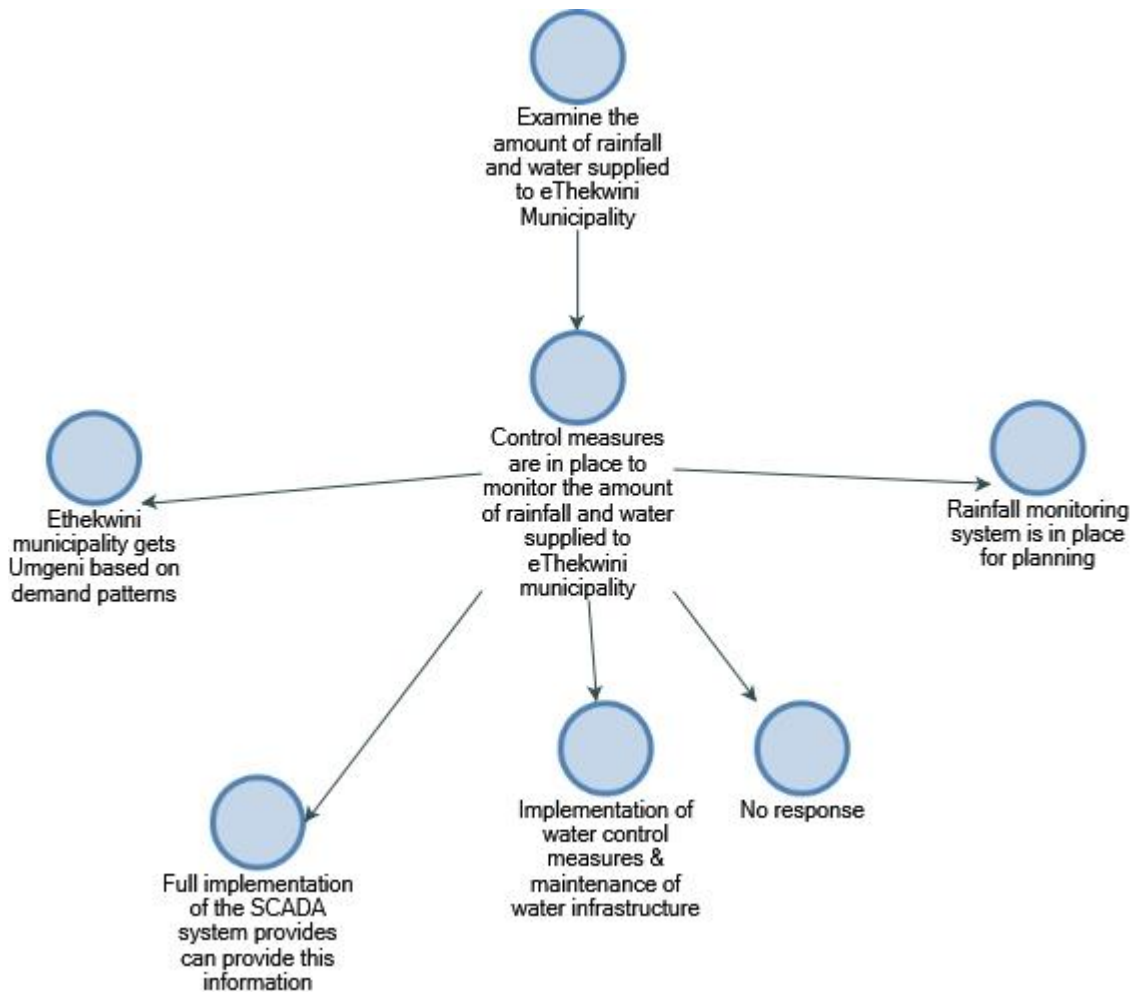


Figure 5.20. Control measures used in monitoring the amount of rainfall and water supplied to eThekwini Municipality

Interpretations: This question is aimed to establish the various control measures that is used to monitor the amount of rainfall and water supplied to EMWS. The researcher also wanted to identify whether there was a correlation between the amount of rainfall and water supplied from Umgeni Reservoir. The responses from participants include: "*eThekwini Municipality gets*

Umgeni based on demand patterns; Full implementation of the SCADA system provides can provide this information; Rainfall monitoring systems is in place for planning; and Implementation of water controls measures & maintenance of water infrastructure.” “No response”.

Conclusion/themes: The findings from the participants have revealed there are several measures employed by the eThekweni Municipality to manage water supply and rainfall at the eThekweni Municipality. Themes include:

- SCADA adoption
- Monitoring water supply

Participants 1, 3, 4, 6, 8, and 9 all confirmed that the adoption of the SCADA system was a need for the monitoring water supply.

The themes generated from the objective shows there is an instrument used to **monitor rainfall amount and water supply**. It also shows there is a relationship between the amount of water dammed from rainfall and water supplied to consumers.

5.2.4 Research Objective Four

Objective 4: To evaluate the Quality Management System (QMS) on water management practices at eThekweni Municipality.

Question 1: Please describe the current Quality Management System (QMS) on water supply at eThekweni Municipality?

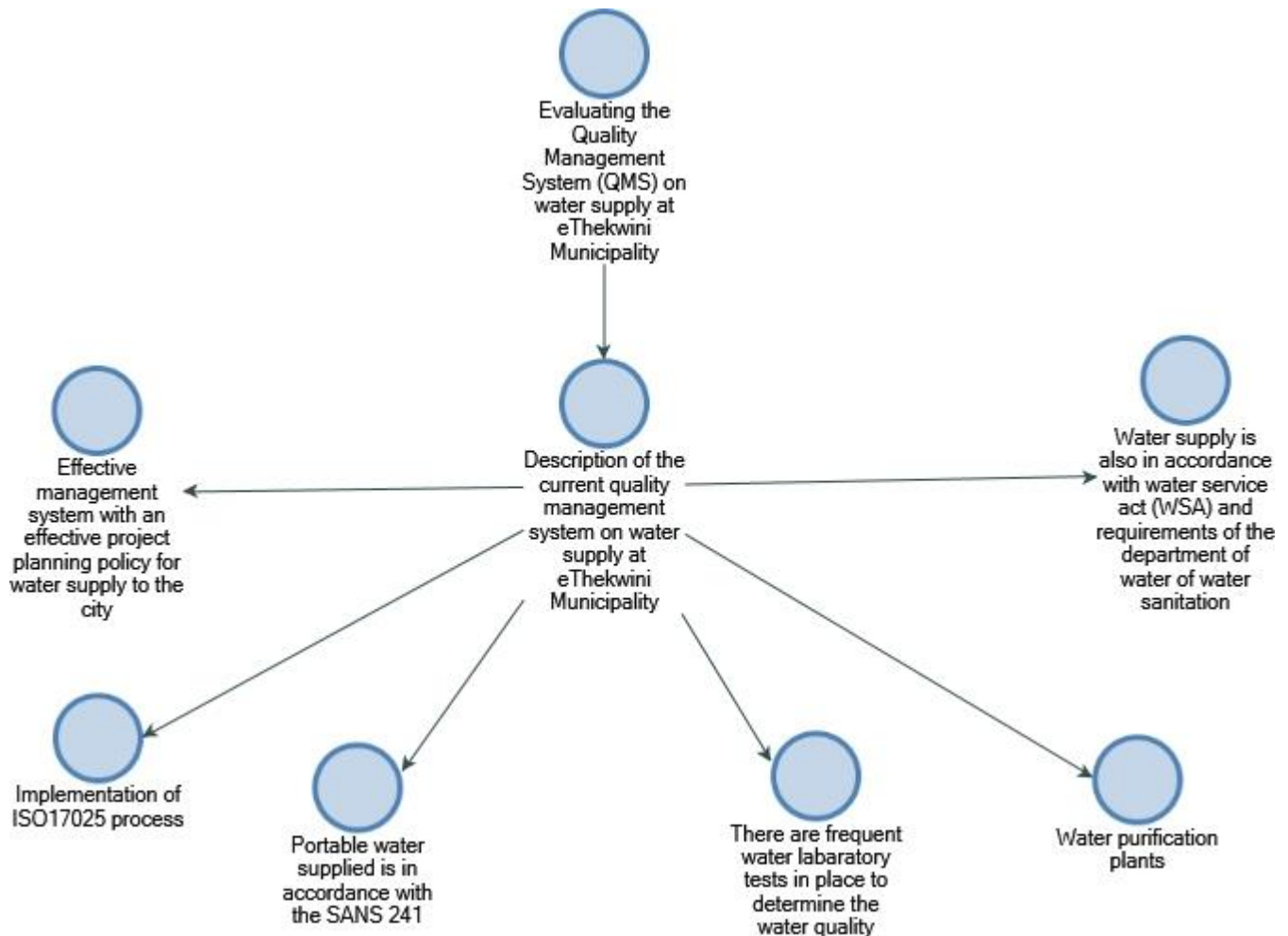


Figure 5.21. Participants' description of the current quality management system on water supply at eThekweni Municipality

Interpretations: This question aimed to understand the effectiveness and efficiency of the current QMS. The researcher found this to be a critical question as the current QMS had a few areas of concern that required improvements. Therefore, the researcher aimed to see how service delivery is evaluated. The researcher intended to gain insight into the type of criteria

used for water acceptability practice and to ensure that the revenue management system (RMS) is improved.

The response from participants includes *“There are frequent water laboratory tests in place to determine the water quality; Implementation of the ISO17025 process; Water purification plants; Effective management system with an effective project planning policy for water supply to the city; Portable water supplied is in accordance with SANS 241; Water supply is also in accordance with water service act (WSA) and requirements of the department of water and sanitation”*.

Conclusion/themes: The findings revealed several water supply quality management criteria adopted and used by EMWS. It indicates an effective and efficient water supply systems. Themes include:

- ISO17025, SANS241,
- Water services act (WSA)
- Water lab tests.

All participants from 1 to 9 advocated for more stringent water quality responses such as ISO, water services, and water lab tests. The participants also stated that there was no current quality management system in place, therefore it was hard to evaluate the quality management system. However, participants concluded that different measures were being used to assist with quality changes.

Question 2: How does water practice meet the criterion of quality management?

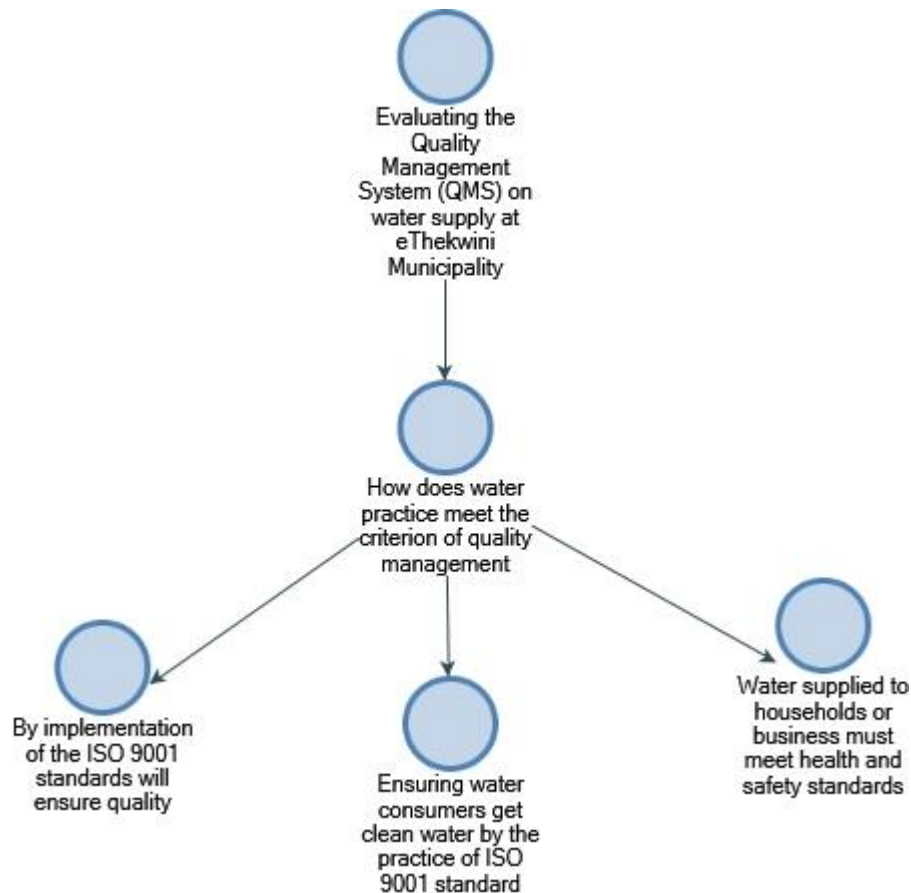


Figure 5.22. How water practice meets the criterion of quality management

Interpretations: The researcher aimed to identify the type of measures that will allow for water practices to best fit the criterion used for quality management.

The responses from participants include “*Ensuring water consumers get clean water by the practice of ISO 9001 standard; By implementation of the ISO 9001 standards will ensure quality; Water supplied to households or business must meet health and safety standards*”.

Conclusion/themes: The findings revealed EMWS adopted the ISO 9001 standard to ensure top quality water supply services to consumers. The theme includes the “*ISO 9001 standard*”.

Question 3: How does the water practice meet the criterion of acceptability?

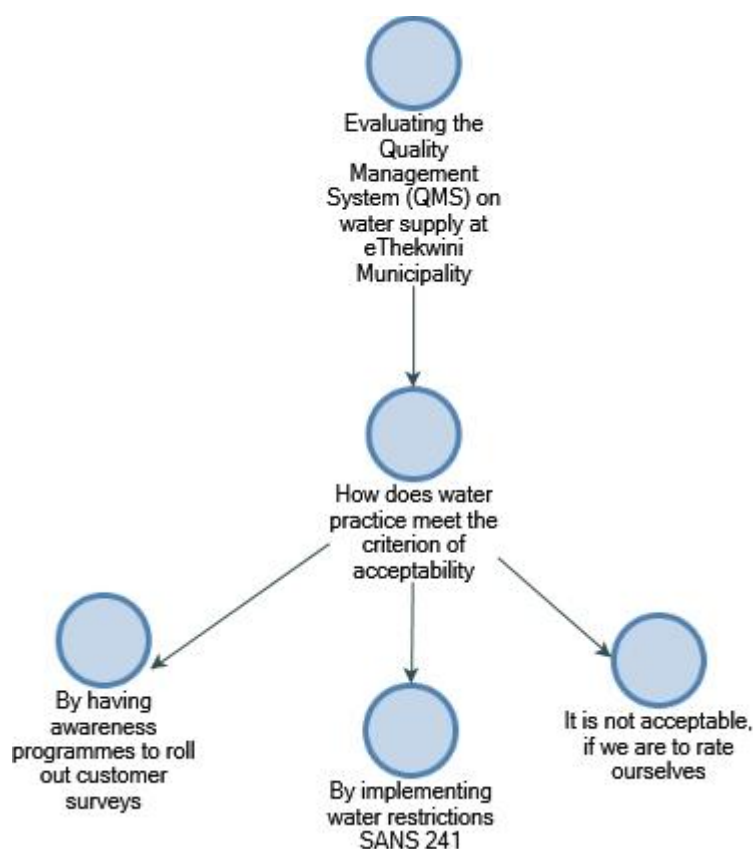


Figure 5.23. How water practices ensure meeting the criterion of acceptability

Interpretations: The purpose of this question was to understand the acceptability criterion used for effective and efficient water practices. Their responses include “*By implementing water restrictions SANS 241; It is not acceptable if we are to rate ourselves; By having awareness programmes to roll out customer surveys*”.

Conclusion/themes: The findings showed a combination of SANS 241 and aggressive awareness programs to sensitive consumers. The theme was water supply awareness programs.

Participants 2, 3, 4, 5, and 8 posited that water supply awareness was important to be included for good quality, as customer feedback will be provided to assess the current criterion for acceptability.

Question 4: How can the current revenue management system be improved on water loss at the eThekweni Municipality?

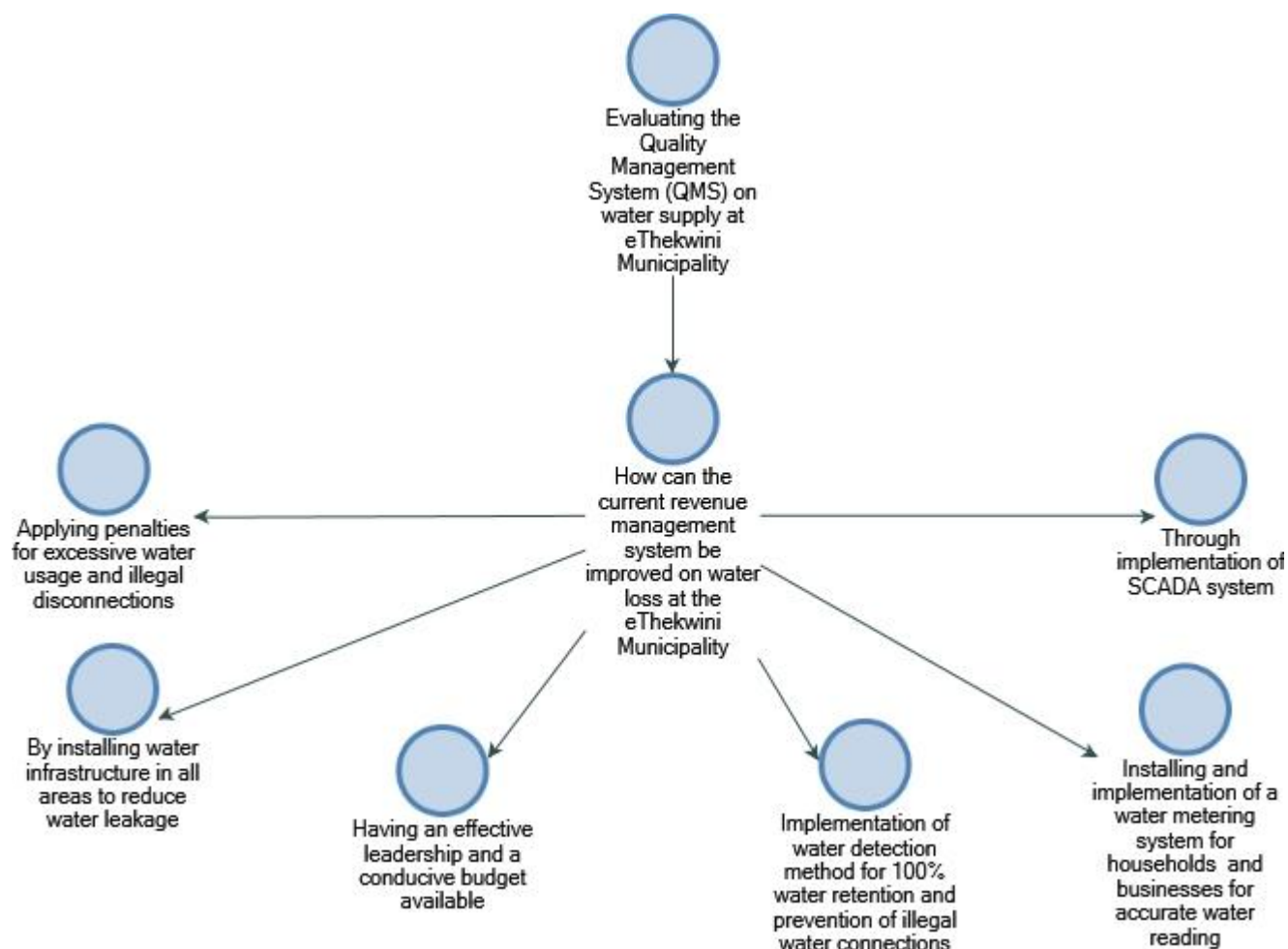


Figure 5.24. Participants views on how the current revenue management system can be improved on water loss at eThekweni Municipality

Interpretations: The researcher wanted to gain insight into how the current revenue management system (RMS) can be improved to detect water loss at an earlier stage, as this will prevent wastage of water and revenue loss.

Their responses include “By installing water infrastructure in all areas to reduce water leakage; Through the implementation of SCADA system; Applying penalties for excessive water usage and illegal disconnections; implementation of the water detection method of 100% water retention and prevention of illegal water connections; Installing and implementation of a water metering system for households and businesses for accurate water reading, and Having effective leadership and a conducive budget available”.

Conclusions/themes: The findings revealed that there are still some revenue leakages in the water supply system, and this needs to be looked at and resolved and the leakages blocked with an efficient accounting system and a state-of-the-art functioning water supply structure.

Themes include:

- Water metering systems
- Water flow disruptions
- Ineffective water infrastructure
- Authorized water connections.

Participants 2, 3, 6, 7, 8, and 9 focused on water metering as a major factor in getting sufficient revenue. Participants 1, 2, 3, 7, and 8 see water flow disruptions as one of the obstacles at the offices. Participants 4, 5, 8, and 9. also acknowledged that ineffective water infrastructure and un-authorized water connections also influence revenues leakages.

The themes generated from the objective show there are several **rigorous processes** used by the eThekweni Municipality in ensuring quality water supply. The processes could be consolidated into a framework that ensures there is a standard quality management system practice in place to ensure quality water supply to consumers.

5.2.5 Research Objective Five

Objective 5: To provide recommendations for a more suitable water detection method which will reduce existing water loss.

Question 1: What is the current water loss detection method that is being used by the eThekweni Municipality Water Department?

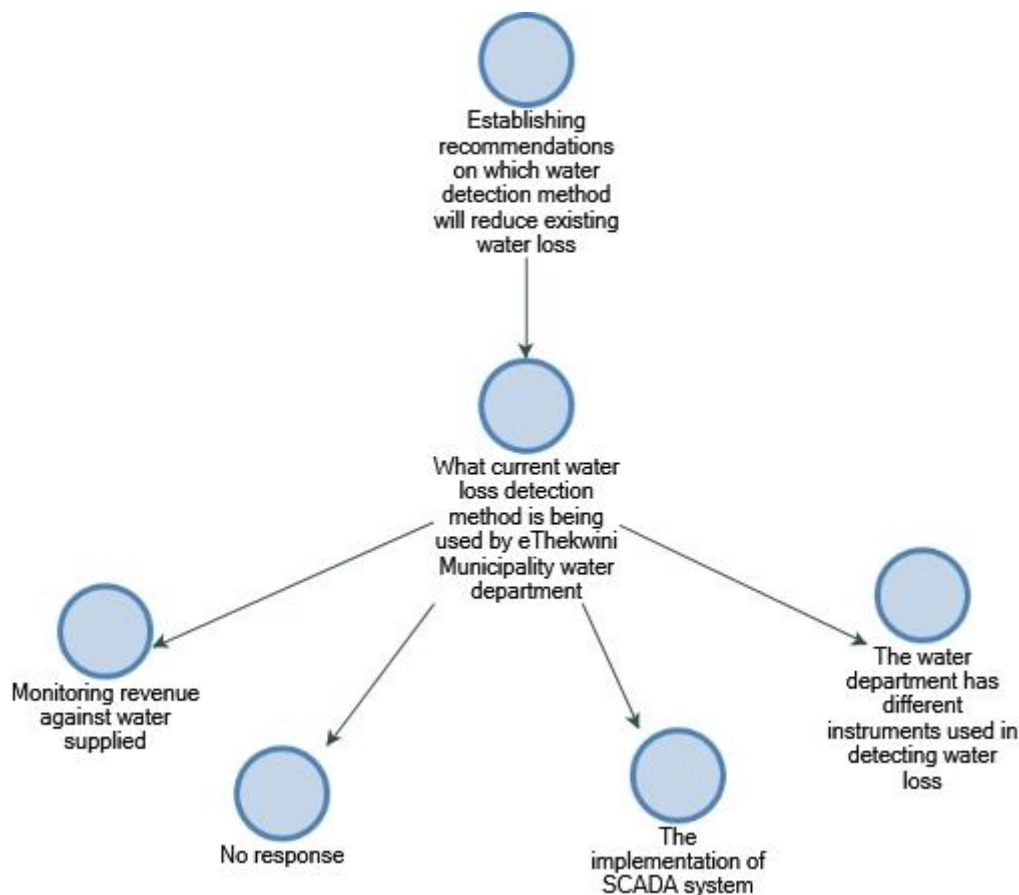


Figure 5.25. Current water loss detection method being used by the eThekweni Municipality department

Interpretations: This question aimed to determine the current method employed by the EMWS department for detecting water loss and leaks.

The responses from participants include the following, “*The implementation of SCADA system; The water department has different instruments used in detecting water loss; and monitoring revenue against water supplied*”.

Conclusion/themes: The findings revealed that the SCADA system is the main tool for detecting water loss and revenue monitoring. Themes include:

- Revenue monitoring
- Water loss detection.

Participants 2, 3, 5, 8, and 9 posited that revenue monitoring is one of the main methods of water and leaks detection. Participants 2, 3, 4, 6, 8, and 9 also stated that water loss detection methods will assist with revenue generation.

Question 2: How effective is the current leak detection method?

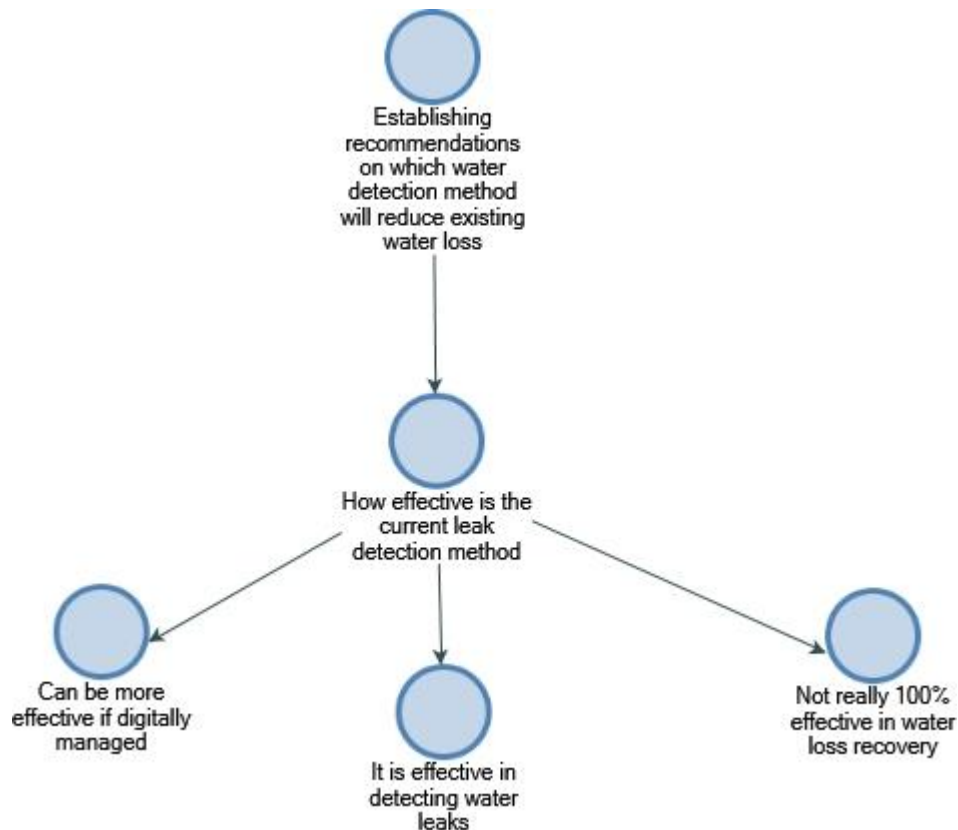


Figure 5.26. Participants' views on how effective the current leak detection method is

Interpretations: This question aimed to gain insight into each research participant's interpretation of the effectiveness of the current leak detection method.

Participants' responses include: *"It is effective in detecting water leaks; Not 100% effective in water loss recovery; can be more effective if digitally managed"*.

Conclusion/themes: The findings showed that the present water leak detection method at EMWS still leaks water, that needs to be plugged (maybe with digital devices) for effective services. Themes include:

- Water loss recovery

- Leak detection.

All 9 participants confirmed that the current leak detection methods were the most frequent methods that assisted with water loss recovery.

Question 3: What percentage of water is recovered through eThekwini’s current water detection method?

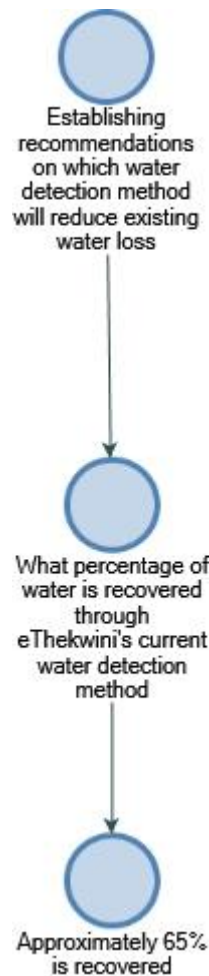


Figure 5.27. Percentage of water recovered through eThekwini’s current water detection method

Interpretations: The purpose of this question was to determine the percentage of water loss recovered whilst utilising the current water detection method. All participants confirmed that “*Approximately 65% of water loss is recovered*”.

Conclusion/themes: Having known that 65% of water loss is recovered, then there is a need to

increase the water recovery rate to 75 or 85% recovery rate.

Question 4: Is the leak detection method effectively monitoring the water loss consumption?

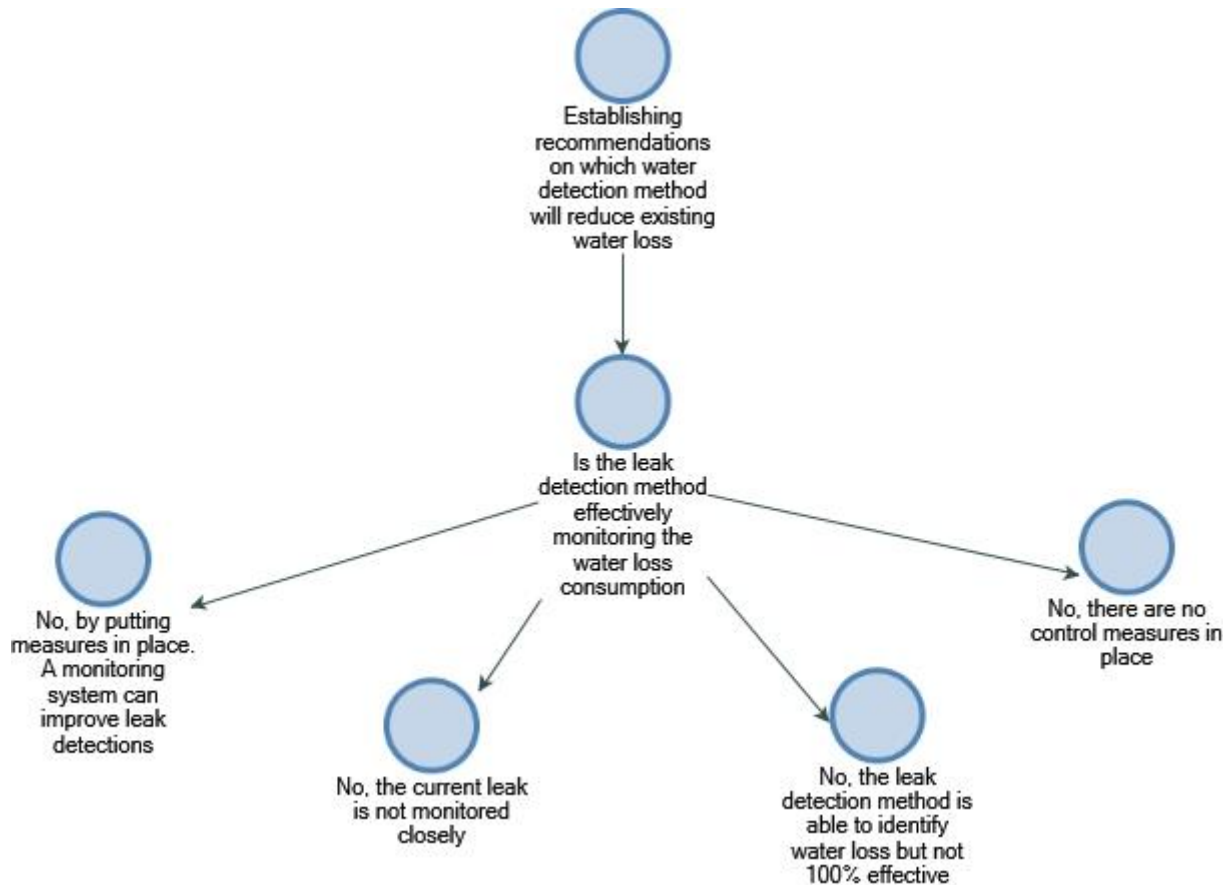


Figure 5.28. Participants' perspectives on the leak detection method effectively monitoring the water loss consumption

Interpretations: This question aimed to further understand the effectiveness of the current leak detection method on the water loss consumption pertaining to the research objective. The researcher wanted to gain an insight into whether the current leak detection method was being monitored to ensure that the water loss consumption decreases.

Participants' responses include “No, there are no control measures in place; No by putting measures in place. A monitoring system can improve leak detections; No, the leak detection method can identify water loss but not 100% effective; and No, the current leak is not monitored closely”.

Conclusion/themes: the findings from participants indicate that the current leak detection method is not adequate in monitoring water loss in the system. It shows the current measures need revamping or restructuring. **Themes** include:

- Leak controls
- Preventing water loss.

Participants 2, 3, 4, 5, 6, 8, and 9 all attributed leaks controls and water loss to the several causes, measures, and the need to find solutions to prevent water loss.

Question 5: In your opinion, which water detection methods could be used to reduce existing water loss?

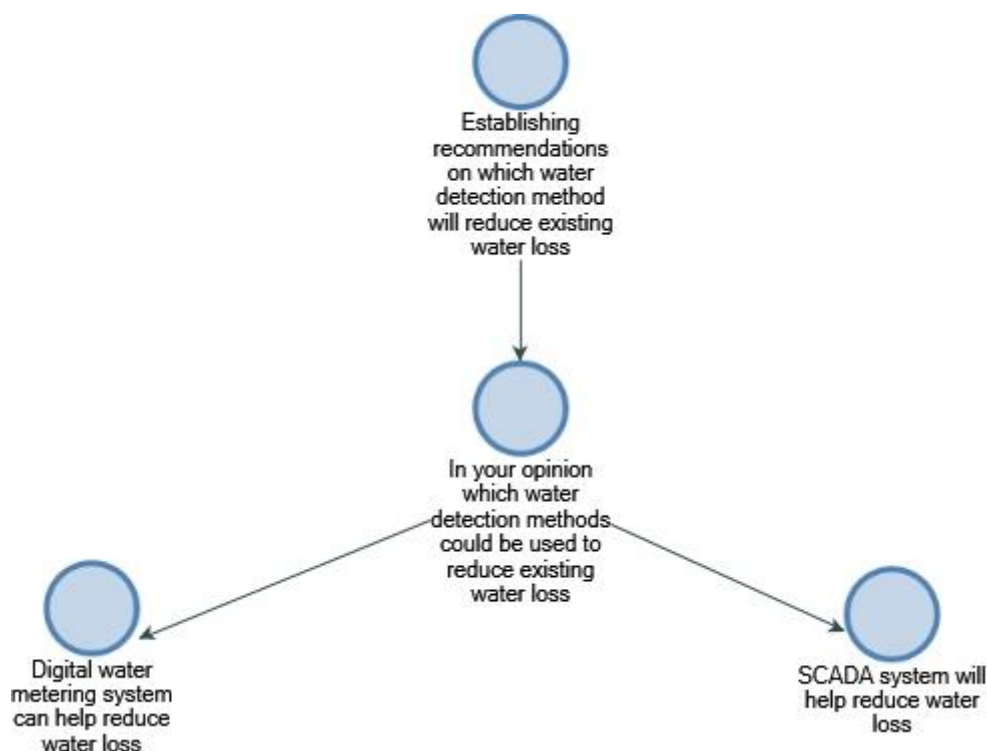


Figure 5.29. Participants' opinions \ on the water detection methods that can be used to reduce existing water loss

Interpretations: The purpose of the question was to ascertain how flexible the EMWS department is when using various water detection methods to recover the existing water loss. Responses from participants include: “The *SCADA system will help reduce water loss, and the*

Digital water metering system can help reduce water loss”.

Conclusion/themes: The SCADA system is the main detection methods used at EMWS. Some of the participants also advocated for a digital water metering system. Themes include:

- Water monitoring tools
- SCADA.

Participants 1, 2, 3, 4, 6, 7, 8, and 9 all advocated for modern watering tools and SCADA as the optional tools to prevent water loss.

Question 6: What recommendations should be put into place to reduce further risk of water shortage?

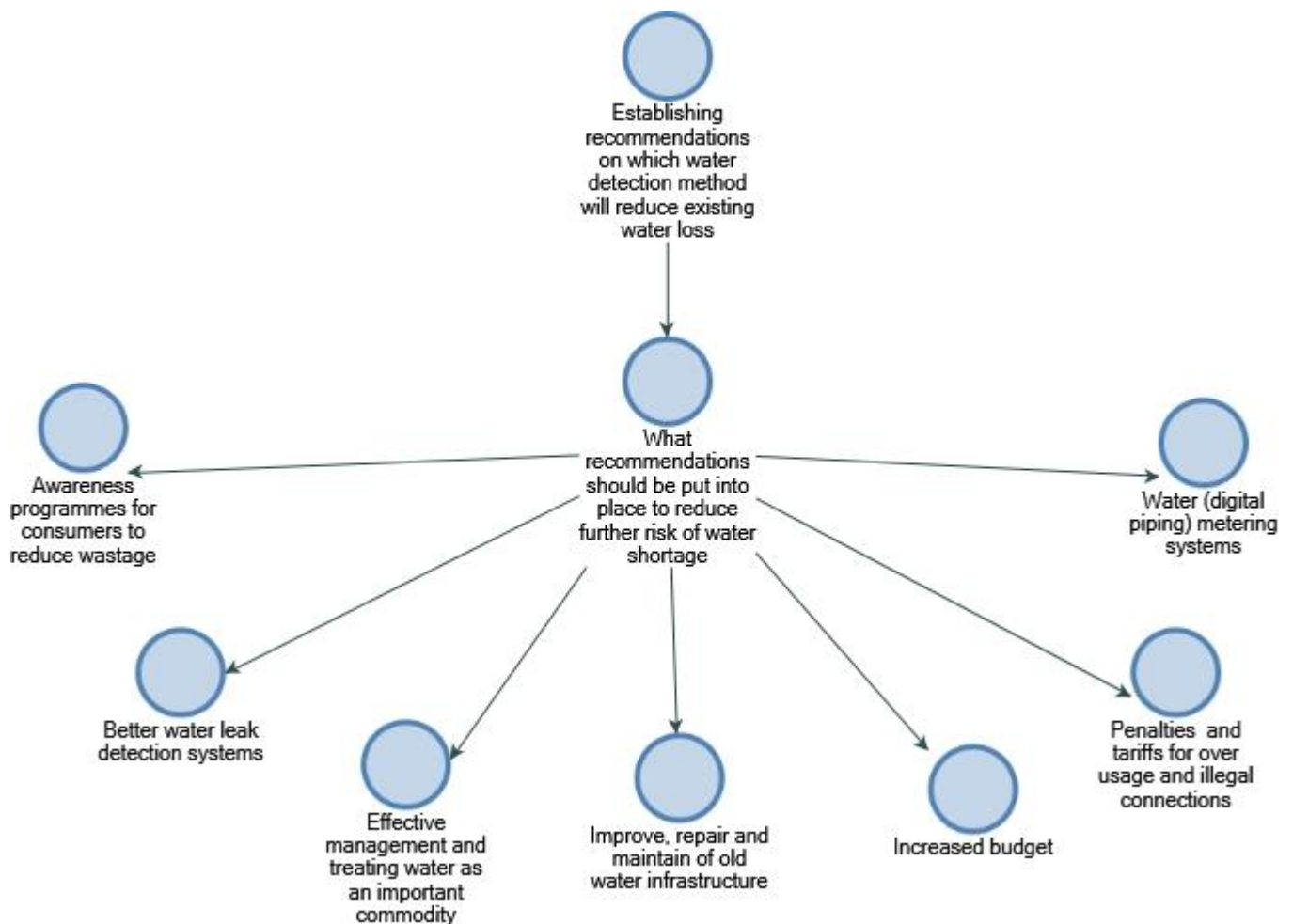


Figure 5.30. Participants’ recommendations to reduce the risk of water shortage

Interpretations: This question aimed to gain insight into each participant’s interpretation of

recommendations that they could propose to further reduce the risk of water shortage.

The participant's responses include *“Improve, repair and maintenance of old water infrastructure; Better water leak detection systems; Water (digital piping) metering systems; Penalties and tariffs for over usage and illegal connections; Effective management and treating water as an important commodity; Increased budget and Awareness programs for consumers to reduce wastage”*.

Conclusion/themes: The findings indicate the several strategies, proposals, and ideas of participants that can be adopted and implemented by the eThekweni Municipality.

The themes generated under this objective shows the different recommendations from participants. All recommendations made were always focused to plug all issues with operations and delivery of quality services by providing constant clean and safe water to consumers.

5.3 Conclusion

This chapter provided a summary of the data collected and the dominant themes identified. A total of nine participants participated in this research study and each respondent's answers were illustrated by quotation to support the research findings that will be discussed in chapter five. A thematic approach was used, which assisted the researcher in coding participants responses under different objectives and see if they adequately answer the research questions. The presented results will be critically discussed below.

Chapter Six

Discussion of Findings

6.1 Introduction

This chapter presents a discussion of the findings presented from qualitative data analysis, which was presented in the previous chapter on data analysis and interpretation. This chapter aimed to further explain the results from the data analysis with past literature on the research objectives.

6.2 Discussion of each Section

6.2.1 Section A

Research Objective one: To explore the accessibility of water supply to consumers within the eThekwinini region.

This section will review the findings of all questions in section A. This entire section is related to the aspects of water supply and research objective one.

What do you understand by the term “water supply”?

Water accessibility is seen as a continuous water supply despite restrictions and shortages, from a consumer perspective. Water supply is also seen as a process involving rendering water supply services to consumers. The majority of the participants mentioned that water supply is a process that is supplied or distributed from the eThekwinini Municipality to households and businesses through the process of facilities, water towers, pipelines, tunnels, and reservoirs.

Muller (2019) defines the provision of water supply and sanitation services as separate but related activities. It involves taking water from a reliable source, treating it to ensure that it meets the required standards and safe to use, then distributing it to households, businesses, and social institutions that require it, this is done through a process of infrastructure. Therefore, the responses from the participants confirmed Muller’s perspective on the term. It indicates that water supply is a process from the source to the Municipality and then to the end-user being

businesses and households, hence, water supply is carried out through infrastructures, such as pipelines, water towers, and tunnels. This question was important as the researcher aimed to gain an insight into the participant's interpretation of water supply.

How has your department contributed, in terms of strategies, towards the mitigation/alleviation regarding the shortage of water supply?

The findings showed that the EMWS department was responsive to water supply leakages and leak detection. The purpose of this question was to establish the extent of the managerial contribution towards the development of strategies towards mitigation and alleviation, hence preventing further water shortage. The researcher identified the following themes: 'water metering infrastructures, water management structures, and leakage prevention to sustain water supply'. The water metering systems were a key strategy implemented by the EMWS department, as participants stated that meter restrictions were fitted onto residential and business meters, as this was a measure to reduce the pressure and the supply of water to the end-user. Some participants raised the concern of "water theft", a concern to the department, and consequently, others argued that if "minimising water theft" was achieved, this will save the Municipality substantial revenue. Brown (2017) states that water theft is an act of taking water in violation of existing regulations. Such violations include not paying the amount due or specified by local water regulations, such as by tampering with meters, tapping boreholes without unnecessary licenses, or installing unauthorised connection to water distribution systems from the municipalities. The participants' responses confirmed the term provided by Brown (2017), that water theft is an act of taking water from a water distribution system in violation of existing regulations.

Water management structures were a concern as many participants mentioned that the department should "fix all water leaks" as this is contributing to unnecessary water loss. Mckenzie, Siqalaba, and Wegelin (2012) state that the number of water losses can be caused through different reasons, including infrastructure leaks, overflowing of reservoirs, burst, and leaking pipes, old piping systems resulting in breakage, approved but unmetered consumption. Unmetered household connections and erroneous registering of metered usage are done through broken water devices, meter reading faults, and billing blunders, as this contributes to the quality of water loss. This supports the statement, EMWS participants have stated water loss occurs through water leaks or burst pipes.

One participant mentioned, “Inspection of all water distribution supply networks to ensure no water loss due to leaks”. This participant provided a positive contribution that their department has implemented a strategy of inspection to overview all water distribution supply networks, other participants had not mentioned the element of “inspection”. “Inspection” can be seen as a positive exercise if implemented by the department, as this will set the standards for service delivery, as well as providing a conducive organisational structure to meet the needs of the city.

How is the shortage of water supply being affected by your department?

Findings for this question showed that department staff were aware of the water shortage concern and made efforts to minimise the usage and preserve it. Departmental information sharing was a key concept as the researcher aimed to investigate whether the EMWS department provided adequate information for strategic development on water shortage. Themes that were identified include water prevention measures; water awareness programs and impact of the performance. Some participants mentioned that their work performance was impacted negatively during peak seasons when dealing with the water crisis. Other participants stated that their department had no direct effect on water supply from any department, hence, employees were taking the necessary measures to preserve water. It was also stated that the participants said that the staff was conducting roadshows to educate other departments and communities. Lastly, the concept of “Impact of close monitoring performance” was identified by participant 9, and this participant stated that “close monitoring on consumption by consumer and adverse usage is being investigated”, therefore the department was investigating the adverse usage of consumers and close monitoring was implemented.

In your opinion, do you think that the shortage of water supply will be a concern in the next 10 years?

Some participants expressed fear about the water crisis, whilst others showed a degree of optimisation that they were certain that there will be no water shortage in 10 years. Since employees are working daily with past and current information, the researcher found this question to be imperative to assess the growing concern of the water shortage, as the EMWS staff were knowledgeable about the current water demand patterns. The researcher concluded that there some improvements in assisting to prevent water shortage. Themes that were derived

include water shortage strategies; water savings awareness and dam maintenance strategies.

“Water shortage strategies” was identified as a theme, and a few participants mentioned that “climate change” was a contributory factor towards water shortage, hence, most participants stated that climate change has affected the weather patterns, poor rainfall patterns have had a negative impact on the level of water in South African dams.

Some participants argued positively and stated that the EMWS department was minimising the concern of water shortage in the next 10 years and addressed “consumer sensitisation”. This was addressed with the initiative of “roadshows”. Participants mentioned that ongoing talks with stakeholders are continuing, hence, discussions were relating to the use of water and preventions were also discussed to minimise the abuse of water.

Participant two also positively argued that the eThekweni Municipality had strong measures in place to address the concern of the water crisis. The “building of dams and extensions have taken place”. The researcher highlights and states that the necessary preparations measures have started and the EMWS department is preparing to minimise the concern of water shortage in the next 10 years. Fasemore (2017) notes that some of the major reasons for the shortcoming in combatting water shortage in KwaZulu- Natal were factors such as the region’s aging and factor of inadequate infrastructure for water retention and distribution. The existing water retention infrastructure such as dams was built during the 1960s-1970s with no further new developments accompanying the rapid population increases in South Africa. This was attributable to the lack of adequate funds for most of the national governments. In South Africa, however, new developments have started, and some are currently in the pipeline for development, including the new Inkomazi dam in KwaZulu-Natal and the Umzimvubu Dam in the Eastern Cape.

Do you think that KZN is heading for a major water crisis? Please explain, in your opinion, why or why not, water scarcity is becoming a major crisis in South Africa?

Several participants believed that the water crisis is inevitable with the various concerns provided, as many participants stated that “water is the most valuable resource and people are reliant on this resource”. However, some participants mentioned with the current water restrictions in place, KwaZulu-Natal may not experience the water crisis. This question aimed to determine the level of concern experienced by KwaZulu-Natal currently and how they will

be affected in the near future. The following themes were derived include climate change impacts; ineffective management of water infrastructure and water restrictions.

It is noted again that “climate change” and “drought” are contributory factors towards the crisis of water, hence, in South Africa, the scarcity of freshwater is decreasing at a rapid rate and therefore, impacting the quality of water, due to pollution and destructions of rivers catchment. Fasemore (2017) argues that South Africa needs to look beyond the river water abstraction and needs to find newer sources of water to meet the increasing population for water demand. This must involve the implementation of new advanced technologies that can be used to ensure suitable water quality targets. New technologies must be implemented for the creation of water supply to meet the rapid increase of South African’s population. Climate change and drought conditions will always be contributory factors towards the water crisis and the impact of water scarcity, hence, the EMWS department needs to strategise around new technologies to meet the supply and the quality standards of water. Van Zyl (2014), states that water quality is measured by taking water samples at different locations in the water supply network and measuring the concentrations of disinfectant residuals and other water constituents in the samples by using standard testing methods. Complaints and feedback from consumers provide more information on water quality integrity. Municipalities have automatic samplers that can take samples at any given time over a specific duration. Measuring tools are also available to continuously measure the concentration of specific constituents in water and signal alarms when critical levels are reached. Consumer complaints and feedback are a valuable source of information on the integrity of the water system and should be monitored for indications of loss of water quality, including reports of smells, odours or dirty water supplied.

Other concerns that were raised by the participants were “poor maintenance of water infrastructure”, “water wastage” and irregular payment of water dues”.

A few participants mentioned that water scarcity is becoming a major crisis in South Africa, as there is a continuation of the influx of informal people that are moving into the KwaZulu-Natal region, hence, they feel that “these people are ripping off the metropolitan areas”. These types of informal people are residents that are from the low-income bracket, which makes it difficult for them to pay for the municipal water services as they have no income. Consequently, if this concern increases, the water demand will exceed water supply and will put pressure on the EMWS department to impose further restrictions to control the existing water supply. According to (Mnisi, 2019), “water scarcity” is referred to as volumetric abundance or non-

abundance of water supply. Water scarcity is the physical reality that can be measured across regions consistently over a period. Two factors drive water scarcity physical (physical or absolute water scarcity) and economic (economic water scarcity).

However, the researcher can conclude that economic water scarcity is caused by inadequate infrastructure development and the lack of investment by eThekweni Municipality in water or a lack of human capacity to meet the demand of water type of scarcity. The observed water scarcity in KwaZulu-Natal is not exclusively attributable to physical drivers but also comprises economic causes. Therefore, economic water scarcity in KwaZulu-Natal is caused by a lack of investment in infrastructure technology, to draw water from rivers and aquifers. Also, the insufficient human capacity to meet water demand may exacerbate scarcity.

Participant four raised and argued the concept of water scarcity if the crisis of water increases in scarce regions, this will lead to an increase in deaths amongst citizens and economic downfall, as health issues will surface. The crisis will also impact tourism in the KwaZulu-Natal, leading to a major proportion of the GDP being cut. Gilbertson, Hurlimann, and Dolnicar (2011) state that more people from the water-scarce location become more supportive of most water conservation behaviours, and they become more interactive in the participation of water conservation behaviours; these initiatives assist citizens and the death rate tends to decrease. This contradicts the responses of the participants, as Gilbertson, Hurlimann, and Dolnicar (2011) state that citizens from water-scarce locations are willing to participate in water conservation behavior, that they are willing to learn to ensure that water is preserved for a longer period.

Stewart (2017) argues that raising awareness about water conservation and water demand management creates issues and facilitates changes in consumer behaviors, as awareness is created through the education of stakeholders and consumers' increasing their knowledge about the subject. The effectiveness of the implementation of any awareness campaign is ultimately measured by the results of the implemented water conservation and water demand measures. Hence, both authors support the concept of increased knowledge on water conservation by citizens and the positive impact by citizens in return. Therefore, if continuous awareness is created by stakeholders for citizens, citizens will practice good water conservation techniques, as they are willing to learn to ensure water preservation meets water demand for a longer period.

Are you experiencing water shortages in the area where you live?

Based on the findings, it was revealed that several participants did not experience water shortages in their areas. Participant nine argued that she was living in a high-end suburban area and was negatively impacted by the frequent interruptions; this could be of the imposed restrictions implemented by eThekweni Municipality Water and Sanitation department for high consumption areas. Fusemore (2017) also states that high-end homes in South Africa located in suburban areas face frequent local water restrictions that prohibit citizens from watering their gardens/ lawns, washing their cars, etc. These water restrictions are enforced by municipalities and these citizens are charged higher prices if they exceed the allowed volume per day, and those who fail to comply with these rules are faced with stiffer penalties by the municipalities. The EMWS department confirms to Fusemore's perspective that there is a direct correlation between high consumption areas and the imposing of water restrictions. Therefore, the researcher concludes, when an area is categorised as a "high consumption" location, the EMWS department enforces further restrictions such as interruptions and higher prices, as opposed to average consumption and low consumption areas not having frequent interruptions and high prices. Hence, further restrictions imposed in high consumption areas will reduce the supply of water as well as the pressure of water in these areas.

Are you aware of any significant water pollution in the area where you live? If yes, what are the causes of pollution?

The findings showed that almost all the participants were knowledgeable and had a strong awareness of the causes of water pollution, while some participants had a fundamental understanding of the causes. The researcher aimed to investigate whether the factors that influenced the current water pollution crisis were fully understood by the participants. Themes include water pollution sources, informal settlements, and water source maintenance.

"Informal settlements" was raised by a few participants, these participants stated due to the burgeoning of informal settlements, many of these informal settlements are not budgeted for by the eThekweni Municipality. Msimang, (2017) notes that people residing in informal settlements face challenges with service delivery from municipalities. This is a result of the

land being occupied illegally, consequently impacting the environment negatively. A lack of basic needs and services leads to citizens from informal settlements to impact the environment negatively; this is through the discarding of waste into rivers and dams due to poor waste management structure. Hence, due to poor sanitation facilities, it was a contributing factor towards water pollution. Consequently, the effects of sewage leakages into rivers as well as throwing garbage also contributes to water pollution. “Sewage spillage” was identified as a theme as well, this theme was highlighted as some participants stated that no proper ablution facilities are available near squatter camps, hence, this is impacting the overflow of sewer manholes, as the sewer reticulation system becomes blocked and therefore, resulting in water pollution. The researcher also identified that many participants stated that businesses within the industrial areas are contributing to this type of pollution, as many businesses are dumping waste in rivers causing contamination. Chemicals flowing into rivers and informal businesses polluting the manholes with plastic by not cleaning their business location areas.

6.2.2 Section B

Research Objective one: To explore the accessibility of water supply to consumers within the eThekwin region.

This section will review the findings of all questions in section B. The entire section is related to the aspect of accessibility of water supply and research objective one.

Describe the relationship that eThekwin has with their water supplier, Umgeni Reservoir.

The findings have indicated that there is a healthy and strong business relationship with the Umgeni Water Reservoir. The strong relationship guarantees a regular supply of water that prevents water shortage. The researcher aimed to identify the relationship between the two organisations. Themes include seamless business relationships and sustainable water supply. “Seamless Business relationships” were identified as a theme. Majority of the participants’ stated that the eThekwin Municipality and Umgeni Reservoir had a strong business relationship. Participants’ responses were that “Relationship with eThekwin and Umgeni Water is very healthy”; “Very good working relationship as the eThekwin Municipality purchases water from Umgeni Water”; “Umgeni’s largest bulk buyer is eThekwin

Municipality. These two organisations have a strong relationship and eThekweni Municipality is dependent on Umgeni Water for the supply of water to their citizens”; eThekweni Municipality has a very good working relationship with Umgeni Water” and “The relationship is very strong due to the relationship that has developed over the years. EMWS is very dependent on the Umgeni Reservoir for bulk water supply”.

“On-going themes to maintain constant water supply” was also identified as a theme. The minority of the participants stated that ongoing meetings assist the department in building a stronger relationship with the supplier”; “ongoing meetings allow the department to ask Umgeni Reservoir queries and challenges, this allows us to maintain a healthy relationship with the supplier in the long run”. However, participants four and seven negatively argued that the relationship between the two organisations is not good and therefore the eThekweni Municipality needs to build on a relationship as they purchase the bulk of their water from this supplier.

Mokonyane (2017), stated that Umgeni Water has performed extremely well and has maintained a strong business performance relationship over the past five years. The EMWS department continues to look forward to realising the promise of water for all areas within KwaZulu-Natal, through Umgeni Water and water sectors collaborators in KwaZulu-Natal in the coming period. Therefore, it can be concluded that the responses from the participants/ confirmed Mokonyane’s perspective on the relationship between eThekweni Municipality and Umgeni Water.

In terms of water quantity, how much water does eThekweni purchase from Umgeni water on a monthly?

The findings revealed that the daily water supply is 790-MR litres or sometimes at 950 million litres daily. This question aimed to determine the quantity of water purchased from Umgeni Water. This question was proposed as the researcher wanted to understand the amount of water purchased monthly to gain a deeper understanding of the amount of water purchased monthly. Themes that were derived include prevention of excessive water and 790 MR of water purchased daily”. Majority of the participants confirmed that the EMWS department purchases approximately 790MR of water daily. Participant eight argued that the EMWS department purchases “950 million litres per day”.

Participant two raised a concern that “water quality has dropped because residents are wasting water and therefore a measurement of purchased water cannot be controlled”. Participant two also stated that “the EMWS department have installed water tanks, and thus helps with storage of water, Therefore, the quantity of purchased water will vary from month to month as some months the EMWS department may have a surplus of water”. Participant four raised that “the city has made citizens aware of the shortage and has requested that water be used sparingly”. “Prevention of excessive water” was also identified as a theme, Participant two stated that “the EMWS department do not waste water by using water extensively in unnecessary areas, this helps to ease the pressure of the quantity purchased”.

How has water supply trends changed in the past five years?

The findings have revealed an increase in water shortage and a corresponding increase in the adoption of water savings mechanisms. The findings also attributed to the changing trends of climate change. The researcher wanted to understand if there was a decline in water supply from the participants. The followings themes were identified: “climate change drought”, water-saving strategies, water shortage, and water demand fluctuations. The majority of the participants stated that the water supply trends did change in the past five years. However, participant four disagreed and stated that “the city has made citizens aware of the shortage and has requested that water be used sparingly”. A few participants stated that the level of climate change has changed in the past five years and that the drought was a contributing factor to the level of water supply trends. However, participant two disagrees and states that drought conditions have stabilised and residents are using water normally.

Mthembu (2019) states that South Africa has become a climatically sensitive and water-stressed country in the last five years. Much of the country has become arid or semi-arid and the whole country has become subject to floods and droughts. In the last few years, there has been variation in the rainfall, and this has exacerbated the stressed environment. The impact of climate change has worsened the serious lack of surface and groundwater resources, exacerbated desertification, and impacted the magnitude, timing, and distribution of storms that produce floods. Therefore, the responses from seven participants confirmed Mthembu’s perspective on the term of climate change. The researcher confirms that there has been a significant change in climate change and this change has impacted South Africa negatively. The increasing concern has been centred around the lack of surface and groundwater resources.

“Sparing- water usage” was identified as a theme, participant four stated that “people are requested to use water-saving mechanisms and help to avoid the strain on Umgeni Reservoir. This will help ease the pressure of water shortage”

“Increase demand” was viewed as a minority view, as participant nine stated that “the usage by consumers increased due to the supply to areas, not receiving water timeously and some areas not receiving at all”, whilst participant six, “the demand of water supply has increased over the past five years due to the increase in population growth”.

Schoeman (2015) states that KwaZulu-Natal has been experiencing severe water restrictions, with 50% reported in late October 2015. With high temperatures in the area of Rand Water, the strain of Johannesburg’s bulk water supply system has increased. With the combination of the lack of rainfall in Gauteng and an increased demand placed on the Ekurhuleni Metropolitan Municipality system, both the City of Johannesburg and City of Tshwane is feeling the strain of water supply. Though localised droughts have become common in South Africa, it is currently in a national drought situation. The responses of the participants confirmed Schoeman's statement that South Africa as a whole has been experiencing challenges with water supply and that water restrictions are being implemented to preserve the current water supply.

What measures are put into place to ensure that water is supplied to citizens within the eThekweni region?

The findings indicate that the EMWS department have implemented a few measures for continuous supply to areas within the eThekweni region. The measures include regular maintenance of water infrastructure, water tanks for preservation and timeous supply, monitoring illegal water connections, and water management processes.

The purpose of this question was to understand the various types of measures that are currently being practiced for continuous water supply in the eThekweni region. The following themes were identified “monitoring illegal water connections, regular maintenance of water infrastructure, use of water tanks, monitoring of demand and supply of water patterns”.

Regular maintenance of the water infrastructure was seen as a concern by the majority of the participants. Participants one and six both agreed that regular maintenance was undertaken. Participant six stated that water infrastructure has been put into place and this has improved the water source in both rural and urban areas. Renewal of old pipes have been replaced with new piping to prevent leaks and burst piping, whilst participant one stated that water infrastructure

is in place and that water maintenance is undertaken around the eThekwinini region. Participant four also positively stated that the water department staff have ensured that routine maintenance on underground pipes were performed as well as attending to burst pipes on an ongoing basis. Participant two stated that monitoring of demand and supply water patterns was crucial as “water at the dams must be maintained at a certain percentage so that all residents receive constant water supply, while participant four argued that the EMWS controls the supply of water., through control pressure measures. This helps residents and businesses to get water supply according to the demand-control water patterns”.

The installation of water tanks was implemented within the eThekwinini region, participant two agreed that the EMWS department has installed water tanks throughout the eThekwinini region, as the department required more than 200 000 tons of storage facilities to supply water timeously to all areas within the eThekwinini region. Ndaliso (2020), states that the EMWS department has increased the number of water tankers within the eThekwinini region. Water tankers were installed in areas where residents are experiencing water shortages. These areas within the city were constantly experiencing intermittent water supply due to aging infrastructure and the increased population in rural areas. The responses of the participants confirmed the statement of Ndaliso’s (2020) who discusses that these water tankers were installed in areas where there was an intermittent water supply. Therefore, the researcher understood the need for water tankers as not all areas had a continuous water supply, as water tankers were used as a measure for continuous water supply and this was practiced in all areas within the eThekwinini region.

What challenges are experienced during the supply of water?

The findings indicate that there were different kinds of services and capacity challenges when supplying water to consumers. This question aimed to understand the various challenges experienced under the current Quality Management System. Themes that were identified include underground water leakages, skills, and capacity building, illegal water connections, water supply disruptions, and poor maintenance of water infrastructures.

All participants stated that there was no water quality management system in place, hence, there were many areas that required attention. A major concern that was raised by all participants was poor maintenance of water infrastructures. In the previous question, participants stated that water maintenance was undertaken around the eThekwinini region and that the water department

staff have ensured routine maintenance of underground burst pipes were attended on an ongoing basis. The responses from the previous question contradict the responses to this question as many of them said that there was a smooth operation of water infrastructure. Some of the participants argued that old infrastructure had resulted in many leaks and this has caused continuous water loss. Participant eight agreed that there was poor maintenance at the reservoir as the valves were being shut for long periods, thus affecting the supply of water to the eThekweni Municipality. Other concerns raised about “poor maintenance of water infrastructure” included lack of security, aging of infrastructure, poor operation, long delays on the repair of water leaks, political interferences, and underground water leaks. Illegal connections were rising, and participants stated that no payments were received. Participant seven agreed with this and stated that citizens within these areas were not treating water as a scarce resource.

Mckenzie and Wegelin (2009) stated that poor maintenance is a massive problem throughout many parts of South Africa and especially disadvantaged areas where maintenance of water supply infrastructure has been neglected for many years. When the water supply infrastructure is maintained properly, it becomes impossible to implement effective water demand management interventions before the maintenance backlog is addressed. Unfortunately, the areas that experience a lack of proper maintenance are often the areas that require the need for water demand management measures and are the areas where the greatest savings could be theoretically achieved. To bring the system up to a reasonable level of service, it is often found that large scale infrastructure replacement or refurbishment is necessary. Only when the system is operating properly the most appropriate water demand management interventions can be successfully introduced. The lack of political support is hampering the successful implementation of the water demand management interventions in many areas and this becomes a major cause of interventions, which could arguably be successful in a different political environment. In most cases, it is found that politicians, particularly at the municipal level do not support water demand management interventions despite the growing concern placed upon the Municipality by the department of water affairs and forestry.

Without proper support from local politicians from the Municipality, it can be difficult to implement many obvious and highly effective water demand management measures. An example is the lack of support for implementing and enforcing water restrictions in many areas. Many municipalities in South Africa experienced intermittent supply in certain parts of their distribution system. For example, in Gauteng, this problem occurs every year particularly

towards the end of August and September when temperatures increase and before the first summer rains occur. Many of these water systems fail to supply the sudden increase in demand and many residents in high zone areas experience severe water shortages. Therefore, the participants' responses affirmed McKenzie's and Wegelin's (2009:11) point of view on "poor maintenance of water infrastructure and lack of political support".

How does practice ensure active, free, and meaningful participation with the consumer?

The findings revealed that consumers were very ignorant of the process of supplying water to their areas. The EMWS department is addressing all water issues and complaints queries and ensuring that consumers are being educated on the process of water supply. Water supply complaints, call centers, consumer queries, and roadshow awareness campaigns were identified as themes.

This question aimed to explore the various practices to ensure maximum consumer participation. Themes that were derived include service delivery issues. Participant nine agreed that the eThekweni Municipality had a fault customer care line which allowed for complaints to be effectively registered, while participant one stated that there was no meaning participation with consumers due to the increase of water complaints being raised. McKenzie and Wegelin (2009) state that another key problem in South Africa is the "lack of support from consumers". This highlights the fact that the per capita water consumption in many areas is significantly higher than in many other countries outside of South Africa which may have greater natural resources. For example, the average per capita consumption in Sebokeng and Evaton is estimated to be more than 200 ℓ/cap·d. This can be compared to other countries such as Brisbane in Australia where a figure of 130 ℓ/cap·d has been implemented and achieved. Therefore, a major shift in the habits of South African consumers will be required to protect the existing water resources in the near future, to ensure that the systems do not degenerate into those experienced by many other developing countries. The EMWS department has made some progress to educate consumers and to change their perceptions and habits regarding water use. This is a slow process and more effort is required to produce significant progress.

Participants three, four, and seven stated that there is a call centre for consumer queries and for consumers to pay their accounts, however, participant five stated that customer surveys were carried out during awareness campaigns for feedback.

Roadshow awareness campaigns were a concern as participant six disagreed and stated that the eThekweni Municipality needs to encourage active engagement between the Municipality and the community. If this was addressed, this will assist in rectifying problems more effectively and efficiently. Thus, stronger relationships will be built within the community. Participant eight argued that social media wasn't fully implemented as a platform for community engagement.

Thompson (2013) states that the eThekweni Water and Sanitation Unit is using various media ranging from print to electronic to provide eThekweni citizens with information to enable easy access to water and sanitation services. These include Suggestion Boxes; Electronic Media Programs; Roadshow; Education Awareness Centre; Internet website and the Call Centre.

Some of the responses from the participants confirmed Thompson's (2013) perspective. Therefore, the researcher agrees with Thompson's (2013) perspective that the eThekweni Municipality has been exploring various practices to ensure maximum consumer participation. Jimenez (2019) stated that active, free, and meaningful participation with consumers is an ambitious goal, and the necessary conditions to understand the benefits are not always in place. One evidence critique of the participation benefits is inconclusive. When participatory processes are not properly implemented or designed, this can have adverse consequences. Failure to have community engagement can result in stakeholder fatigue, objectives not being met, and legitimization of marginalisation and inequalities. Too often "community and stakeholder participation" becomes an obligatory component of water projects that are put in place to secure their legitimacy. Therefore, such water projects have often disregarded the fact that communities are not homogenous, and the benefits of participation risk are captured by the local elite.

6.2.3 Section C

Objective 2: To explore the relationship between the supply of water and water restrictions within the eThekweni Municipality.

The researcher aimed to gain a deeper understanding of the implementation of water restrictions and the related effect on the current water supply. Questions under section C focused entirely on water restrictions, looking at the importance and impact on water supply. This information was critical as the researcher assessed the need for water restrictions enforced by the EMWS department during the current water crisis.

What is the perspective of the eThekweni water management department on the issue of water shortage and water restrictions?

The findings indicate the various measures implemented by the EMWS implements whenever there is a water crisis. The purpose of this question was to understand the EMWS department's concern regarding the water shortage and water restrictions being enforced. Themes that emerged were water restrictions, maintaining the consistent water supply, customer satisfaction, sparing usage of water, and water crisis.

Water scarcity has been a growing concern and the EM has ensured that effective water management measures are put into place to ensure that existing water supply is used sparingly to all regions within KwaZulu-Natal while maximising customer satisfaction, as stated by participant six.

Maintaining consistent water supply was raised by the majority of the participants, participant eight stated that the dams had adequate water levels. This participant also mentioned that the reservoir had adequate water for now and that there would be no water shortage or implementations of water restrictions. Participant four agreed that the eThekweni Municipality is making every effort to ensure that water supply is optimal for the city.

Monitoring of water shortage weekly was seen as effective practice, as fines and tariffs were charged for over-usage of water. eThekweni Municipality (2017) stated in 2017 that the EMWS department was looking into increasing the restrictions from 15 percent, which was not being achieved, to 20 percent as the dam levels were still low. Hence, the demand was not reduced by the consumers, which necessitated the implementation of stage three water restrictions.

Participant eight's response does not affirm the eThekweni Municipality's viewpoint on the adequate water supply and implementation of water restrictions. eThekweni Municipality's spoken stated that the EMWS department was going to increase the water restrictions from 15 percent to 20 percent as the dam levels were low and the initial percent was not effective.

Do you think, there is a correlation/relationship between the supply of water and water restrictions?

The findings showed that the EMWS department is flexible according to the severity of the water supply crisis, as the implementation of water restrictions is based on the level of water supply. This question aimed to understand the flexibility of water restrictions imposed by the EMWS department. Themes that emerged included effective water distribution and flexible water restrictions.

The majority of the participants stated that there was a correlation between water supply and imposing of water restrictions. Participant six agreed that measures were implemented and that there was a correlation. The participant also agreed on the effectiveness of the water management distribution, which has led to the supply of water throughout the KwaZulu-Natal region.

eThekweni Municipality (2017) stated that the consumer area of residence was important as this will identify their respective reservoir zone. Whenever there were interruptions in the system, high-level zones or those residing near the reservoir will be first to run out of water and the low-level zones will be impacted last. When water was restored the low-level zones will get water first, the system will fill up and the high-level systems will be filled up last.

What's the importance of placing water restrictions?

The findings showed that water restrictions have become a necessity during the shortage of water supply and must be controlled during the water crisis in KwaZulu-Natal. The question aimed to understand the need and how the EMWS department enforces water restrictions throughout the KwaZulu- Natal region. The following themes emerged fair distribution of water, effective control of water supply sources, and sparing water usage.

Participant one and five agreed that enforcing water restrictions will eliminate the amount of

water shortage. Both mentioned that these restrictions will force and create awareness amongst citizens to use water sparingly and if they do not abide by the restrictions then they will pay penalties for overuse of water.

Participants six and eight agreed that restrictions will reduce water consumption in high usage areas and that consumers will use water more sparingly during severe drought conditions. Participant eight suggested that sustainable practices will assist with continuous water supply, while participant nine agreed that the implementation of sustainable practices; for example, the 3R's (Reduce, Reuse and Recycle) can provide continuous water supply to all areas within KwaZulu-Natal. eThekweni Municipality (2017) states that the implementation of water restrictions in the systems is not practical as one system may achieve savings and the other systems may not. This forces Umgeni Water to reduce the water supply as instructed by the eThekweni Municipality Water and Sanitation department. Therefore, the responses from the participants do not confirm with the eThekweni Municipality's perspective on the implementation of water restriction, as the participants' stated that water restrictions will eliminate water shortage and will reduce water consumption in high usage areas.

Briefly describe the effectiveness of enforcing water restrictions in high consumption areas?

The findings have indicated that water management practices were effectively managed in high consumption areas. The purpose of this question was to understand the success of enforcing water restrictions in high consumption areas during a water crisis. Themes emerged include customer servicing issues; water preventions and monitoring water supply and usage.

Participants' mentioned the severity of enforcing water restrictions and agreed that the community suffers due to demand exceeding supply as citizens are compelled to use water sparingly due to the strict measures of water restrictions. Participants two, four, and eight agreed that tariffs and penalties are charged for over usage of water.

Participant three stated that high consumption areas are highlighted, and stronger restrictions are enforced on these areas, while participant two argued that the practice of water disconnection was implemented for illegal connections of water supply.

Within eThekwini, which region is the highest consumption area?

The findings have shown that “Umlazi” and “Tongaat” regions were categorised as high consumption areas by eThekwini Municipality. The question aimed to investigate a deeper understanding of eThekwini’s high consumption areas in terms of water supply. The following two regions were identified themes, which include Umlazi and Tongaat.

All the participants had indicated that Umlazi and Tongaat were high consumption areas and that the EMWS department was concerned about water supply to these areas.

Please explain the type of criteria that is used, in the implementation of water restrictions to specific areas?

The findings revealed that the SCADA system was the only criterion that can be used in the implementation of water restrictions at the eThekwini Municipality. The purpose of this question was to understand the various factors that contribute to the criteria when implementing water restrictions. The themes that emerged from this question include the SCADA system and water restrictions.

Eight participants agreed that the SCADA system can be used as the main criterion when implementing water restrictions, as this system helps to reduce the wastage of water. Participant three stated that the SCADA system retrieves information about high consumption areas. This system will help us target specific areas and restrictions to reduce the pressure/flow of water supply will be made accordingly. However, participant six disagreed and stated that “it becomes difficult to analyse water patterns as there are many unknown and poorly defined variables, as there are specific disparities between water demand and water supply. Therefore, using a standardised criterion is not effective and there is no system in place”.

6.2.4 Section D

Objective 3: To examine the amount of rainfall and water supplied to the eThekwini Municipality.

Section D relates to the above objective to examine the amount of rainfall and water supplied to the eThekwini Municipality. This section focuses entirely on the correlation between the amount of rainfall and water supplied from Umgeni Water to the eThekwini Municipality. Due to the EMWS department purchasing water in bulk and being Umgeni Water's biggest buyer, the researcher aimed at gathering a deeper understanding of Umgeni Water's operations and supply practices. The researcher found this information useful as there was a current water shortage at the main dams.

What control measures are being put into place to monitor the amount of rainfall and water supplied to the eThekwini Municipality?

The findings from the participants revealed that there are several measures employed by the eThekwini Municipality to manage water supply and rainfall within the KwaZulu-Natal region. This question aimed to establish the various control measures that monitor the amount of rainfall and water supplied to the eThekwini Municipality. The researcher also wanted to understand the relationship between the amount of rainfall and water supplied from the Umgeni Reservoir. The themes that emerged included: monitoring water supply and SCADA implementation.

The implementation of the SCADA system was seen as a majority view. Participants three, six, eight, and nine agreed that the implementation of the SCADA system will assist with the effectiveness and efficiencies of the water metering systems. Quantity specifications can also be monitored between the eThekwini Municipality and Umgeni Reservoir through the SCADA system, stated by both participants.

Participant four argued that the use of the SCADA system was not necessary as the environmental department monitors the amount of rainfall and alerts the EMWS department to plan, this was done through the monitoring system. However, participant eight stated that well-maintained infrastructure can also assist with measures to control the amount of rainfall.

6.2.5 Section E

Objective 4: To evaluate the Quality Management System (QMS) on water management practices at eThekweni Municipality.

Section E evaluates the effectiveness and efficiency of the current Quality Management System. This section also focuses on the current practice of the QMS system and how service delivery is evaluated. The researcher intended to gain insight into the type of criteria used for water acceptability practice and to ensure that the revenue management system (RMS) is improved.

Please describe the current quality management system on water supply at eThekweni Municipality?

The findings revealed that there is no actual quality management system in place, but findings show that the EMWS department is using various measures to meet quality standards. The purpose of this question was to understand the effectiveness and efficiency of the current quality management system. The researcher found this to be a critical question as there were few concerns regarding the quality management system and the department required improvements. The following themes emerged, ISO 17025, SANS241, water service act (WSA) & DWS, and Water lab tests.

The majority of the participants' stated that water laboratory tests were used as a practice implementation of the ISO 17025 as this helped to assess the quality of water.

Participant six argued that there was no quality management system implemented, thus, there were too many bottlenecks in the system that prevented the quality, efficiency, and effectiveness of the system. This prevents the ISO 9001 from being achieved, as eThekweni Municipality has only a water laboratory to test water supply from Umgeni Reservoir before supplying water to businesses and households.

Requirements of SANS 241 were raised by participants five and eight. Both participants agreed that potable water was supplied in accordance with the requirements of SANS 241, as this was the Water Service Act (WSA) and the requirements of the EMWS department.

How does water practice meet the criterion of quality management?

The findings indicate that the implementation of the ISO 9001 standard was required. This standard will ensure quality water supply to consumers and businesses. The question aimed to identify the different criterion measures for best water practices. The only theme that emerged was “ISO 9001 standard”.

Eight participants stated that the implementation of ISO 9001 was required. Participant four argued that the total quality management system may be lacking due to water shortages as the ISO 9001 standard was not implemented and that rainfall needed to be assessed. Participant six mentioned that the EMWS department has a standardized criterion that is used to inspect the water specification before the water is supplied to KwaZulu- Natal citizens. This participant also stated that health and safety standards are complied with in general. However, participant nine agreed that the implementation of the ISO 9001 standard will meet quality standards and enhance the service delivery of water supply. eThekweni Municipality will be impacted positively with this standard and this will make EM a SMART city.

How does the water practice meet the criterion of acceptability?

The findings showed a combination of SANS 241 and aggressive awareness programs that can assist sensitive consumers. The purpose of this question was to understand the acceptability criterion for best water practices. Two themes were identified, SANS 241, and water supply awareness programs.

Majority of the participants stated that the SANS 241 standards can be used as acceptability criteria, while participants seven and nine agreed that roadshows and awareness programs can be used as acceptability criteria to create awareness around the water compliance standard. However, participant four argued that the EMWS department cannot be rated to other countries as this was not acceptable.

How can the current Revenue management system be improved on water loss at eThekwin Municipality?

The findings revealed that there are revenue leakages in the water supply system, and this will need to be analysed and resolved with an efficient accounting system and a state-of-the-art functioning water supply structure. The purpose of this question was to understand how the current revenue management system was used to improve the detection of water loss and prevent revenue loss. Themes included “water leakages, efficient water infrastructure, 100% water detection system, water metering system, and illegal water connections”.

Majority of the participants suggested that there was a need for a SMART water metering system, while participant six provided a discussion that the implementation of a water metering system, will provide a more accurate water reading. However, participants one and eight both agreed that the installation of water infrastructure in all areas can improve the quality of the system and decrease the amount of water wastage.

Applying penalties for excessive water usage and disconnecting water supply through illegal connections were raised by a few participants. However, participants six and eight provided that an implementation of a water detection method will assist with water retention recovery and the prevention of illegal water connections will be achieved.

Sithole (2019) stated that the EMWS department was looking at models from other provinces as to how they were dealing with the issue of non-revenue water. The eThekwin Municipality is currently paying an excess of R163, 6m towards non- revenue water annually, and non-revenue water trends are growing approximately 2% yearly. Despite the various challenges, the EMWS department has made positive progress in interventions, which includes the installation of new Pressure-Reducing Valves (PRV), removing illegal connections, metering unmetered properties, maintaining existing PRV’s and conducting active leak detections.

6.2.6 Section F

Objective 5: To provide recommendations for a more suitable water detection method which will reduce existing water loss.

Section F evaluated the effectiveness and efficiency of the various water detection instruments currently being used to detect water loss. In this section, the researcher analysed the various possible water detection methods to recover water loss and was able to provide recommendations by improving the current water detection method to recover close to 100% water loss.

What is the current water loss detection method that is being used by eThekweni Municipality Water Department?

The findings revealed that the SCADA system is the main tool for detecting water loss and revenue monitoring. The question aimed to understand the most current method employed by the EMWS department for detecting water loss and leaks. Two themes were derived, revenue monitoring and water loss detection.

Majority of the participants mentioned that the SCADA system will assist with the reduction of water loss. Temido (2013) states that the information provided by the SCADA systems enables the reduction of real losses in the water supply. Two reasons allow this technology to increase the efficiency of active leakage control: water tanks levels monitoring, which allows for the detection of leakage and overflows, and the night monitoring coupled with step testing (closing of valves), this allows for the enabling easier location of leaks. Any small leakage that goes undetected is a potential future large- scale burst, this action measure ensures indirectly a reduction of the amount of water loss. Therefore, the responses from the participants confirmed Temido's perspective on the implementation of the SCADA system and that this system will assist with the reduction of water loss.

Participant four stated that the EMWS department uses various water detection instruments to assist with the recovery of water loss. This participant disagreed that no set instrument can assist with 100% recovery. However, participant nine provided a discussion on the monitoring of revenue and stated that when the EMWS department is in a deficit, then the department implements strategic plans to analyse the lost revenue. The use of a detection method is imperative. As these plans are to get to the root of the problem caused, this helps to refrain from continuous water loss as the water detector can be used to identify the exact problem area.

Van Zyl (2014), states that there are various techniques for identifying water leaks through active detection. There are some methods that are better suited to certain pipe materials and diameters. The author suggests that there are different techniques to test for water leaks, as follows:

- **Gas Injection:** The purpose of this method is to find the presence of a tracer gas that has been injected into an empty pipe through a gas detector. The most common gas that is used is hydrogen, but helium is occasionally used. A probe is used alongside the pipeline to detect gas which is released through leaks in the pipe.
- **Manual listening stick:** A listening stick or a stethoscope with an earpiece is pressed against fittings to listen for nearby water leaks in the pipes.
- **Leak noise correlation:** This type of technique is done through leak noise correlators which compare the noise from two different points of the pipeline. When the noise signal reaches the respective sensors, the duration of detecting that noise is the estimate of the location of the leaking pipe. Noise correlators will pick up non-leak sources of noise and these leaks should be verified by using ground microphones. Municipalities can use two types of noise correlators:
- **Accelerometers.** This method uses two accelerometer sensors that are fitted on the pipe on either side of the suspected leak position. This method becomes effective when identifying leaks on metallic pipes.
- **Hydrophones.** This method is not effective in plastic pipes due to their higher elasticity, and in large diameter pipes due to the higher diameter of the walls thickness ratios. Hydrophones are placed in water, for the instance of hydrants, which allows for the noise signal to be picked up directly from the water.
- **In-line detection techniques.** This technique is used for large diameter pipelines. Probes are used and are placed in pipes to pick up leak noises as they pass through it.
- **Leak noise loggers** are placed on the fittings of the pipes and this helps to pick up the noise created by the leak in the pipe.

Therefore, the response from participant four confirms Van Zyl's perspective that there are different water detection instruments to identify exact water problem areas. However, Van Zyl provides different techniques that can be used to detect water leaks within the eThekwin region.

How effective is the current leak detection method?

The findings showed that the present water leak detection method at EMWS has not been effective and therefore water leakage still occurs. The purpose of this was to understand the effectiveness of the current leak detection method. Themes that emerged include ineffective leak detection and water loss recovery.

The majority of the participants' agreed that the current leak detection method was not effective and that they were not fully guaranteed to be successful as the water loss is currently high. The participants also stated that there were too many undetected water leaks occurring and this resulted in a loss of revenue and quality water being wasted. However, participants four and six both agreed that the current leak detection method was effective but could be more effective if it was digitally managed, as it was not 100% guaranteed for 100% water loss recovery.

Rondganger (2015) states that the eThekwin Municipality hopes that the implementation of newer technology will help to stem massive losses, as the EMWS department begins stringent water restrictions in the face of crippling drought. Water losses were caused by vandalism, illegal connections, and the aging of water infrastructure. The city will implement a roll-out system of "early warning" that will assist the department in the monitoring of their water leak detection systems. This will affect the department's bulk water trunk mains as non-revenue water losses were increasing. The EMWS department revealed that the city's known water losses had increased to 40% at the end of September 2015 and that the city was spending millions on real-time monitoring and would implement all bulk water meters. It is very cost-effective to install water monitoring systems on trunk mains, as the department aims to have full visibility of the strategic infrastructure by the end of June 2019.

The author further stated that in February 2015, non-revenue water loss was 29.8% and at the end of September 2015, the average was 39.6%. This was seen as a concern as the EMWS department had the largest non-revenue water budget compared to all municipalities in South Africa. From 2008 to 2011, the eThekwin Municipality invested R2.1m to replace all old water main infrastructure, but approximately R300m per annum was allocated to replace all old water distribution systems. Head of water and sanitation, Ednick Msweli, addressed his committee and stated that the city needed R1.5b over the next five years to replace and upgrade all old infrastructure and pipes, due to the city losing more than R600m a year because of water losses. Another concern was that 237m litres of water were lost each day due to ailing water

infrastructure, and this accounted for 26% of water lost. Measures were in place and the EMWS department ensured between 200 to 400 faults per day was repaired, and 95% of the water leaks were repaired within 24 hours, and priority was given to larger water tanks. In 2015, the EMWS employed 103 plumbers to repair major water leaks within six to eight hours, consequently, the eThekweni Municipality faced challenges in reducing water losses as these losses were compounded by the mushrooming of informal settlements. This had grown from 550 in 2011 to more than 800 in 2015, hence some of which were illegal connected water supply. More than 30% of dwellings in informal settlements have illegal connected water supply from the water mains, this was one of the factors contributing to water loss.

What percentage of water is recovered through eThekweni's current water detection method?

Findings have shown that 65% of water loss is recovered, and the recovery rate will need to improve. The purpose of this question was to understand the percentage of water loss recovered whilst utilizing the current water detection method.

Six participants had agreed that approximately 65% of water loss was recovered through the existing current water detection method. Therefore, there is a need to increase the water recovery rate from 65% to 75% or 85%. As the recovery rate increases, water loss will decrease and this will increase revenue generation as more water is supplied to consumers and businesses.

Is the leak detection method effectively monitoring the water loss consumption?

The findings indicate that the current leak detection method is not adequate in monitoring water loss in the system. It shows the current measures need revamping or restructuring. The purpose of this question was to understand the effectiveness of the current leak detection method for water loss consumption. Themes that emerged include leak control measures are weak and water loss prevention is not 100 % effective.

All participants agreed that the leak detection method was not effective and that there were no control measures to monitor effective water loss recovery. However, participant six argued that the leak detection method was able to identify water loss but couldn't guarantee 100% water loss recovery, whilst participant five argued that the leak detection method was not being monitored closely.

In your opinion, which water detection methods could be used to reduce existing water loss?

The findings have shown that the SCADA system was the main detection method that could be used within the EMWS department. Some of the participants also advocated for a digital water metering system. The question aimed to understand the flexibility of the EMWS department when using various water detection methods to recover existing water loss. Two themes were identified namely the digital water metering system and SCADA.

A few participants suggested that the digital pipping metering system will assist with more accurate results and this will assist the EMWS department when billing consumers and businesses. Consumers and businesses will pay a more accurate amount as the system has identified a more accurate water reading. Sithole (2000) states that the digital pipping metering system detects and alerts both the department and the consumer of any possible leakages in the consumers' property or business. This system makes it easy for earlier detection of any leakages such as dripping taps, running toilets, and pipe leakages. The digital pipping metering system makes it easier for the department to determine the efficiency of the water distribution system and determine accurate results for billing purposes to consumers and businesses. Therefore, the participants' responses affirmed Sithole's viewpoint on the digital pipping metering system in determining accurate results for billing consumers and businesses on their water consumption usage.

It becomes difficult for the EMWS department to write accurate reports about the actual water consumption and losses. In most cases, consumers do not like reading their analogue water meters, and thus, consumers rely on their bill to see their monthly water consumption. Consequently, the EMWS department does not have a system in place to alert consumers on their daily water consumption or any possible leakages around their property. The current technologies that are being employed by the EMWS department to keep track of water consumption usage, are the old analogue water meter readers. The EMWS department hires these water meter readers to go from house to house to take readings from the water meter to issue the bill to the consumer. This approach can result in infrequent monitoring and errors of the water meters, and inefficient systems to alert the EMWS department in real-time about inconsistencies with the water meter readings. Inconsistencies bring about frequent billing

errors that can result in the customer paying an unrealistic bill or the department losing revenue over errors.

Mckenzie and Wegelin (2009), states that's a key problem that's affecting South Africa and is very significant in many areas: low-income areas with very high leakage become a problem as consumption is measured and bills are sent out to consumers, as the monthly consumption per property is 50 kℓ. Of this 50 kℓ, the consumer only pays for 44 kℓ, and the remaining 6 kℓ is received as a free basic allowance to consumers. Since these are low-income areas, residents are often unable to pay for the services and their water bill accumulates. This becomes an ongoing concern, and the water department tends to address these problems by installing a form of restrictor or a prepaid meter. If this water demand intervention is implemented successfully, hence household leaks will be repaired as part of the process and accumulated accounts will be written off as a "once-off". The water department provides this gesture of goodwill on the basis that the consumer agrees to pay all water usage from that date forward.

This approach is required in many parts of South Africa, as the water department derives realistic estimates on what is achievable through successful implementation s of various WDM interventions. If it is assumed that all water consumption bills are paid and the demand remains at pre-intervention levels, there will be a serious discrepancy as the assumed increase in revenue water will not materialise. This impacts on the financial viability of the proposed water interventions. Therefore, the EMWS department must examine the payment levels carefully to ensure that the predicted savings and/or reductions in overall water demand are realistic.

The majority of the participants were consistent and have suggested the implementation of the SCADA system. The participants stated that this system will be able to identify existing water loss and will provide effective monitoring devices that will apply to the 4th industrial revolution technology. Temido (2013) states that the information provided by the SCADA systems enables the reduction of real losses in the water supply. Two reasons allow this technology to increase the efficiency of active leakage control: water tanks levels monitoring, which allows for the detection of leakage and overflows; and the night monitoring coupled with step testing (closing of valves). This allows for the enabling easier location of leaks. Any small leakage that goes undetected is a potential future large- scale burst, this action measure ensures indirectly a reduction of the amount of water loss. Hence, the researcher concludes that the implementation

of the SCADA allows for effective monitoring, which detects current water losses and provides immediate solutions to rectify these problems.

What recommendations should be put into place to reduce further risk of water shortage?

The findings have shown several strategies, proposals, and ideas of participants that can be adopted and implemented by the eThekweni Municipality to reduce further risk of water shortage. The question aimed to understand the participants' recommendations on how to reduce water shortage risk further. The majority of the participants stated that renewing/upgrading old piping and infrastructure was needed to ensure continuous water supply with minimum leaks and burst pipes.

Water detection methods and SMART water metering systems were raised by participants one, two, five, and eight. These participants stated that by implementing this recommendation, this system will contribute to effective revenue management. The Palance Group (2014) states that municipalities experience many challenges and some of the current realities include consumer defaults on water bills; consumers bypassing their meter systems and this resulting in loss of revenue, and lack of accurate data management and recording. Most municipalities implement water demand measures to ensure a desired reality is achieved, by ensuring the following real-time and accurate billing of water consumption; preventing losses in revenues by detecting water leaks. The consumer only pays for what they have consumed thus the consumer remains in charge of their consumption and subsequently their bills. The municipal sector practices revenue management of their utility as this is important in developing markets. On the other hand, the cost of water is always increasing, hence, consumers are looking for ways to cut back on their expenses. The smart metering technology can assist the Municipality in revenue management, as this system helps to track the consumer's consumption. Consequently, the customer is in a position to record water consumption accurately and pays for the exact usage. Therefore, the participants' responses affirmed The Palance Group's perspective on the smart metering system. Through the implementation of the smart metering system, both the author and participants stated that this will assist with accurate monitoring of water consumption and consumers will be billed accordingly.

Enforcing stiff penalties for water wastage and excessive consumption was seen as a minority view, participants stated that penalties could be enforced for illegal connections. Sim,

Sunderland, and Scott, (2014) state that this outcome has increased the EMWS department to supply free basic water to communities. The EMWS department has increased its water supply from 6000 litres per household per month to 9000 litres based on community concerns, as these communities have large households and 6000 litres are not sufficient. This platform is seen as a way of ensuring that customers enter into a formal system rather than participating in the practice of illegal connections.

6.2 Conclusion

This chapter has provided a detailed discussion of findings and was derived from what emerged from the participants during the data collection process. Based on the results presented and discussed in this chapter, it is evident that the findings are largely congruent with the literature available. The current chapter has provided insight into the EMWS department and the decisions that are implemented when focusing on continuous improvement of the current Quality Management System. This also outlined that, based on the research problem, water security is becoming a major concern and is seen as the number one priority in South Africa. The discussions and findings provide recommendations that will assist in areas for future research. This will be provided in the concluding chapter.

Chapter Seven

Recommendations and Conclusion

7.1 Introduction

This chapter outlines the key findings in the context of the research problem and establishes whether the problem has been adequately addressed. The study investigated the challenges in assessing water management practices within eThekweni Municipality. This chapter also addresses whether the study has satisfied and achieved the research objectives and answered the research questions. It concludes with a proposal to the EMWS department within the Durban Metropolitan Area. This recommendation will ensure continuous improvement and the implementation of a quality management system to assist with the reduction of water loss. Finally, this chapter will provide limitations and suggestions for future research areas.

7.2 Problem Statement

The problem statement of this study expressed challenges that are currently being experienced by both the EMWS department and citizens. Furthermore, the importance of strategy implementation was to articulate a Quality Management System to ensure continuous improvement. Therefore, this study focused mainly on improving the current Quality Management System and to ensure that water loss is reduced. This will assist in the conservation of the current water supply. Five research objectives were identified in this research on the assessment of the eThekweni Municipality 's Quality Management System on water supply.

South African citizens are already using the term 'crisis' when addressing the issue of water supply. South Africa has become the 30th driest country in the world and is now classified as semi-arid, even though South Africa is in the sub-tropic region. In the eThekweni region, dam levels were 20% lower than at the start of 2010. According to the eThekweni Municipality, these statistics indicate that even in a good year of rainfall, water resources to households and businesses will still be restricted.

Water security has been a major concern on the agenda for many years, but the recent extended drought period in South Africa has affected many provinces making it a number one priority. As water loss becomes inevitable and replenishes over time, the resource needs to be managed more effectively and efficiently as rainfall patterns become more intermittent.

The nature of this problem suggested the use of an exploratory case study design. This design was relevant to this study because of the different practices affecting the water management system within KwaZulu- Natal. In this study context, an exploratory case study design was preferred as it helps explore the full nature of the phenomenon while understanding the current underlying issues that exist with the eThekweni water region. A qualitative research approach was used, which provided value when determining the critical issues experienced when assessing water management practices. The research study was conducted in KwaZulu-Natal at the eThekweni Municipality Water and Sanitation department. Purposive sampling was employed as the sampling type. The sample size consisted of nine participants and face-to-face semi-structured interviews were used as a data collection method tool. NVivo 12 was employed as the thematic analysis technique for this qualitative study.

All the participants were from the EMWS department and provided valuable knowledge about the issues currently at hand within the eThekweni region. All participants were senior employees within the EMWS department and were a part of the Municipality for longer than five years. The participants provided valuable insight regarding the critical issues and the cause and effect relationship pertaining to the water crisis, as well as providing recommendations on how to implement a Quality Management System towards the goal of increasing water supply and reducing water loss.

7.3 Research Objectives

There was a total of five research objectives for this research study, the research objectives will be used to structure this chapter and each research objective will be discussed in relation to the literature. The research objectives of the study are:

- To explore the accessibility of water supply to consumers within the eThekweni region.
- To explore the relationship between the supply of water and water restrictions within eThekweni Municipality.
- To examine the amount of rainfall and water supplied to the eThekweni Municipality.
- To evaluate the Quality Management System (QMS) on water management practices at eThekweni Municipality.
- To provide recommendations for a more suitable water detection method which will reduce existing water loss.

7.3.1 Research Objective One

To explore the accessibility of water supply to consumers within the eThekweni region

Water is becoming a seminal environmental security factor of the emergent national security landscape, as this is an essential resource for survival as there is no substitute. Renewable freshwater has become a fundamental principle to human society as many people in South Africa are unable to receive enough freshwater to meet their needs.

Due to inconsistent water supply, selected areas within the KwaZulu- Natal region faced challenges in purchasing water from the eThekweni Municipality. As a result, people are forced to turn to unsafe/untreated water from wells, nearby rivers, and lakes. To ensure water supply to be continuous and effective, the infrastructure needed to be supported by the appropriate pipes and valves at the borehole. Protecting the quality of water, the infrastructure of water supply needs to be treated as well as the source and distribution methods.

Illegal connections were one of the biggest challenges that the eThekweni Municipality was experiencing. As a result of this challenge, the community mobilisation patterns were an effective measure to educate the community on the challenge of illegal connections and bring

awareness of the negative impact of water supply services. Many other challenges were exacerbated by the ineffectiveness of the current water management practices and the type of skilled workers of the organisation.

The findings revealed firstly that water accessibility is seen as continuous; there is water supply despite the implementation of water restrictions. However, water was also seen as the most valuable resource and citizens are reliant on this resource.

Secondly, findings have shown that the participants were knowledgeable and had a strong awareness of the causes of water pollution and water shortages. Consequently, participants were making every effort to minimise the usage and preserve the existing water supply within the eThekweni region. Lastly, due to water scarcity, the current water supply is being affected, hence, the current dam levels cannot meet the supply of the increasing demand from municipalities.

7.3.1.1 Recommendations

- The 3R formula can be used during the period of water scarcity to combat water buffer management in severe water shortages. The significance of the 3R formula allows for the storage of water during the wet periods so that the water which is collected is available during the dry seasons.
- Installation of a desalination water plant. This plant will provide citizens within the eThekweni region with potable water (clean and fresh drinking water). Desalinated water will exceed water quality standards. The installation of water desalination plants will reduce pressure on freshwater supplies that come from areas that require protection. The desalination process uses tried- and tested technology, this effective method has been proven in other countries.

7.3.2 Research Objective Two

To explore the relationship between the supply of water and water restrictions within eThekweni Municipality

South Africa is currently experiencing its worst recorded drought since 1992 and therefore the need for water restrictions has become imperative. eThekweni Municipality has enforced water restrictions in challenging areas to preserve water for longer periods. Therefore, the EMWS department needs to ensure that the required water supply for businesses and industries

operations are fulfilled.

Findings have indicated that the eThekwini Municipality and Umgeni Reservoir have a healthy and strong business relationship. This strong business relationship has confirmed efficient service delivery to the eThekwini Municipality, as this service delivery guaranteed consistent water supply without water shortage interruptions; however, different kinds of services and capacity challenges were identified when supplying water to consumers.

Lastly, the daily water supply was between the range of 790 MR to 950 MR litres daily. The water demand has increased and therefore water-saving mechanisms have increased due to the significant demand in the water supply. The demand for continuous water supply has called for measures to be implemented by the EMWS department in all regions.

7.3.2.1 Recommendations

Some additional water-saving mechanisms can be used to conserve water supply for longer periods

- Installing drip irrigation systems, this system is 90% more effective than traditional sprinkler systems.
- Roughly every citizen uses approximately 60 litres of water per day just for toilet flushing. A water-saving toilet device will reduce the usage by 50%.
- Showering is recognised as more water-efficient than bathing; however, showering still adds up to 20% of indoor water usage. Therefore, average citizen users approximately 35 litres of water when showering, by installing a water-saving showerhead will reduce the shower usage by up to 20%.

7.3.3 Research Objective Three

To examine the amount of rainfall and water supplied to the eThekwini Municipality

In South Africa, rainfall has become a growing concern to both water suppliers and municipalities. Rainfall patterns have changed over a period and businesses and households are experiencing the effects of El Nino (Filho, 2017), a phenomenon that warms the ocean with a warm current in the Pacific Ocean and leads to increasing drought in the southern hemisphere.

The effects of this climate change are lower and erratic rainfall and reduced water supply.

As the concern for rainfall increases, the country becomes drier and the supply of water is reduced. As the population increases together with economic and other activities, the demand for water increases. Therefore, participants indicated that strong measures must be implemented to monitor the rainfall into the KwaZulu-Natal dams.

Findings have revealed that the SCADA system was the only criterion that could be used in the implementation of water restrictions at the eThekweni Municipality. The use of the SCADA system was suggested for logging (recording) all operational entries. Trending of the SCADA system can be used for statistical measurement as this will assist in plotting the measurement on selected time scales. Shading of the system can provide both manual and automatic control tripping which will assist in the water supply emergency.

Secondly, water restrictions have become a necessity during the shortage of water supply and must be controlled during the water crisis in KwaZulu-Natal. It was also revealed that the EMWS department is flexible according to the severity of the water supply crisis, as the implementation of water restrictions were based on the level of water supply.

Thirdly, water management practices were effectively managed in high consumption areas and it was found that Umlazi and Tongaat areas were categorised as high consumption by eThekweni Municipality. Lastly, several measures were employed by the eThekweni Municipality to manage water supply and rainfall within the KwaZulu- Natal region. Lastly, the major concern for the achievement of this objective is the concern that there may be possible shortcomings in the Mgeni system. The Albert Falls and Inanda Dam have shown a significant decrease in water levels and this poses a major concern. Therefore, possible recommendations will need to be implemented to ensure renewable water practices are achieved to meet current and future human demands.

7.3.3.1 Recommendations

The implementation of the SCADA system can assist with the management of water practices. This system will identify factors that would need to be considered when supplying water to high consumption areas. The recommendation of the SCADA system will be discussed in Section 7.3.5 on research objective five.

7.3.4 Research Objective Four

To evaluate the Quality Management System (QMS) on water management practices at eThekweni Municipality

The implementation of a Quality Management System is a strategic decision that demonstrates the commitment to development and the application of the QMS model. The QMS aims to ensure continual improvement of its effectiveness by evaluation. This type of commitment must be carried out and demonstrated through employees by informing the organisation about the importance of meeting customer requirements and customer satisfaction, compliance with legal requirements, setting quality objectives, and a Quality Policy.

Determining the QMS scope for evaluation is one of the main objectives in the implementation stage. The scope needs to be examined and defined according to the eThekweni Municipality's issues and customer needs and expectations as well as legal and regulatory compliance obligations. The QMS information scope and justified exclusions must be identified and documented, as this can help with future decisions relating to the adoption of a Quality Management System.

Findings revealed firstly that the eThekweni Municipality had no actual quality management system in place. Thus, the EMWS department is using various measures to meet quality standards.

Secondly, a combination of SANS241 and aggressive awareness programs were suggested to assist sensitive consumers with their concerns. Thirdly, revenue leakages were identified within the water supply system and this needed to be rectified with an appropriate accounting system and a state-of-the-art functioning water supply structure. Lastly, a smart water metering system was identified as a need as this system will assist in better accuracy reading, identifying water flow interruptions, illegal connections.

This objective has been achieved due to challenges with the eThekweni Municipality's water management system. The eThekweni Municipality Water and Sanitation department, therefore, must establish, maintain, and continuously improve their water management practices. This includes the various processes needed within the department as these changes will need to be in accordance with the requirements of the ISO 9001 standard for effective management of water

distribution.

7.3.4.1 Recommendation

In today's global water industry, Smart Water Metering can be used to record the consumption of water. Once this monitoring and billing information is measured, the information is then communicated to the water utility department daily. In the water industry, measurement of water intervals are approximately 30 to 60 minutes, if the intervals are longer than 60 minutes, then inadequate information will be provided to the water utility. Where the Water utility is permitted to use a communication channel, this type of communication channel obtains the reading on the water meter and indicates the demand for water supply. This channel also ascertains whether the water supply has been flowing through the smart meter and onto the customer's premises. The smart water metering system will issue a command to the meter to perform specific tasks such as disconnecting the water supply or restricting the pressure flow. The smart water meter also comes with an in-house display, which will provide users with real-time feedback on their water consumption and their costing. Consequently, this system will assist with better revenue management within the eThekweni Municipality and better water management practices.

7.3.5 Research Objective Five

To provide recommendations for a more suitable water detection method which will reduce existing water loss

Sustainable water management requires an equilibrium between supply and demand for water quality and water quantity. These are major challenges but are familiar to water management specialists. Due to the rising concern about water scarcity, this research objective was not achieved as complications in water conservation persist. Complications are also seen to be challenges but constraints are seen as bottlenecks within the interaction of water provisioning and the provisioning of other resources, such as land, mineral resources, and energy.

Findings have shown that the SCADA system is the main tool for detecting water loss and monitor revenue. This will assist the current leak detection tool as the current method was not guaranteed to be successful as the water loss percentage in KwaZulu-Natal was high. Consequently, the water loss percentage was currently 65%, and the recovery rate needed to improve.

Water detection methods have become hurdles for sustainable water management practices as this required interaction across both scientific disciplines and government entities. Thus, addressing these issues will be very difficult, but ignoring these critical issues will guarantee failure in water management as the dynamic of the 21st century will unfold.

7.3.5.1 Recommendations

There are various methods for detecting water distribution system leaks. These methods usually involve using sonic leak-detection equipment, which identifies the sound of water escaping a pipe. These devices can include pinpoint listening devices that make contact with valves and hydrants, and geophones that listen directly on the ground.

1. The researcher proposes a leak detection sensor to be used. This will reside directly on the pipes itself. This process is the most accurate way of monitoring and detecting leaks, however, these devices can listen to two points simultaneously to pinpoint the exact location of a leak. The system will alert and provide an early warning of leaks detected to the EMWS department operator or operators on a Google-based map, allowing for a quick response to minimise loss.
2. A proposed implementation of the SCADA system for the EMWS department was based on the analysis of the eThekweni Municipality value chain, including all organizational processes and their activities. The following activities will highlight the efficiency and effectiveness of the SCADA system operation:
 - One of the activities to achieve greater efficiency and effectiveness in water operation is the prevention and detection of failures in the water supply system.
 - The remote information received by the system will assist the EMWS department to respond quickly when problems occur, such as burst pipes or water system mechanical failures. If these cases occur, the EMWS department will receive an alarm that offers immediate knowledge of the specific problem, and provide useful context information to speedily locate the problem and repair it. Therefore, this process will allow for a reduction of that specific problem and reduce the consequent service disruption.

- The information made available by the SCADA system to the EMWS department will also assist in improving the systems operations. This will assist with better management of the water storage capacity, optimisation of the water pumping operation stations, and pressure management.
- If the control valves and pumps are enabled, the SCADA system will allow for a quicker response in emergencies, such as burst pipes. Remote control gathered from the system's monitoring, can lead to a reduction of human resources and the traveling needs of the Municipality.
- The SCADA system will also generate information that will assist in a decrease in water production, this improves the efficiency of the active leakage control (ALC). It will lead to less non-planned repairs, for example, burst pipes and service connections. This improvement will also assist with the responsibility of significant flows of water losses, with a shorter duration.

7.4 Other Recommendations

- The findings have revealed that there is no quality management system in place. This indicates that there are currently limited measures in place to evaluate the quality of water management practices. It is recommended that the EMWS department needs to introduce a quality management system. By implementing this system, the EMWS department can incorporate green practices to process, measure, evaluate, and report all sustainable water management practices across the eThekweni Municipality and according to the ISO 9001 standard. There should be a creation of quality criteria, performance areas, and the setting of quality targets across all units within the eThekweni Municipality. These quality requirements and criteria should be included in each eThekweni Municipality performance appraisal and must be reviewed regularly to ensure that KPI's are achieved and that awards are allocated accordingly.
- Findings also revealed that some senior managers and managers were knowledgeable about the current water management practices within the eThekweni Municipality, this has indicated that these participants did not understand the benefits of implementing a quality management system within the Municipality's operation. It is believed that heads, deputy heads, senior managers, and managers influence management practices amongst employees

through their experience and skills. Therefore, the researcher encourages these specific individuals to become instrumental within the workplace and become aware of quality and sustainability criteria and standards. If training and development on quality and sustainability criteria are implemented for all employees, this will contribute to an effective and efficient quality management system, as all employees will be in alignment with their quality and sustainable targets.

- Enforcement of desirable quality taskforce of all quality management policies must be implemented across all departments within the eThekweni Municipality. The quality taskforce should involve all levels of employees and regular reports should be provided to management for review. This will allow management to measure quality efficiency and effectiveness within the department and a comparison can be made involving all other departments. If each contributes to quality efficiency and effectiveness, this will indicate that the eThekweni Municipality is moving towards a “Smart City”.
- Roadshows and awareness campaigns on water management practices and quality standards are not fully demonstrated to citizens and businesses around the eThekweni region, hence consumers are not aware of how water management practices and quality standards affect the EMWS work operation. Therefore, quality innovation awareness programs should be carried out to all units within the eThekweni Municipality, and tailor made programs on quality initiatives and sustainability practices should be implemented. Quality innovation awareness programs and campaigns should be implemented immediately in all units and the involvement of all employees should be achieved. This will gradually introduce a quality management system implementation.

The study revealed several challenges that could unfold when implementing quality water management practices at the eThekweni Municipality water and sanitation department. These challenges can affect the implementation of a quality management system. The challenges are discussed below.

- **Maintaining the commitment of drivers of quality management changes**
There is a need for constant motivation for the commitment of quality management practices at the eThekweni Municipality, because of the challenges of employees being

demotivated or exhausted from their current job duties. Therefore, each department can provide recognition of awards or provide support for their additional efforts.

- **Political dynamics within the eThekweni Municipality must be focused on achieving its mission and vision.**

To achieve effective and efficient quality management practices, it is recommended that the management and politics of the eThekweni Municipality should be reduced to a minimum. Political dynamics should not interfere with the employment of staff and departmental operations rather assist the department in achieving its strategic objectives for the city. Political leadership should support an advanced implementation of the quality management system in the EMWS department through the ISO certification process.

- **Quality change management issues and inadequate understanding of its benefits**

When implementing a new system, it is often difficult to manage change and therefore this stagnates the progression of the implementation. It is recommended that the eThekweni Municipality introduces a plan of action for change management, for a smooth implementation of the quality management system. The change management process should entail the benefits and reasons for change, as well as educating and training staff on the implementation of the quality management system.

- **Inadequate funding for quality innovation projects and non- inclusion of quality management practices as key performance indicators (KPIs)**

It is recommended that quality innovation projects funding should be separated from other operational funding as quality innovation projects require attention to detail when implementing and costing becomes a challenge when a project is implemented for the first time. It is imperative to include KPIs on the expectation of quality management practices at the eThekweni Municipality.

- **Non- engagement with relevant stakeholders and cultural influences**

There should be adequate involvement and engagement with critical stakeholders of the departments. This engagement will identify diverse cultural influences within the

departments and measures to correct these differences will be achieved.

- **Quality task- team deployed for monitoring of all quality innovation projects with the eThekweni Municipality**

The eThekweni Municipality should regularly deploy a quality task team to monitor, evaluate, and provide feedback on all quality innovation projects and initiatives within the eThekweni Municipality.

7.5 Contribution

This research study contributes some understanding of water practices and provides information for future studies regarding the assessment these water practices. This research study also provides findings and possible recommendations that could be implemented by the eThekweni Municipality to ensure continuous improvement and overcome current challenges with water loss and the supply of water. The reason this topic was chosen is that water is becoming a scarce commodity in South Africa and the effect of climate change is evident in erratic rainfall patterns. South Africa has been experiencing drought conditions in the past decade with below-average precipitation, resulting in a prolonged shortage of water and this has impacted on the current water management practices at eThekweni Municipality.

This study contributes to some initial ideas on the proposal for a Water Quality Management System. The effective and efficient quality practices of using ISO 9001 will also be addressed when implementing new practices to enhance continuous improvement.

Recommendations provided to the Municipality will be based on a newly developed Water Quality Management System. The shortage of water can be attributed to the reduced supply of lower rainfall and loss of water through undetected leaks in pipes and opportunistic use.

7.6 Ethical Considerations

Ethical consideration has been given to all participants in this research study. The information obtained through interviews will continue to be treated with strict confidentiality and the participants' privacy is of utmost importance to the researcher. During the study, all research participants were treated with the utmost respect, and at no time was the self-respect and self-esteem of the participants' violated.

7.7 Implications

This study aims to provide measures to develop a Water Quality Management System and ensure better water management practices. Water scarcity has become one of South Africa's biggest challenges and better management is required to maintain the existing water supply. eThekweni Municipality is one of the biggest municipalities within the KwaZulu-Natal region; however, the EMWS management needs to implement quality strategies to ensure continuous improvement in their existing water management practices by investing in research and development. Other researchers have also provided recommendations and opinions on the identified problem areas noted in the earlier chapters.

The researcher has proposed a few recommendations in this chapter to assist the EMWS department in improving its water management practices. Adopting the proposed recommendations could assist the EMWS department to reduce the excessive water loss percentage to zero and allow for more effective and efficient quality management practices.

7.8 Limitations

The study encountered the following limitations:

The study was conducted using the EMWS department within the eThekweni Municipality only. It is arguable whether the findings can be generalised to all the municipalities within the KZN province. The researcher had intended for several sections within the EMWS department to participate so that comparisons could be made, and the accuracy of results could be measured. Twenty employees were informed through written formal proposals. E-mail follow-ups were done but some employees were reluctant to participate. One of the main reasons for

employee non-participation was not being available during the period for this study. Some other reasons for the reluctance of employee participation were lack of time, lack of interest in the study, and no perceived value for themselves in this study.

The researcher experienced difficulty in sourcing other water quality management system studies conducted within municipalities in other regions to support the findings of this research study. Many authors have alluded to the fact that this topic is not well researched and hence there is not much research material available.

Research responses to any question-based study were based on human emotion. While conducting interviews, some participants took adequate time and effort to provide concrete answers, and yet others could have answered the questions under stress, depression, duress, anger, and/or purely to satisfy the researcher. The researcher gave participants time to answer each question and ask for clarification when needed.

The researcher avoided formulating personal opinions and ensured that the practice of boardroom judgment was exercised during the duration of this study. Based on the interviews the researcher found that participants lacked knowledge of terminologies and concepts used, although these were used daily. Therefore, the researcher had to breakdown and explain each question and concept before some participants could answer.

7.9 Future Study

- The growing concern about water scarcity creates the need for continuous research. The current study primarily dealt with the eThekweni Municipality.
- It would be interesting to see further research conducted with various neighboring municipalities to see how they cooperate and collaborate to reduce the growing challenges of water scarcity.
- Further research could entail consumer and business influence on water quality preferences. While this study has revealed that there are many challenges experienced when assessing water management practices within the eThekweni Municipality region., extensive research into such variables should be explored.
- The study could also be extended to neighboring countries outside South Africa such as Botswana, Namibia, Zimbabwe, and Mozambique. It would provide researchers with valuable insight into how these countries manage the crisis of water scarcity and what

measures are put into place to ensure an effective and efficient Quality Management System.

- Further studies could incorporate more open-ended questions. This will provide a more detailed understanding of employee perceptions and customer expectations.
- A comparative study could be undertaken with a developed country such as the United Kingdom or the United States of America, as these countries are also experiencing major water scarcity issues.
- Future studies could also focus on the demand and supply perspective of water and how water demand is better managed, rather than isolating the demand perspective independently.

7.10 Summary and Conclusion

This chapter brings the study to a close. This research has explored multiple forms and factors relating to the assessment of water management practices within the eThekweni Municipality region. The study contributes to the growing body of literature regarding the effectiveness and efficiency of the current processes for a Quality Management System pertaining to the eThekweni Municipality.

The study has provided a deeper understanding of the areas of water and the challenges of water supply within the eThekweni Municipality. This chapter has emphasised the research objectives and questions which were specific and pertinent to this study. The study aimed to explore the accessibility of water supply to consumers within the eThekweni region; to explore the relationship between the supply of water and water restrictions; to examine the amount of rainfall and water supplied to the eThekweni Municipality ; to evaluate the Quality Management System (QMS) on water supply at eThekweni Municipality, and to establish recommendations as to which water detection method will reduce existing water loss. All these above objectives were fulfilled throughout the study. The research has demonstrated the outcomes which can be expanded on for future content.

This chapter provided recommendations that the EMWS department and the eThekweni Municipality could implement; this will ensure continuous improvement of their quality water management practices. The recommendation has been proposed in conjunction with the

numerous bodies of literature available, feedback provided by the participants, and the interpretation provided by the researcher. The researcher discussed in detail the recommendations that will enhance an effective and efficient quality management system and make eThekweni Municipality a “Smart City”. The latter part of this chapter provides certain limitations that restricted the researcher from taking the research study to the next level. Taking into consideration the limitations and delimitations, direction has been offered for future research.

In conclusion the researcher hopes that the findings of this study and the corresponding suggestions will implement a Quality Management System with reference to the ISO 9001 standard. This will impact the Quality Management System positively and ensure that the system is more effective and efficient for the future.

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Appendices

Appendix A: Consent Form and Interview guide

Master of Commerce - Supply Chain Management Dissertations

An Assessment of eThekweni Municipality 's Quality Management System on Water Supply in KwaZulu- Natal.

CONSENT FORM

Researcher	Mr Alexander Samuels	078 048 8530	alexandersamuels15@gmail.com
Supervisor	Dr T. Ramluckan	031 260 8854	RamluckanT@ukzn.ac.za
CO- Supervisor	Prof Brian McArthur		McArthurb@ukzn.ac.za

Dear Participants,

My name is Alexander Bradley Samuels, a Master's Degree Student, at the Management, I.T Governance School of the University of KwaZulu Natal, with the following contact details: email address: alexandersamuels15@gmail.com

You are being invited to consider participating in a research study about the quality management system on water supply in KwaZulu - Natal: a case study on eThekweni Municipality

In South Africa, the eThekweni Municipality in KZN is not an exception, as many households and businesses do not receive a regular continuous supply of water. According to Section 27(1)(b) of the Constitution of the Republic of South Africa, of 1996, it states that "Everyone has the right to have access to sufficient water". The scarcity of water becomes an increasing problem and continues to escalate at an alarming rate as the supply of water to households and industries are restricted.

As the problem of water scarcity continues to rapidly increase in the rest of South Africa, these developments therefore call for an investigation on the problem of water shortage within the eThekweni region. Measures to address water shortages at eThekweni are unknown. The researcher will investigate the impacts and causes of water shortages and therefore suggest tailored made solutions as recommendations to prevent further water loss.

The aim of this study is to analyse the accessibility of water supply within eThekweni region. Therefore, the researcher will investigate the effectiveness and efficiency of processes of a water supply quality management system at eThekweni Municipality.

The final report will be shared with participating Municipality for consideration during the review of its quality management system. The study requires the participants to answer all questions honestly and fairly. The participants are also expected to indicate if they want the questions to be asked in a language that they are familiar with, ask for repeat or clarity as well as request not to answer the specific question when the participants are not comfortable to answer.

This study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (approval number).

In the event of any problems or concerns/questions you may contact the researcher at 0834634342 or the UKZN Humanities & Social Sciences Research Ethics Committee, contact details as follows:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban

4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

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

I hope you will take the time to complete this survey.

Sincerely

Investigator's signature_____Date_____

INTERVIEW GUIDE

Respondent's Name and Surname: _____

Date:_____

Duration: _____

Section A: Water Supply

To explore the accessibility of water supply to consumers within the eThekweni Municipality

1. What do you understand by the term “water supply”?
2. How has your department contributed, in terms of strategies, towards the mitigation/alleviation regarding the shortage of the water supply?
3. How is the shortage of water supply being affected by your department?
4. In your opinion, do you think that the shortage of water supply will be a concern in the next 10 years?
5. Do you think that KZN is heading for major water crisis? Please explain, in your opinion, why or why not, water scarcity is becoming a major crisis in South Africa?
6. Are you experiencing water shortages in the area where you live?
7. Are you aware of any significant water pollution in the area where you live? If yes, what are the causes of pollution?

Section B: Accessibility of water supply

To explore the accessibility of water supply to consumers with the eThekweni region

1. Describe the relationship that eThekweni has with their water supplier, Umgeni Reservoir?
2. In terms of water quantity, how much water does eThekweni purchase from Umgeni water in a year?
3. Has the water supply trends changed in the past five years?
4. What measures are put into place to ensure that water is supplied to citizens within the eThekweni region?
5. What challenges are experienced during the supply of water?
6. How does practice ensure active, free, and meaningful participation with the consumer?

Section C: Correlation between Water supply and Water Restrictions

To determine the correlation between the supply of water and water restrictions.

1. What are the perspectives of the eThekwini water management department on the issue of water shortage and water restrictions?
2. Do you think, there is a correlation/ relationship between the supply of water and water restrictions?
3. What's the importance of placing water restrictions?
4. Briefly describe the effectiveness of enforcing water restrictions in high consumption areas?
5. Within eThekwini, which region is the highest consumption area?
6. Please explain on the type of criteria that is used, in the implementation of water restrictions to specific areas?

Section D: Examining the amount of rainfall

To examine the amount of rainfall and water supplied to the eThekwini Municipality

1. What control measures are being put into place to monitor the amount of rainfall and water supplied to eThekwini Municipality?
2. Is there a correlation/relationship between rainfall and water supply?
3. What is the current percentage of eThekwini's dams?

Section E: Quality Management System (QMS)

To evaluate the quality management system (QMS) on water supply at eThekwini Municipality

1. Please describe the current quality management system (QMS) on water supply at eThekwini Municipality?
2. How does the water practice meet the criterion of quality management?
3. How does the water practice meet the criterion of acceptability?
4. How can the current Revenue management system be improved on water loss at the eThekwini Municipality.

Section F: Water Detection Method

To establish recommendations as to which water detection method will reduce existing water loss.

1. What is the current water loss detection method that is being used by eThekweni Municipality Water Department?
2. Describe the cost involved in the decision to implement a leak detection method?
3. How effective is the current leak detection method?
4. What percentage of water is recovered through eThekweni's current water detection method?
5. Is the leak detection method effectively monitoring the water loss consumption?
6. In your opinion, which water detection methods could be used to reduce existing water loss?
7. Is there a correlation between the amount of water loss and the shortage of water?
8. What recommendations should be put into place to reduce further risk of water shortage?

Appendix B: Ethical Clearance



14 January 2021

Mr Alexander Bradley Samuels (212556623)
School of Management, IT & Governance
Westville Campus

Dear Mr Samuels,

Protocol reference number: HSS/1837/018M

Project title: An assessment of eThekweni Municipality's Quality Management System on water supply in KwaZulu-Natal

Amended title: Assessing Water Management Practices within the KwaZulu-Natal region: A case study of eThekweni Municipality

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 28 September 2020 has now been approved as follows:

- Change in title

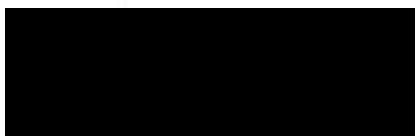
Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the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

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

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

Best wishes for the successful completion of your research protocol.

Yours faithfully



.....
Professor Dipane Hlalele (Chair)

/ms

Appendix C: Editor's letter

THE WRITING STUDIO
Writing and Editing Practice

Certificate 2020/12/2

2 December 2020|

TO WHOM IT MAY CONCERN

This dissertation, entitled **Assessing Water Management Practices within the KwaZulu-Natal region: A case study of eThekweni Municipality**, by Alexander Samuels, has been edited and reviewed to ensure technically accurate and contextually appropriate use of language for research at this level of study.

Yours sincerely



CM ISRAEL, BA Hons (UDW) MA (UND) MA (US) PhD (UNH)
LANGUAGE EDITOR AND WRITING CONSULTANT
Connieisrael90@gmail.com Mobile 082 4988166

Appendix D: Turnitin Report

Turnitin Originality Report

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Scm practices By Alexander Samuels

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