THE ROLE OF LEAN MANAGEMENT PRINCIPLES IN ACHIEVING SUCCESSFUL WATER MANAGEMENT: THE CASE OF HARRY GWALA DISTRICT MUNICIPALITY

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THE ROLE OF LEAN MANAGEMENT PRINCIPLES IN ACHIEVING SUCCESSFUL WATER MANAGEMENT: THE CASE OF HARRY GWALA DISTRICT MUNICIPALITY

By

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DECLARATION

I, Adelaide Nomnandi Dlamini and 195230540, hereby declare that the treatise/dissertation/thesis submitted for Masters in Business Administration is my own original work and that it has not been previously submitted for assessment or completion of any postgraduate qualification to another University or for another qualification.

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Adelaide Nomnandi Dlamini

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ABSTRACT

Water is life and a basic human need. It is a scarce resource which must be managed in a sustainable way. Empirical evidence suggests that globally the current supply systems will not satisfy the demand. Some of the challenges include depleted water resources due to uneven and inadequate rainfall, effects of climate change, poor asset management, water losses and poor water quality. Since there is a universal need for water, without water life would cease to exist; moreover, water is limited in quantities and hence sustainable management of this resource remains a global imperative. This research sought to investigate and understand the role of lean management in ensuring successful water management at Harry Gwala District Municipality, located in KwaZulu-Natal. To achieve the above goal, the research sought to investigate the efficiency of the production processes, strategies to conserve water and manage the demand, human resources and organisational development, as well as financial planning and management. The research adopted a qualitative research design and interpretivism research paradigm. The research findings acknowledged the strides made by the Municipality in relation to extending the infrastructure footprint to the communities that previously did not have water. The research further revealed that Harry Gwala District Municipality is challenged in relation to providing an uninterrupted and efficient water supply to consumers. This is due to poor project planning, project management and monitoring, poor maintenance of infrastructure, ageing and dilapidated infrastructure, illegal connections and high water losses. The workforce is inadequate with concerns about ill-discipline and lack of productivity by some employees. The organisational culture does not allow for innovation and has a bearing on ill-discipline and productivity. The research noted that the Municipality is unable to provide successful water management, owing to infrastructural challenges, wastage, lack of continuous improvement and the organisational culture. It was further noted that these challenges can be addressed using lean management principles with particular focus on waste elimination, continuous improvement, employee involvement, promoting efficiency in the production processes and the use of catalytic technology.

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ABBREVIATIONS

AFS:	Annual Financial Statements
CI:	Continuous Improvement
CRM:	Customer Relations Management
DWS:	Department of Water and Sanitation
HGDM:	Harry Gwala District Municipality
IDP:	Integrated Development Plan
MFMA:	Municipal Finance Management Act
MRP:	Material Requirement Planning
NRW:	Non-Revenue Water
PDGP:	Provincial Growth Development Plan
RMP:	Resource Management Plan
SANS:	South African National Standards
SDG:	Sustainable Development Goals
TPM:	Total Productive Maintenance
WSA:	Water Service Authority
WHO:	World Health Organisation
WTP:	Water Treatment Plant
JIT:	Just-In-Time
VSM:	Value Steam Mapping

CHAPTER 1: SCOPE OF THE STUDY

1.1 INTRODUCTION

Harry Gwala District Municipality is a Water Services Provider (WSA) responsible for the provision of potable water. The purpose of the study is to investigate the role of lean management principles in achieving successful water management at Harry Gwala District Municipality, located in KwaZulu-Natal. The topic was largely informed by high water backlogs, poor revenue collection, poor water quality, ageing infrastructure, dysfunctional water schemes, water losses and under-developed water resources. Water is life, a basic human need and a scarce resource with no substitute. The Municipality as a WSA has a Constitutional mandate to ensure that all its citizens have access to potable water. The study unpacks water management and lean management principles and makes proposals on how lean management principles can help address the above mentioned challenges and help achieve successful water management.

1.2 PROBLEM STATEMENT

Water is life and a basic human need. It is a scarce resource which must be managed in a sustainable way. The effects of climate change globally point to a looming water crisis. Empirical evidence suggests that the current water supply systems will not satisfy future demands (Guppy & Anderson, 2017, pp. 2-3). The Department of Water and Sanitation in its Strategic Plan cites the probability of a water crisis in the country, due to inadequate investment and maintenance of infrastructure, drought, climate change, deteriorating water quality and lack of engineering capacity (South Africa Department of Water and Sanitation, 2020/2021-2024/2025, p.8). In addition to the above challenges, Malobela and Sihna, (2011, pp. 993-994) posit that South Africa is experiencing a number of challenges in relation to water management, which include inadequate rainfall, rapid population growth, limited physical resources, contaminated surface water supply, ageing infrastructure, ground water levels that are decreasing and stagnant economy.

Harry Gwala District Municipality is not immune to these challenges, and several water schemes were reportedly dysfunctional and partially functional. The municipality's water supply system was challenged by an unreliable water supply due to insufficient and underdeveloped water sources such as dams. Furthermore, ageing infrastructure, water losses, poor water quality, higher water backlogs, reliance on water carting, frequent

break-downs in the production and supply networks and water supply interruptions have exacerbated the situation (Harry Gwala District Municipality 2017/2018, pp. 10 & 15, Harry Gwala District Municipality 2019/2020, pp. 127 & 288). Based on the above, the study explored the role that lean management can play in ensuring successful water management.

The purpose of the study was to understand the role that lean management can play in achieving successful water management at Harry Gwala District Municipality. Future research can be done at a provincial and national level on how lean management can be used to ensure successful water management. This research will benefit Harry Gwala District Municipality through the development of a plan with clear interventions to mitigate the impact of water scarcity, ensure successful water management and provide policy recommendations for provincial or national application.

1.2.1 Background to the Study

Since there is a universal need for water, without water life would cease to exist, water is limited in quantities and hence sustainable management of this resource remains a global imperative (Sanchez, Alvarez-Garcia & de la Cruz del Rio-Rama, 2018, p.2). According to the Sustainable Development Goals (SDG) report, one of the challenges is the proportion of the global population estimated at 785 million, who did not have access to basic drinking water in 2017 (United Nations, 2019, p.34). The United Nations in the SDG report (2019, p. 9) estimates that by 2030 seven hundred (700) million people could be displaced owing to intense water scarcity. Furthermore, Guppy and Anderson (2017, pp. 2-3) state that the gap between water demand and water availability by 2030 will be approximately 40% and water scarcity which is exacerbated by climate change, could cost some regions up to 6% of their Gross Domestic Product.

Section 156 of the Constitution of the Republic of South Africa, Act 108 of 1996 under schedule 4 part B, assigns the provision of water and sanitation services limited to potable water supply systems and domestic waste-water and sewage disposal systems, to local government (South Africa, 1996, p.150). To give effect to the Constitution of the Republic of South Africa, the Local Government: Structures Act No. 117 of 1998 section 83 further divides powers and functions between the District and Local Municipalities. Accordingly, the provision of potable water supply systems is assigned to the District Municipalities. As a result of the above-mentioned prescripts, Harry Gwala District Municipality, located

in KwaZulu-Natal, is a Water Services Authority (WSA). WSA "means any municipality, including a district or rural council as defined in the Local Government Transition Act, 1993 (Act No. 209 of 1993) responsible for ensuring access to water services" (South Africa, 1997, p. 10).

According to the South African Department of Water and Sanitation (DWS) Strategic Plan (2020/21 to 2024/25, p. 9), South Africa has a low annual rainfall of 500mm which is significantly lower than the world average of 800mm. This is due to the country's semi-arid climatic conditions. The Strategic Plan further points to the country's water deficit of 96 million m3/a. According to McKenzie, Siqalaba and Wegelin (2012, p. 15), nonrevenue water in South Africa is estimated at 37%. This is significantly high in a country that has a water deficit, as investments in new water services infrastructure require revenue generated from the existing water supply networks.

KwaZulu-Natal province, where the research study is located, has ten District Municipalities and one Metropolitan Municipality. The total population for the province is estimated at 11 289 086 (Statistics South Africa, 2019, p. vi). KwaZulu-Natal is the second largest province after Gauteng province. According to the KwaZulu-Natal Provincial Planning Commission Situational Overview report (2016, p.136), a number of WSAs in the Province have a water deficit and as such will not be able to meet the 2035 water demand. The report proposes the implementation of water efficiency measures for industrial and domestic use, rainwater harvesting, recycling and low-water technologies in order to conserve and manage water (KwaZulu-Natal Provincial Planning Commission, 2016, p. 136).

Harry Gwala District Municipality is not immune to the above mentioned global, national and provincial challenges and there is an urgent need to respond to the above proposal of implementing water efficiency measures, low-water or no-water technologies and water re-use strategies. Hence the focus of this study was on Harry Gwala District Municipality and exploring the role of lean management in achieving successful water management. The Municipality has a population of 502 265 and the 2030 vision is based on the Municipality being the leading Water Services Authority (WSA) in the province (Harry Gwala District Municipality (HGDM), 2018/2019, pp. 19 & 243). The municipality's mission statement emphasises stakeholder engagements and ensuring potable and uninterrupted water supply (Harry Gwala District Municipality (HGDM), 2018/2019, p.480).

Lean Management originated from Japan after the devastating effects of the second world war. Manufacturers could not afford to rebuild their facilities and Toyota Production System adopted lean manufacturing by producing automobiles with minimal production inputs (inventory, personnel, investment) and an increase in its product offerings (Bhamu & Sangwan, 2013, p. 877).

1.3 THE RESEARCH QUESTIONS

1.3.1 Primary Research Question

What is the role of lean management principles in ensuring successful water management at Harry Gwala District Municipality?

1.3.1.1 Secondary Research Questions

QR1: Is the municipal financial planning geared towards successful water management?

RQ2: What is the condition of water infrastructure and how are water processes structured?

RQ3: What are the strategies implemented by the municipality to address water conservation and demand management?

RQ4: Describe the current human resources capacity and how the organisational culture is responding to successful and lean water management in the provision of water?

All these questions have been successfully responded to in chapters 4 and 5.

1.4 THE RESEARCH OBJECTIVES

The primary objective was to investigate whether lean management principles can be used at Harry Gwala District Municipality in order to address challenges in the water production and supply processes to achieve successful water management. In order to achieve the primary objective, the research sought to achieve the following secondary research objectives: to understand the financial position and sustainability of the

municipality and the extent to which it prioritises water provision adequately. To investigate the structuring of water production processes and the extent to which it eliminates waste and encourages continuous improvement. Further to that, another objective was investigating the strategies implemented by the municipality to conserve water and manage demand in order to meet the current and future demand. The study aimed at assessing human resources capacity, productivity and organisational culture and the extent to which the municipal leadership collectively promotes innovation. Lastly was developing a lean water management plan, using lean management principles in order to ensure successful water management at Harry Gwala District Municipality.

1.5 METHODOLOGY OF THE STUDY

1.5.1 The Research Design

In research, there are generally three types of research designs: qualitative, quantitative and mixed methods. This study adopted a qualitative research methodology.

Qualitative research is non-numerical, it does not employ statistical tools in the analysis and presentation of findings (Rahnam, 2016, p.103). Qualitative research is defined as an approach that seeks to explore and understand meanings that respondents attach to a problem or phenomenon under investigation (Creswell, 2014, p. 4). Qualitative research uses open ended questions. Open ended questions do not suggest obvious answers. Qualitative research is more honest and does not have obvious answers (Maree, 2016, p. 5). In qualitative research there are several research designs that have been used extensively - phenomenology, ethnography, grounded theory and the case study (Salvador, 2016, p.110). This research adopted a case study approach as it focuses on Harry Gwala District Municipality.

A mixed-methods design integrates both qualitative and quantitative research techniques, methods and approaches into a single study (Johnson & Onwuegbuzie, 2013, p. 17; Creswell, 2014, p. 110). There are three types of mixed methods: convergent parallel mixed methods, explanatory sequential mixed methods and exploratory sequential mixed methods (Creswell, 2014, p. 110)

Quantitative research tests objective theories and further examines the nature of the relationship between variables under investigation. This is done using numerical measuring instruments and data is analysed using statistical tools (Creswell, 2014, p. 4).

Quantitative research generates data that is numerical. It entails quantifying and analysing variables using statistical techniques (Apuke, 2017, p. 42).

The methodology considered qualitative data collection through in-depth interviews and entailed the analysis of the approved Budget and audited Annual Financial Statements (AFS) using the financial ratios to understand if water management is prioritised by the municipality.

1.5.2 Research Paradigm

There are three types of research paradigms, positivism, intepretivism and critical theory. These research paradigms are linked to the research designs as discussed above. As a qualitative research study, the study is located in the interpretivist research paradigm. Interpretivism holds that social reality is highly subjective as is dependent on people's perceptions (Collis & Hussey, 2009, p. 56).

Positivism uses empirical research and scientific evidence to generate knowledge as it deems reality to be independent of people's perceptions (Collis & Hussey, 2003, p. 57). Critical theory is opposed to positivism and focuses primarily on deconstructing the world and breaking down institutional arrangements that promote oppressive ideologies and social inequalities (Henning, 2004, p.23).

1.5.3 Sampling Design

The qualitative sampling unit was Senior and Middle Managers at Harry Gwala District Municipality. To corroborate the qualitative findings, secondary data was collected from the approved Municipal Budgets and Audited AFS for the past fourteen years to access water management expenditure and water losses. Senior and Middle Management at Harry Gwala District Municipality were chosen as the qualitative sample based on the judgmental sampling technique. In a judgemental sampling technique, the researcher uses his or her judgment in selecting respondents who are deemed to be a reasonable representation of the population (Jawale, 2012, p. 188).

The respondents were selected for the research as they had in-depth understanding of the different aspects pertaining to the research. All the respondents were at managerial levels and have full understanding of water provision in terms of the successes and challenges facing the municipality. Respondents were predominantly from the

Infrastructure Services and Water Services Departments, largely the Engineers who are at the coal face of providing this service to communities. The respondents were responsible for project conceptualisation, planning, project implementation and operations and maintenance, and were deemed to be well versed with all the areas of research.

Other respondents were specialists in the Financial Service Department responsible for the compilation, management and reporting on the budget including the compilation of the AFS, procurement of goods and services and managing inventory. Corporate Services respondents were specialists in human resources development, training, developing the organisational structure, recruitment and selection and employee discipline and productivity. All the respondents are expected to work in unison to ensure successful water management at Harry Gwala District Municipality. They had more in-depth knowledge about the subject matter. They were knowledgeable about the current operations and provided credible insights.

Though the respondents had been identified during the write up of the research and in the analysis of the in-depth interviews, their names are not used in the research report. All the respondents were assigned research codes in order to ensure full compliance with the approved code of ethics and confidentiality. The interview guide did not require personal details and responses remained anonymous.

1.5.4 Measuring Instrument

Two instruments were used for collating all the information of this study. Data collection covering secondary information from the audited AFS was used to measure monetary and financial information. A comparison was made across financial years to assess if the Municipality is improving on, or regressing from, the water management goals set. The ratios that were analysed include capital expenditure to total expenditure, current ratio, repairs and maintenance as a percentage of property, the plant and equipment carrying values and water distribution losses. These ratios were carefully chosen to depict financial planning and management, as well as the extent to which this is geared towards successful water management.

The data was also collected using an interview guide covering four main sections; namely the demographics, the effectiveness of the water production processes, water

conservation and demand management and human resources and organisational development.

1.5.5 Data Analysis

Data analysis is the transformation of collected data into meaningful information from which conclusions are drawn. Data collected was analysed using qualitative tools. Qualitative data analysis is a non-linear and intertwined process of data collection, analysis and reporting (Maree, 2016, p.109). The secondary data analysis was aimed at comparing the different financial and budgeting ratios under investigation. The information was analysed and presented using tables. The secondary data provided more clarity on the nature and extent of the problem statement and the research questions.

Of the twelve respondents interviewed, eight were interviewed using the Zoom application and four were interviewed using face-to-face interviews. This was mainly necessitated by COVID-19 which came with restrictions and necessitated leap frogging to technology in several areas and operations. All interviews were recorded, and transcripts were prepared. From the information collected through the interviews, themes and categories from the responses were identified which formed patterns for discussion, interpretation and subsequently drawing conclusions. This was done using thematic analysis with the aid of NVIVO version 10. Qualitative data analysis was driven by content analysis techniques. Maree (2016, p. 111) defines content analysis as a systematic way of compressing words into content categories, themes or concepts using coding. This analysis was integrated, corroborated and contrasted with the secondary data analysis in order to draw valid conclusions.

1.6 DEFINITION OF CONCEPTS

District Municipality – means a municipality that has a municipal executive and legislative authority in an area that includes more than one municipality, and which is described in section 155 (1) of the Constitution as a category C municipality (South Africa, 2000, p. 15).

Water Services Authority – is a municipality that is responsible for the provision of water and ensuring that consumers have adequate access to water services (South Africa, 1997, p. 10).

Consumer – refers to the end user of the product (water) in both formal and informal settlements (South Africa, 1997, p. 8).

Basic Water Supply – "means the prescribed minimum standard of water supply services necessary for the reliable supply of a sufficient quantity and quality of water to households, including informal households, to support life and personal hygiene" (South Africa, 1997, p. 8).

Sustainable Development – provides a mechanism through which society can interact with the environment and meet basic needs without damaging resources for the future. It is a developmental paradigm that calls for improved living standards, protecting ecosystems and the environmental to minimise pollution and mitigate the effects of climate change (Benaim & Raftis, 2008; Browning & Rigolon, 2019, cited in Mensah, 2019, p.6).

Financial Statement – is a statement of the Municipality's financial position, performance and cash-flow (South Africa, 2003, p. 16).

Integrated Development Plan – is a five year strategic plan that guides and informs development in a municipality (South Africa, 2000, p. 44).

Water Management - according to Van Zyl (2011, p.104), water management entails the movement of water from source to the end user.

Water Conservation and Demand Management - the KwaZulu-Natal Planning Commission (2016, p. 83) in the Situational Overview report defines Water Demand Management as a strategy to influence water demand in order to promote economic growth, social development and environmental protection. Water conservation is preserving water and matching the demand with the supply (Kumari & Singh, 2016, p. 76)

Water Losses – also known as non-revenue water is made up two components, Apparent losses (unauthorised consumption and metering inaccuracies) and Real losses (leakage on transmission and/or distribution mains, leakage and overflows at utility's storage tanks and leakage on service connections up to the point of customer metering) (Van Zyl, 2011, p.105).

Financial Management - Buger and Woods (2008 cited in Cheruiyot, Oketch, Namusonge and Sakwa, 2017, p. 213) define public financial management as an

effective use of financial resources with a focus on prioritisation of scarce resources in order to ensure delivery of services to the communities in a sustainable way.

Financial Sustainability – is about providing services in a manner that seeks to ensure that the budget is sufficient to cover capital and operating expenditures and infrastructure maintenance which is inclusive of replacements and repair of infrastructural assets (South Africa, 2000, p. 17).

Lean Management – is a manufacturing technique that focuses on streamlining and synchronising production flows, reducing waste and ensuring continuous improvement in the production or manufacturing processes (Longoni, Pagell, Johnston and Veltri, 2013, p. 3301).

1.7 OUTLINE OF THE STUDY

The study has five (5) chapters that follow an outline discussed below:

Chapter One (1) introduces the scope of the study, unpacks the problem statement, research questions, research objectives, methodology of the study and definition of terms.

Chapter Two (2) deals with successful water management as a dependent variable in the form of a literature review. The analysis is structured to give a full perspective of water management globally, nationally, provincially and locally. The chapter covers independent variables such as financial planning and management, water production processes, water conservation and demand management and human resources and organisational development. Chapter two (2) also unpacks lean management as a theoretical framework within which the study is located. The focus is on Just-In-Time (JIT), 5s, Total Productive Maintenance (TPM), Waste Elimination, Continuous Improvement (CI), Poka-Yoke, Value Stream Mapping (VSM), Material Requirement Planning (MRP) and Jidoka as lean management methods.

Chapter Three (3) outlines the methodology of the study, including the research paradigm, research approach, sampling design and technique, recruitment of respondents, data collection, data quality focusing on data reliability and validity and ethics clearance.

Chapter Four (4) focuses predominantly on the qualitative data findings based on the in-depth interviews. The quantitative descriptive analysis of the secondary data responds to

the first research question and is further used to corroborate and validate the qualitative findings.

Chapter Five (5) deals with the discussion of findings and recommendations. It further outlines the limitations of the study and areas of future research in relation to the research topic.

1.8 Summary

This chapter introduced the study and outlined the problem statement, the research questions and objectives. Furthermore, it introduced the research methodology and definition of key terms. The next chapter will review literature including the legal framework in relation to water management. The next chapter is structured to provide global, national, provincial and district perspectives in relation to water management, independent variables of successful water management and lean management as a theoretical framework within which the study is located.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this chapter is to review literature in relation to water management and lean management as a theoretical framework within which the study will be located. The review of literature is premised on two major themes, water management and lean management. The chapter provides a comprehensive analysis of water management globally, nationally, provincially and locally. It further explores literature on water management, challenges and possible solutions in relation to water management, water provision, water losses, water quality, infrastructure maintenance and cases of successful water management. At a national, provincial and local levels the review will further entail the legislative and policy framework. The literature review of this theme will ascertain the extent of the research problem and further provide an empirical basis for the recommendations and proposals towards successful water management. The review of literature will further focus on financial planning and management, water production processes, water conservation and demand management and human resource and organisational development as critical independent variables towards water management. Lastly, is the review of lean management principles and their role towards ensuring successful water management. The focus will be on what lean management is and unpacking its principles and the extent to which they can achieve successful water management.

2.2 WATER MANAGEMENT DEFINED

Water is defined as “a scarce resource, essential for life and to carry out the vast majority of economic activities; it is irreplaceable, non-expandable by the mere will of man, irregular in its way of presenting itself in time and space, easily vulnerable and susceptible to successive uses” (Sanchez, Alvarez-Garcia & de la Cruz del Rio-Rama, 2018, p.1). The Sustainable Development Goals (SDG) report by the United Nations (2019, p.34) defines fresh water as a precious resource for sustained human livelihood. Water is life, a basic human need and has no substitute. Everyone depends on it. It is a scarce resource which must be managed in a sustainable way. According to Van Zyl (2011, p.104), water management entails the movement of water from source to the end user.

Water management entails two major components; water resources and water services. Water resources, also referred to as water sources, include dams, lakes, rivers, underground water and springs where water is drawn from. Water services include water supply and distribution to different users (Nleya, 2008, p. 274).

Successful water management therefore entails maintaining a suitable quality of water for intended use, sufficient and sustainable water quantities, reliable and safe water resources and providing an uninterrupted supply of water as per the standards set from time to time by the DWS as a regulating authority. For successful water management, all the above requirements which cover the supply and demand side must be met. Another critical factor in water management is water security. Colow, MacDonald, Nicol and Robins (2010, p. 248) define water security as the availability of clean water in sufficient quantities to meet the needs of all consumers and other water users.

2.3 THE GLOBAL CONTEXT

2.3.1 Global Water Challenges

There is a universal need for water and without water life would cease to exist. Water is limited in quantities; hence sustainable management of this resource remains a global imperative (Sanchez et al., 2018, p.2).

The SDG report indicates that significant progress was made between 2000 and 2017 in the provision of potable water globally, with the highest level of service increasing by 10% from 61% to 71% respectively. Good progress was noted in Central and Southern Asia, Latin America and the Caribbean (United Nations, 2019, p.34). Despite the gains, the United Nations notes several global water challenges.

One of the challenges is the proportion of the global population estimated at 785 million that did not have access to basic drinking water in 2017, with one out of four health care facilities globally with no access to potable water in 2016 (United Nations, 2019, p.34). Guppy and Anderson (2017, p.3) argue that there is a looming global water crisis and that water scarcity globally is currently affecting more that 40% of the population. The United Nations in the Sustainable Development Goals report (2019, p. 9) estimates that by 2030 seven hundred (700) million people could be displaced owing to intense water scarcity. Furthermore, Guppy and Anderson (2017, p. 2-3) make the following projections:

- That by 2050 about 2.3 billion people globally will be residing in areas with severe water-stress, especially in North and South Africa and South Asia.
- That 40% of the global population is currently affected by water scarcity.
- That the gap between water demand and water availability by 2030 will be approximately 40%.
- That the global demand for water is expected to grow by 50% in 2030.
- That approximately 1.8 billion people are currently using sources of drinking water with faecal contamination.
- That water scarcity which is exacerbated by climate change could cost some regions up to 6% of their GDP.
- That ageing infrastructure and poor maintenance have resulted in 30% of global water abstraction being lost due to leakages.
- That 80% and more of wastewater globally returns to the environment without adequate treatment.

These are serious challenges that require a concerted effort from global actors; hence the SDG with goal 6, attempting to address these challenges.

According to the United Nations (2019, p. 35), global demand for water has increased drastically over the last century whilst water resources are continuously being depleted. Some of the factors that have led to the increase in demand are changes in consumption patterns, growth, climate change, urbanisation, social and economic development. As the demand for water continues to increase there is a significant decline in quantity and quality of water resources in several regions (Sanchez et al., 2018, p.1).

Kumari and Singh (2016, p.75) posit that globally water is being wasted, polluted and depleted. Empirical evidence suggests that a number of cities across the globe are facing severe water shortages due to a limited rainfall, climate change, population growth, water waste, industrialisation and dilapidate water supply infrastructure (Kumari & Singh, 2016, p. 75).

Dziedzic and Karney (2014, p. 584) place emphasis on industrial growth, climate change, insufficient and deteriorating water infrastructure, population growth and urbanisation as five critical macro trends that have an impact on water supply. Climate change has a number of negative implications such as temperature increases and drought which further constrain water resource capacity. Empirical evidence suggests that water scarcity is likely to increase due to climate change and greenhouse warming which will inevitably

affect water resources that are already constrained (Malobela & Sihna, 2011, p. 994). Drought has affected several countries with the United States of America losing between US$ 6 to 8 billion in the agricultural sector annually (Guppy & Anderson, 2017, p. 3). Climate change will inevitably have a negative impact on water quality as changes in sea levels and precipitation patterns are more likely to increase flooding, erosion and depositing pathogens, pollutants and toxins into waterways (Malobela & Sihna, 2011, p. 994). Further to that, empirical evidence suggests that in Malawi between 1991-1992, a drought resulted in wells drying up causing absolute scarcity of water (Calow, MacDonald, Nicol & Robins, 2010, p. 248). Population growth, industrial growth and urbanisation have inevitably increased water demand, and this has placed enormous pressure on the current and available water supply system. Malobela and Sinha (2011, p. 993) place emphasis on inadequate water sources and inadequate rainfall as some of the primary difficulties contributing to water problems. Dziedzic and Karney (2014, p.584) advocate for water to be regarded as a key priority, whilst Malobela and Sinha (2011, p. 993) point to a critical need to manage and conserve all water resources.

2.3.2 Global Water Losses

Global water losses are estimated at 30% and are mostly attributable to the ageing infrastructure, leakages and poor maintenance (Guppy & Anderson, 2017, p. 2). Water losses remain a major challenge and globally the total cost of non-revenue water is estimated at US$141 billion per annum with emerging economies losing approximately 45 million cubic metres of water, enough to serve approximately 200 million people daily, due to leakages (Guppy & Anderson, 2017, p. 6).

2.3.3 Global Water Quality

Water quality is critical in the provision of water and satisfying human and environmental needs. The World Health Organisation (WHO) developed guidelines for drinking water quality. The guidelines provide guidance on water quality monitoring, assessment and surveillance. The guidelines are used by health and water regulators and policymakers and serve as a baseline for the development of national or country specific drinking water standards.

It is estimated that 90% of sewerage and 70% of industrial waste in developing countries are discharged into water courses without adequate treatment (Cooley, Ajami, Ha,

Srinivasan, Morrison, Donnelly & Christian-Smith, 2013, p.5). Globally it is estimated that more than 80% of wastewater is returned to the environment without adequate and proper treatment with negative repercussions on ecological systems, environmental and human health (Guppy & Anderson, 2017, p. 6).

In order to attain sustainable development and to mitigate the impact of climate change, a more concerted effort towards minimising human made environmental pollutants is critical. Failure to do so will be one of the biggest developmental failures which could constrain social development, economic growth and prosperity. Globally, Asian rivers are reportedly more polluted with bacteria levels from human waste up to three times higher than global averages (Cooley et al., 2013, p.5). This is a serious threat to human life, the ecosystem and will increase purification costs, an expense that can be avoided.

According to the WHO (2011, p.8), a more preventative approach to water management is required in order to ensure water safety from the catchment source to the end user, and ensuring collaboration with other stakeholders by adopting a multidisciplinary or multi-sectoral approach towards the management of water quality.

2.3.4 Infrastructure Maintenance

The challenge of water losses due to leaks will get worse if the infrastructure is not adequately maintained. According to Guppy and Anderson (2017, p. 6), the capital investment needed in the United States of America, an advanced economy, to maintain infrastructure is estimated at US$195 billion in 2040. If there is no adjustment in the current funding stream infrastructure maintenance will be underfunded by US$144 billion. Malobela and Sinha (2017, p. 994) refer to the study by the World Bank which found that to maintain and improve the existing global water infrastructure and delivery system, would require about $600 million dollars.

2.3.5 The Sustainable Development Goals

Noting the existing and looming global challenges, in 2012 the United Nations hosted a conference on Sustainable Development in Rio de Janeiro. This conference agreed on a 2030 Agenda for the eradication of poverty and achieving sustainable development. The conference agreed on seventeen (17) SDGs. Goal 6 which relates to the research study, is to ensure availability and sustainable management of water and sanitation for all. The SDGs draw from the work done in the implementation of the Millennium Development

Goals (MDGs) which were also coordinated by the United Nations and whose life span came to an end in 2015. Some of the indicators relating to water included: -

Table 2.1: *SDG Water Indicators*

1	By 2030, achieve universal and equitable access to safe and affordable drinking water for all
2	By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
3	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
4	By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
5	By 2030, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
6	By 2030, expand international cooperation and capacity-building support to developing countries in water and sanitation related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies
7	Support and strengthen the participation of local communities in improving water and sanitation management

Source: Sustainable Development Goals (United Nations, 2019)

From the above analysis it can be concluded that water provision and management are a global priority and have an impact on the attainment of all sixteen SDGs. Sustainable water provision is required to address poverty, hunger, health (waterborne diseases) and promote gender equality (women who collect water). The United Nations (2019, p. 29) in its report on SDGs indicates that inadequate water supply, polluted water systems and inadequate sanitation are a major health risk and are linked globally to 60% of waterborne diseases such as diarrhoea. The report further states that several diseases can be safely managed with safe drinking water.

Successful water management is therefore critical in the overall attainment of all the SDGs. There are cities that have transformed their water utilities and are managing water successfully.

2.3.6 Cases of Successful Water Management

2.3.6.1 The Case of Teplice in Czech Republic

There are regions that have succeeded in managing water successfully, and a case in point is the city of Teplice in the Czech Republic which had 40% water losses (Eminger, 2011, p. 1). Teplice is one of the tourist attractions in the Czech Republic and is well known for its spas. The main challenges in the city were water leaks and a dysfunctional water supply system as a result of the expansion of the city (Eminger, 2011, p. 1). The city had challenges in evaluating non-revenue water, leakage evaluations were unsystematic and there were inconsistencies in data inputs. In addressing these challenges, the city established District Metering Areas by dividing the water distribution network into smaller and more manageable areas. This intervention made it easier for the city to meter precisely water inflows and outflows, as well as balance and stabilise its distribution flows. A complex data collection software system was acquired which allowed for data to be collected and analysed more efficiently and effectively, resulting in the reduction of water leaks. The data collection software had unique financial analysis capabilities which enabled the city to make more informed and smarter decisions on leak detection and repair activities.

The city further implemented an automated service tool to run and prepare outputs during specific intervals. The system was web-based and was interfaced with leak control, network repair, leak identification and pressure optimisation tools. A novel leak monitor was also acquired. Overall, the interventions included asset management and billing, water pressure management, reduction of non-revenue water, real-time online monitoring and real-time leakage management. These interventions led to a 43% reduction in the total number of water leaks in six months and return on investment within a year of implementation (Eminger, 2011, p. 1).

2.3.6.2 The Case of Phnom Penh in Cambodia

Another successful water management system was noted in Phnom Penh, Cambodia's capital city. The city has a water utility called Phnom Penh Water Supply Authority (PPWSA). The city had a number of challenges including inadequate infrastructure, corruption, budgetary constraints and inadequate institutional structures (Tortajada & Biswas, 2019, p. 548). For institutions to thrive requires good governance structures that are capable of providing leadership and adequate oversight. Guppy and Anderson (2017,

p.6) attribute the failure of water utilities to governance matters, which often entail fragmentation, lack of accountability and lack of transparency which all hinder economic efficiency and expose institutions to fraud and corruption.

After the signing of the peace agreement and the elections that were sponsored by the United Nations, sanctions were lifted leading to a profound transformation in Cambodia and leapfrogging of the water utility by transforming its leadership and governance into a more committed and determined leadership (Tortajada & Biswas, 2019, p. 548).

In fifteen years the water utility in Cambodia increased water production by approximately 440%, expanded its distribution network by 557%, reduced water losses from 72% to 6.2%, increased the customer base by 660% and increased pressure in the water distribution system by 1260% (Tortajada & Biswas, 2019, p. 548). These achievements can be attributed to leadership, decision making processes and improvement in governance (Tortajada & Biswas, 2019, p. 548). This means that good governance, leadership and good organisational culture coupled with continuous improvements contribute immensely to successful water management.

2.4 THE SOUTH AFRICAN CONTEXT

2.4.1 The National Profile

South Africa is a constitutional democracy with a constitution which is the supreme law of the country. South Africa has nine provinces – Eastern Cape, Western Cape, Northern Cape, Gauteng, Free State, Mpumalanga, North West, KwaZulu-Natal and Limpopo. The country has an estimated population of 58 775 022 (Statistics South Africa, 2019, p.18). Gauteng and KwaZulu-Natal account for 15 176 116 and 11 289 086 which is 25.8% and 19.2% respectively of the overall population of the country (Statistics South Africa, 2019, p.18.). Whilst Gauteng has shown a steady increase from 2002, KwaZulu-Natal's population has decreased from 20.8% in 2001 to 19.2% in 2019. Despite the decline it is still the second biggest contributor to the country's population. South Africa has three spheres of government: National, Provincial and Local Government. The local government sphere is made up of the District and Local Municipalities. Below is the legislative framework guiding the provision of water and the status quo of water in the country.

2.4.2 Legislative and Policy Framework

The Constitution of the Republic of South Africa (Act 108 of 1996, p. 13), s27(1) of the Bill of Rights stipulates that “everyone has a right to have access to – sufficient food and water.” The Constitution further propels the state to “respect, protect, promote and fulfil the rights in the Bill of Rights” (South Africa, 1996, p. 6). The Constitution, under s15 2(1) also provides for the establishment of both Provincial and Local Governments and sets the objectives of local government which are to provide democratic and accountable government for local communities, to ensure the provision of services to communities in a sustainable manner, to promote social and economic development, to promote a safe and healthy environment and to encourage the involvement of communities and community organisations in the matters of local government.

Schedule 4 of the Constitution allocates the function of water and sanitation services limited to potable water supply systems and domestic wastewater and sewage disposal systems to Local Government. The provision of this function by local government must be done in a way that fulfils the objectives of local government as outlined above. Anything contrary to the above would be in violation of the Constitution.

To give effect to the Constitution, National Government promulgated the National Water Act (Act No 36 of 1998) and the Water Services Act (Act No 108 of 1977). The primary responsibility of this legal framework is to regulate and protect water resources.

Below is a water reliability index which also serves as a key performance indicator:

Table 2.2: *Water Reliability Index*

Service Reliability	Water Services
Non-functional	When a system does not provide water for more than 14 days over a three-month period
Major problems	When a system does not provide water for 8-14 days over a three-month period
Significant problems	When a system does not provide water for 2-7 days over a three-month period
Minor problems	When a system does not provide water for not more than 2 days over a three-month period
No problem	No interruption

Source: Statistics South Africa (2016)

DWS has developed norms and standards in respect of tariffs for WSAs and bulk water service providers. The norms and standards allow WSAs to perform due diligence before developing a tariff structure. The norms and standards further provide for the tariff structure to consider both direct and indirect costs associated with operations, maintenance and refurbishment of infrastructure and place emphasis on community consultations on the proposed tariffs.

South Africa is also striving towards the implementation of the 2030 vision in order to achieve global commitments as laid out in the SDG report. To that effect, the National Development Plan (NDP) was developed by the National Planning Commission. The NDP outlines the country's 2030 vision in relation to water as "before 2030, all South Africans will have affordable access to sufficient safe water and hygiene sanitation to live healthy and dignified lives" (South Africa National Planning Commission, 2012, p. 154).

The plan acknowledges policy reforms and improved access to water post 1994 and the resultant reduction in water backlogs. The above notwithstanding, the plan notes the backlogs that still exist and deteriorating water quality. The plan acknowledges the pressure put on this resource by different users and proposes effective ways of managing this resource and engaging water users on the current constraints of the water supply systems and opportunities (South African National Planning Commission, 2012, p. 155).

In 2014 the government adopted the Back to Basics Strategy which seeks to suggest new ways of doing things in order to solve the current challenges facing local government. The strategy is built on five indicators that measure the performance of the Municipalities in terms of getting the 'basics' right. The five indicators are; putting people first, delivering basic services, good governance, sound financial management and building capacity (South African Department of Cooperative Governance and Traditional Affairs, n.d, p. 10). The South African National Standards for drinking water (SABS, 2015, p. 241) provides detailed compliance standards in relation to the microbiological, physical, aesthetic and chemical determinant that WSA should comply with.

2.4.3 Roles and Responsibilities

In terms of the Strategic Framework for Water Services (South Africa Department of Water and Sanitation, 2003, p. 11-20) the role of the National government is policy formulation, regulation, support and information management. Local government WSAs are responsible for ensuring access to water, planning and regulation in the areas of jurisdiction and provision.

2.4.4 Water Management and Provision

According to DWS Strategic Plan (South Africa Department of Water and Sanitation, 2020/21 to 2024/25, p. 9), South Africa has a low annual rainfall of about 500mm which is significantly lower that the world average of 800mm. The country's water requirements are 10 233 million m^3/annum and the current yield of surface water is 10 337 million m^3/annum indicating a deficit of 96 million m^3/annum.

2.4.5 Water Use

The largest water user is the Agricultural sector at 61% followed by the municipal sector at 27%. The municipal sector is responsible for potable water. Other users such as power generation, mining, bulk and industrial use including conservation and forestation jointly make up the remaining 12% (South Africa Department of Water and Sanitation, 2020/2021-2024/2025, p. 10). This study focuses on the municipal sector, the second largest water user.

2.4.6 Water Sources

There are different water sources in South Africa such as surface water, ground water, return flows and other (Reddick & Kruger, 2019, p.7). Figure 2.1 below depicts water sources in percentage form.

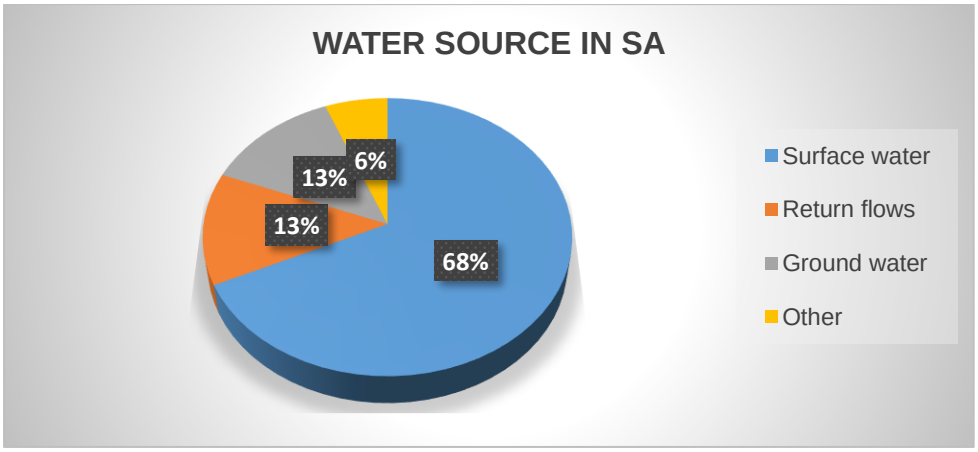

Figure 2.1*: Water Sources in South Africa*

Source: Reddick and Kruger, Market Intelligent Report (2019)

South Africa has a total number of 5 511 registered dams with a total storage capacity of 33 219 million m^3 (South Africa Department of Water and Sanitation, 2017/2018, p.9). Most of the country's dams (78%) are considered small (less than 12m), with 21 % considered medium sized (12m-30m) and only 3% considered large (30m and higher). Of the 5 511 dams, 854 are owned by the state (322 by the DWS, 333 by the Municipalities and 76 by other state departments). The remaining 4 657 dams are owned by the private sector (4 322 by the agricultural sector and 335 by mines, industries and businesses). Despite the state owning fewer dams than the private sector, state dams have a water storage capacity of 94% (South Africa Department of Water and Sanitation, 2017/2018, p. 36).

The national demand for water in 2019 was 10 233 million m^3 per annum; and the reliable national yield was approximately 10 137 million m^3 per annum, an indication of a national water deficit of 96 million m^3 per annum (South Africa Department of Water and Sanitation, 2020/2021- 2024/2025). This means the demand exceeds the supply. In order to offset the deficit, transfer schemes are used to service the demand. South Africa does not have commercially navigable rivers while uneven rainfall patterns result in low seasonal flows into the rivers (Persons, 2017, p. 156). Hence successful water management should be a national imperative, considering the current deficit.

2.4.7 Backlogs

Water provision in South Africa can be classified into four categories: inside the dwelling, inside the yard, access point outside the yard and no access to piped water (Statistics South Africa, 2016, p.65).

Table 2.3: *National Backlogs*

	Inside the dwelling	Inside the yard	Access point outside the yard	No access to piped water
Census 1996	44.2	16.6	19.6	19.7
Census 2001	32.3	29.0	23.2	15.5
Census 2011	46.3	27.1	17.9	8.8
Community Survey 2016	44.4	30.0	15.5	10.1

Source: Statistics South Africa (2016)

Great improvement has been noted in reducing the number of households with no access to piped water from 19.7% in 1996 to 10.1% in 2016. Notwithstanding the reduction in backlogs, a regression in the form of an increase in backlogs was noted from 8.8% in 2011 to 10.1% in 2016. An access point outside the dwelling has decreased from 19.6 % in 1996 to 15.5% in 2016. This can be attributed to an increase in yard connections which has increased from 16.6% in 1996 to 30% in 2016. Access to water inside the dwelling has remained stagnant from 1996 to 2016, with a marginal increase from 44.2% to 44.4% respectively.

Malobela and Sihna (2011, p.993) argue that the majority of people in South Africa are affected by inadequate management of water resources, with rural communities being the hardest hit as they do not have access to potable water and sanitation facilities. The way in which water is being managed and conserved remains an imperative for the South African Government.

2.4.8 Water Losses

According to McKenzie, Siqala and Wegel (2012, p. 15), nonrevenue water in South Africa is estimated at 37%, which is within the world average of 36, 6%. Water losses consist of "apparent or commercial losses and real or physical losses and typically includes all losses on the municipal side (up to the consumer meter) of the reticulation system" (South Africa Department of Water and Sanitation, 2017, p.3). It is a sum of the physical and commercial losses and is calculated as the difference between the System Input Volume and authorised consumption (South Africa Department of Water and Sanitation, 2017, p.3).

Many municipalities are struggling with water losses, but there are successful interventions implemented in different parts of the country to address this challenge and to ensure successful water management. One such case is the city of Cape Town, which is not immune to the challenge of water losses. As part of the City's Water Demand Management, pressure management technology was introduced as a first phase of a larger water conservation and demand management strategy (McKenzie, 2014, pp. 180-181). This initiative proved to be successful. The table below outlines the benefits of pressure management.

Table 2.4: *Benefits of Pressure Management*

Area	Water Savings (million m3/yr)	Cost (R)	Savings @ R6.20/m3 (r/year)
Khayelitsha	9 million m3/yr	2.7 million (2001)	R55 million/yr
Mfuleni	0.4 million m3/yr	1.5 million (2007)	R2.5 million/yr
Gugulethu	1.6 million m3/yr	1.5 million (2008)	R10 million/yr
Mitchells Plain	2.4 million m3/yr	7.7. million (2009)	R15 million/yr
Total	13.4million m3/yr	13.4 million	R83 milliom/yr

Source: McKenzie (2014)

Pressure management generally lowers consumption, controls water flows, reduces leaks and reduces pipe bursts by ensuring that water flow is within the carrying capacity of the pipeline.

2.4.9 Water Quality

The South African National Standard (SANS) 241 specifies the standards in relation to acceptable drinking water. The standards include microbiological, physical, aesthetic and chemical determinants (South African Bureau of Standards, 2015, p. 3). The standards are used by WSA to ensure that the water provided complies fully with SANS 241 in terms of numeric limits provided. Water that is compliant with SANS 241 is deemed to present an acceptable risk for consumption. Safe drinking water has enormous benefits to the wellbeing of human and eco-system life and the promotion of environmental, social and economic sustainability.

DWS developed a Drinking Water Quality Framework for South Africa. The Framework is based on an integrated systems approach focusing on prevention and risk management from the catchment to consumers. According to Hodgson and Manus (2006, p.673), the quality of drinking water being provided at point-of-use is of vital consideration, as current investigations in South Africa on water quality have indicated major water quality problems in non-metropolitan areas. This is attributable to a lack of understanding by WSAs regarding the requirements for effective drinking water quality management, inadequate management including monitoring of drinking water services, inadequate asset management, inadequate WSA institutional capacity (staffing, funding, expertise, education) and a lack of intervention to address poor drinking water quality when detected (Hodgson & Manus, 2006, p.673).

2.4.10 Infrastructure Maintenance

Fourie and Zhuwaki (2017, p. 151) opine that “asset management emphasises achieving infrastructure outputs that are directed at meeting the needs and expectations of customers and key stakeholders.” Maintaining infrastructure is critical in ensuring uninterrupted provision of service, improving the useful lives of assets and reducing asset impairments. Infrastructure maintenance requires physical capacity, financial resources, consistent preventative maintenance and reliability improvement strategies (Fourie & Zhuwaki, 2017, p. 151).

Industrialisation puts more pressure on infrastructure as it increases the demand and over-stretches the carrying capacity of the asset. This requires a funded infrastructure maintenance plan that is informed by the conditional assessment of assets. Ngoune and Kholopane (2016, p. 2386) emphasise the impact of population growth, in that it puts pressure on the existing water resources which in turn, require maintenance and upgrades to cope with the demand.

There are other identified challenges such as breakdowns, pipe deterioration, infrastructure shortages, lack of repairs, vandalism and limited storage capacity as major challenges contributing to the water crisis (Ngoune & Kholopane, 2016, pp. 2388-2389).

2.5 THE PROVINCIAL CONTEXT

2.5.1 The Provincial Profile

KwaZulu-Natal province, where the research study is located, has ten District Municipalities and one Metropolitan Municipality. The total population for the province is estimated at 11 289 086 (Statistics South Africa, 2019, p.vi). KwaZulu-Natal is the second largest province after Gauteng province. The total number of households nationally increased from 14.5 million in 2011 to an estimated 16.9 million in 2016. Gauteng and KwaZulu-Natal provinces registered the highest number of households in 2016, at 29.3% and 17% respectively. The smallest number of households was observed in Northern Cape at 2.1% and Free State at 5,6%. A survey that was conducted by Statistics South Africa in 2016 revealed that municipalities that reported poor services were most common in the Eastern Cape, KwaZulu-Natal, and Limpopo. About 24.0 % of households in the

Eastern Cape and 11.6% of households in KwaZulu Natal were dependent on unimproved sources of water (Statistics South Africa, 2017, p.27).

Based on the survey by Statistics South Africa (2016, p. 31) which considers the geographic interdependence between regions, the analysis identifies statistically significant hot or cold areas. Hot spots are “significant clusters of low values (relatively few interruptions), while cold spots represent significant clusters of high values (high percentage of disruptions)” (Statistics South Africa, 2016, p.31). Based on the survey, hot spot municipalities were concentrated in the Western Cape, Gauteng, and Northern Free State, and cold spot municipalities were mostly clustered across the Eastern Cape and KwaZulu-Natal as well as central Limpopo. The growing population puts more pressure on water supply systems that are already constrained.

2.5.2 Legislative and Policy Framework

Provinces draw their mandate from the Constitution of the Republic of South Africa. In relation to water management, the role of the Province through the Department of Cooperative Governance and Traditional Affairs is to support and monitor the performance of Municipalities. Below is the policy framework of the Province that relates to water.

KwaZulu-Natal Planning and Development Act, No. 6 of 2008 provides norms and standards, promotes uniform planning and addresses historic imbalances etcetera. It regulates the work of the municipalities in relation to town planning and adherence to the town planning schemes. In line with the SDG and the National Development Plan, the province has developed a Provincial Growth and Development Plan (PGDP) which clearly articulates its 2035 vision and developmental agenda. The plan has the following seven goals: inclusive economic growth, human resources development, human and community development, strategic infrastructure, environmental sustainability, governance and policy and spatial equity. In relation to Goal 4, the strategic infrastructure, the main objective in relation to water and sanitation is to “ensure availability and sustainable management of water and sanitation for all” (KwaZulu-Natal Planning Commission, 2019, p. 15).

The plan further confirms that inadequate investment in basic infrastructure has undermined the development and growth prospects of the province. This is partly due to

inadequate and reactive maintenance programmes by the WSAs (KwaZulu-Natal Planning Commission, 2019, p.127).

2.5.3 Water Backlogs

According to Statistics South Africa (2016, p.65), the total water backlog in KwaZulu-Natal is 19%, significantly above the country's 10.1%. Harry Gwala District Municipality has the second highest water backlogs in the province. The KwaZulu-Natal Situational Overview report (KwaZulu-Natal Provincial Planning Commission, 2019, p. 137) indicates a number of WSAs in the Province have a water deficit and as such will not be able to meet the 2035 water demand. The report proposes "an urgent need to implement water efficiency measures, and move towards rain harvesting, groundwater use, low-water or no-water technologies, industrial water efficiency, desalination and water re-use strategies" (KwaZulu-Natal Provincial Planning Commission, 2019, p. 137).

2.5.4 Water Losses

According to DWS (South Africa Department of Water and Sanitation 2017, pp. 42-43) in their report on Benchmarking of Water Loss, Water Use Efficiency and Non-Revenue Water in South African Municipalities (2004/2005 to 2015/2016), the performance of Provinces in relation to water losses and non-revenue water estimates is summarised below.

The Eastern Cape municipalities indicated water losses of 149.61 million m^3/a (45.0%) and Non-Revenue Water (NRW) of 158.65 million m^3/a (47.8%), Free State municipalities indicated water losses of 96.91 million m^3/a (46.6%) and NRW of 106.91 million m^3/a (51.4%), Gauteng municipalities indicated water losses of 404.07 million m^3/a (27.4%) and NRW of 528.84 million m^3/a (35.9%), KwaZulu-Natal municipalities indicated water losses of 299.80 million m^3/a (43.0%) and NRW of 327.44 million m^3/a (46.9%). The Limpopo municipalities indicated water losses and NRW of 155.02 million m^3/a (55.1%). The North West municipalities indicated water losses and NRW of 105.58 million m^3/a (55.1%). The North West municipalities indicated water losses and NRW of 105.58 million m^3/a (51.1%). The Northern Cape municipalities indicated water losses of 42.0 million m^3/a (44.6%) and NRW of 44.5 million m^3/a (47.3%). The Western Cape municipalities indicated water losses of 80.48 million m^3/a (16.7%) and NRW of 102.7 million m^3/a (21.3%).

All the provinces except for the Western Cape showed water losses that are significantly above the norm of 15%-30% as prescribed by National Treasury MFMA Circular No.71.

2.5.5 Water Quality

DWS introduced three incentive-based initiatives to improve water quality, the blue drop, green drop and no drop certifications programmes. Blue drop is for drinking water quality management, green drop for wastewater management and no drop for water use efficiency and water loss management (South Africa Department of Water and Sanitation, 2014, p.6). The first Blue Drop Report was released in 2009 and microbiological compliance was 93.3 % against the National Standard (South Africa Department of Water and Sanitation, 2017, para. 1). In 2012 compliance was 87.6% and 79.6 % in 2014. This is a serious regression on water quality throughout the country (South Africa Department of Water and Sanitation, 2017, para. 1)

The provincial performance points to serious deficiencies, as all provinces except for Mpumalanga regressed with only one province retaining the same score. The Western Cape blue drop score was 94% in 2012 and regressed to 89% in 2014; KwaZulu-Natal was 92% in 2012 and regressed to 86% in 2014; the Free State declined from 82% in 2012 to 75% in 2014; the Eastern Cape regressed from 82% to 72%; Mpumalanga increased from 60.9% to 69.9%; the Northern Cape retained 68%; North West declined from 79% to 63% and Limpopo from 79% to 62 % (South Africa Department of Water and Sanitation, 2017, para. 1). The regression in water quality is indicative of serious deficiencies in water quality prevention and monitoring processes. DWS attributes the regression to insufficient skills especially the process controllers and generally non-adherence to the water monitoring programme.

2.5.6 Infrastructure Maintenance

According to the Provincial Growth and Development Plan (KwaZulu-Natal Provincial Planning Commission, 2016, p. 85) “there is also a school of thought that the severity of the drought is a direct correlation to the poor maintenance programmes of water services authorities, poor borehole upgrades and spring protection, high water losses due to leakages not been attended to urgently, water theft and lack of bulk and reticulation planning.”

The South Africa Human Rights Commission (2018, p.4) outlines the following challenges affecting water provision; poor construction and maintenance of water infrastructure, lack of, or poor monitoring of, service delivery projects tasked to external contractors, lack of ongoing maintenance, lack of upgrading and expansion of bulk infrastructure to meet the current and future demand, lack of maintenance of water treatment and waste water treatment infrastructure. These impede the ability of the water utilities to provide water more efficiently.

2.6 DISTRICT CONTEXT

Harry Gwala District Municipality is made up of four local Municipalities – Umzimkhulu, uBuhlebezwe, Dr Nkosazana Dlamini-Zuma and Greater Kokstad.

2.6.1 Legislative Framework

The District draws its mandate from the Constitution of the Republic, Act 108 of 1996. The Act provides for the establishment of Local Government, Objects of Local Government and designated powers to Local Government. In terms of the Constitution, Harry Gwala District Municipality is a category C municipality as it has executive and legislative authority in an area that includes more than one municipality.

To give effect to the Constitution of the Republic, the following laws have been promulgated:

The Municipal Structures Act, No.117 of 1998, provides for the establishment of Municipalities, division of powers and functions and the establishment of governance structures.

Municipal Systems Act, No.32 of 2000 aims “to provide for the core principles, mechanisms and processes that are necessary to enable municipalities to move progressively towards the social and economic upliftment of local communities, and ensure universal access to essential services that are affordable to all” (Municipal Systems Act, No 32 of 200, p. 3). The Act further provides a framework for community participation in the affairs of the municipality, need for integrated development planning, performance management credit control and debt control, municipal services etcetera.

Municipal Finance Management Act, No.56 of 2003 aims to “secure sound and sustainable management of the financial affairs of municipalities and other institutions in

the local sphere of government; to establish treasury norms and standards for the local sphere of government; and to provide for matters connected therewith" (South Africa, 2003, p.3).

Municipal Systems Act No 32 of 2000 further requires municipalities to prepare and adopt a single and inclusive strategic plan called the Integrated Development Plan (IDP) developed in terms of Chapter 5 (South Africa, 2002, p.44). This is a five-year plan which is reviewed annually. Harry Gwala DM has developed and adopted the IDP as a tool to guide development in the region. According to the IDP of the district the infrastructure in urban areas needs upgrading and maintenance, adding that bulk water supply is a major constraint which requires urgent attention.

The District has also developed a District Growth and Development Plan which is a 2030 plan for the District and is fully aligned with the SDG, National Development Plan and the Provincial Growth and Development Plan. The District has developed and adopted a Water Services Development Plan which contains the state of water infrastructure and proposed interventions to address the challenges. The Municipality is also embracing the District Development Model which aims to develop one plan for the District which is inclusive of other functions rendered by Local, Provincial and National Departments, including the Civil Organisations and the private sector.

2.6.2 Water Sources

The district draws water from the following water resources:

Table 2.5: *District Water Resources*

DAM	SIZE	OWNERSHIP
Home Farm Dam	Small dam – below 12m	Harry Gwala District Municipality
St Isadore	Small dam – below 12m	Ixopo Irrigation Board
Crystal Springs Dam	Small dam – below 12m	Harry Gwala DM
Ngundwini Dam	Small dam – below 12m	SAPPI
Kempsdale Dam	Small dam – below 12m	Harry Gwala DM

Source: Harry Gwala District Municipality, Water Services Department (2020)

The Municipality owns three dams and has entered into abstraction agreements with SAPPI and Ixopo Irrigation Board.

2.6.3 Functionality of Water Schemes

The District is currently managing and maintaining about 133 water schemes. Of the total number of schemes, fully functional schemes are between 42 and 43 (60%) (Harry Gwala District Municipality, Water Services Department, 2019-2020). About eleven (8%) water schemes are dysfunctional and about forty-three (32%) are partially functional. Discrepancies have been noted between the reliability index supplied by Statistics South Africa and the scheme functionality assessment tool by the District Municipality. Fully functional schemes are not those with no problem or minor problems as per the reliability index, they can be classified as those that have major problems. This means those schemes that do not provide water for 2-7 days over a three month period. The municipality does not have a scheme that has no interruptions or a system that does not provide water for not more than 2 days. Partially functional schemes as per the municipal assessment tool include those that have significant problems and do not provide water for 8-14 days over a three-month period. Dysfunctional schemes can be ranked as non-functional in terms of the reliability index.

From the above it should be noted that water reliability is still a huge challenge which could potentially cripple the attainment of the goals outlined in the SDG report, National Development Plan, Provincial Growth and Development Plan, IDP and the District Growth and Development Plan.

Below is data relating to the backlogs, meaning those household that do not have access to potable water.

2.6.4 Water Backlogs

According to the WSDP and the IDP (Harry Gwala District Municipality, 2020/2021, p. 245), water backlogs are at 28%. According to Statistics South Africa (2011, p. 56) the backlog on water at Harry Gwala District Municipality is 34.8%. This means that the District must confirm the extent of its backlogs in order to craft a credible plan to address them.

2.6.5 Water Quality

In relation to water quality, the District had 23 Water Treatment Plants (WTPs), inclusive of the package plants (Harry Gwala District Municipality, 2018, p.15). DWS performed

an assessment of water quality using the blue drop. The last audit was done in twenty-three WTPs owned by the District Municipality except for one WTP owned by the water board. The results indicated that fourteen (60%) of the Water Treatment Works scored below 50% in terms of water quality (Harry Gwala District Municipality, 2018, p.15). Of the twenty-three WTPs, eight WTPs scored between 50% and 70% and only one (1) WTP, which is owned by Umgeni Water Board, scored 90.11% (Harry Gwala District Municipality, 2018, p.15).

2.6.6 Water Losses

Table 2.6: *Water Losses*

FINANCIAL YEAR	% WATER LOSS	SYSTEM INPUT VOLUME	STOCK LOSS	PRICE	FINANCIAL LOSS
2018/2019	31.9	4 004 130 kl	1 278 831 kl	R7.05	R9 015 758,55
2017/2018	38.2	3 850 033 kl	1 468 869 kl	R6.20	R9 106 987,80
2016/2017	40.4	5 459 092 kl	2 205 931 kl	R5.40	R11 912 027.40

Source: Harry Gwala District Municipality, Audited Annual Financial Statements (2018/2019, 2017/2018 and 2016/2017)

Water losses are one of the main challenges in the municipality. According to the audited Annual Financial Statements, water losses have been largely due to water carting due to the drought, ageing infrastructure and illegal water connections. Though the municipality has managed to reduce its water losses over the past three financial years, 31.9% is still significantly high and ought to be reduced considering the lack of well-developed water resources and backlogs in the District.

2.7 FINANCIAL PLANNING AND MANAGEMENT

Buger and Woods, (2008 cited by Cheruiyot, Oketch, Namusonge, Sakwa, 2017, p. 213) define public financial management as a process of effective utilisation of both scarce and public resources through adequate prioritisation and striving towards value for money in the provision of services to communities. Nzuza and Lekhanya (2014, p.157) indicate that globally, municipal financial performance has been subjected to improvements with governments restructuring the legal frameworks in order to improve the financial performance of municipalities. To this effect, the South African government promulgated laws and regulations to ensure sound financial management inclusive of the Public Finance Management Act (PFMA), No.1 of 1999 and the Municipal Finance Management Act (MFMA), No. 56 of 2003.

National Treasury issued MFMA circular 71 with ratios for assessing the financial position, financial performance and financial health of the municipalities (South African National Treasury, 2014, p.1). Water is a source of revenue and a credible tariff structure is required; hence section 74 of the Local Government: Municipal System Act, No. 32 of 2000 provides for the formulation of a tariff policy on the levying of fees for municipal services. Nzuza and Lekhanya (2014, p.157) note that emerging and advanced economies are continuously transforming municipal financial systems, but such steps are shrouded by lack of transparency and inefficiencies.

National Treasury (South African National Treasury, 2018, p.3) confirms that several municipalities do not have sufficient cash coverage to fund their operations. Common challenges include underspending on capital grants, increases in consumer debt, creditors not being paid on time owing to poor cash flows, inadequate spending on asset management, high water losses, adoption of unfunded budgets and persistent decline in audit outcomes. These will inevitably impact negatively on service delivery and successful water management.

2.8 WATER PRODUCTION PROCESS

The main objective of water services is “to produce water which meets the minimum quality standards from resources (ground water or surface water) that may necessitate preliminary treatments to make water safe and potable, and to distribute such water to supply final users throughout distribution networks” (Mercadier, Cont & Ferro, 2016, p. 216). The complexity of this process gives rise to a complex network of assets which must be congruent and compatible in order to minimise waste and breakdowns. Shoeb (2017, p. 42) identified eight types of waste that are prevalent in the manufacturing industries: defects, overproduction, unnecessary processing, waiting, inventory, complexity, unused employees and movement. It is also important to empower employees through training and teamwork in order to share experiences and to understand the importance of producing quality service, getting it right the first time and eliminating different wastes in the production processes (AL-Najem, Dhakal & Bennett, 2012, p.128). This will encourage employee involvement, a sense of responsibility, ownership, productivity and efficient production processes (Denison, 2000 cited in AL-Najem et al., 2012, p.129).

It is also important to have work scheduling which must allow for faster communication, more flexibility, create space for innovation and continuous improvement and quick

decision making processes (Jedynak, 2015, p.58). Kolinska and Domanski (2017, p.109) place emphasis on the production bottlenecks, the need to identify and quantify bottlenecks in each workstation and the need for effective production management. Bottlenecks in the production process can be caused by machines or human beings and will inevitably affect the throughput. Wang, Zhao and Zheng (n.d., p. 3) define bottlenecks as anything that limits optimal performances in the production process.

2.9 WATER CONSERVATION AND DEMAND MANAGEMENT

Water Conservation is defined as a reduction in water loss, water use or water demand (Kumari & Singh, 2016, p. 76). Water Demand Management is also seen as convincing consumers to minimise waste by using water more efficiently (Van Zyl, 2011, p. 105). The province of KwaZulu-Natal in the Situational Overview report define Water Demand Management as:

> "The adaptation and implementation of a strategy by a water institution or consumer to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability in general terms" (KwaZulu-Natal Provincial Planning Commission, 2016, p.81).

Water conservation entails minimising waste, eliminating water losses, adequate protection of water resources and ensuring water is used effectively and efficiently (South African Department of Water and Sanitation, 2017, p. 12). Kumari and Singh (2016, p. 78) propose that emphasis by WSA must be on the no drop strategy, re-using water as much as possible, changing consumers' attitudes, using production processes and adopting technologies that will minimise water waste, maintaining infrastructure to reduce leaks and educating the public on the need to conserve water.

Another important factor in water demand management is adequate water metering infrastructure (domestic and bulk). Van Zyl (2011, p. 2) argues that water metering provides for credible billing, improvements in water sales and income, reductions in water losses and are essential for managing the demand.

Water can be categorised in two forms – authorised consumption which is revenue water, and water losses which account for non-revenue water. According to Van Zyl (2011,

p.105), authorised consumption consists of billed authorised and unbilled authorised consumption and water losses consist of apparent and real water losses, often referred to as non-revenue water. Apparent water losses consist of illegal water connections and inaccuracies in the metering system and real water losses constitute leaks in the distribution networks, overflows from reservoirs and storage facilities. Water meters require adequate management of assets, which entails fixing faulty meters timeously and replacing dysfunctional meters in order to have credible billing.

Rainwater harvesting, which means collecting water from rainwater, water efficiency, improved designs and water reuse are some of the strategies that can be used to conserve water and meet the demand (Kumari & Singh, 2016, pp. 77-78)

Another critical factor in water conservation and demand management is public education. It is important to continuously raise awareness on water savings to different users and influence behavioural changes in the consumption patterns in order to conserve water (Zhang, Chen, Sheng, Ip, Yang, Chen, Sang, Tadesse, Yee Lim, Rajabifard, Bueti, Zeng, Wardlow, Wang, Tang, Xiong, Li & Niyogi, 2019, p. 6). This is more so because empirical evidence suggests that the “human figure print” is the major contributor to freshwater sources that are becoming extinct as a result of overconsumption (Zhang et al., 2019, p.6).

Kumari and Singh (2016, p. 76) posit that water efficiency reduces water demand and is a critical tool towards water conservation. Without adequate water efficiency strategies, the current water challenges will worsen with negative repercussions on human beings, the economy and other ecosystems.

2.10 HUMAN RESOURCES AND ORGANISATIONAL DEVELOPMENT

According to Mwaniki and Gathenya (2015, p. 432), human resources is a backbone and an integral part of any organisation and the success of the organisation is largely dependent on the performance of employees and how they are managed in order to attain set goals. An important component of lean management is not only reducing waste; it includes decreased operational costs, improved product or service quality, job satisfaction and employee productivity (Womack et al., 1990 cited in Gill, 2012, p. 51). All the above objectives cannot be achieved if employees are not capacitated to attain the lean goals. Ulrich (1998 cited in Mwaniki and Gathenya, 2015, p. 436) argues that human resources can achieve excellence by partnering with senior managers in order to improve

planning, implement the organisational strategy, ensure efficiency, reduce costs and maintain a quality service to the consumers.

A positive organisational culture is a critical success factor in any organisation including lean management. Al-Najem, Dhakal and Bennet (2012, p. 119) state that “a number of factors such as top management commitment and leadership, empowerment and training of human resources, building relations with suppliers and customers, enhancing departmental relations and teamwork need to be taken into account in order to implement a successful lean system.” To achieve the above requires buy-in from top-management and leadership. Organisational culture is also defined by the calibre of its employees, the extent to which teamwork is promoted, shared vision, shared values and ethics. Jawaad, Amir, Bashir and Hasan (2019, p.5) posit that proper training can help redefine employees’ conduct and performance. This will allow for continuous improvement in the organisation. Further to that, Mwaniki and Gathenya (2015, p. 432) posit that employees who are high on productivity tend to maximise the competitive advantage of the organisation by reducing costs and delivering high quality output. This is critical in the implementation of lean management.

According to Pearce and Pons (2013, p.3), true lean management is people-centred and entails good organisational culture, staff empowerment, innovation, productivity and waste elimination. One of the areas of emphasis in lean management is the participation of all employees in the organisation. Longoni et al. (2013, p.3304) encourage companies to adopt Human Resources practices that support lean management, training, employee involvement, teamwork, incentives and a positive organisational culture.

According to Spears and Bowen (1999 cited in Al-Najem, Dhakal and Bennet, 2012, p.124), how people work, how people connect, how the production line is connected and how to improve are four critical rules for organisations to be successful. These are the rules that have been implemented by Toyota. Lean management is about culture and organisational attitudes and not a mere use of tools (Pearce & Pons, 2013, p. 3). Understanding the organisational culture and identifying gaps that could work against waste elimination and ensuring that lean management is part of the organisational strategy is vital.

Lean management provides for the empowerment of multi-disciplinary or cross-disciplinary teams in order to identify and eliminate production waste, and realise lean management gains (Kajesh, Sridhar & Krishna, 2016, p.528).

Al-Najem et al. (2012, p. 130) cite factors that organisations need to focus on as “top management, leadership, training, suppliers and customer relations, departmental relations and teamwork.”

From the above analysis it is clear that water supply is challenged globally, nationally, provincially and locally; hence a new approach is required to better manage this scarce resource and meet demand. In this case the lean management framework will be explored in order to determine its role in ensuring successful water management at Harry Gwala District Municipality.

2.11 THE THEORETICAL FRAMEWORK

The study is located within lean management, a theoretical framework that encourages efficiency in the production processes, waste elimination without additional resources, responsiveness to customer needs and continuous improvement.

2.11.1 Lean Management Defined

Lean management originated in Japan after the devastating effects of the second world-war. Manufacturers could not afford to rebuild their facilities and Toyota Production System adopted lean manufacturing by producing “automobiles with lesser inventory, human effort, investment, and defects and introduced a greater and ever growing variety of products” (Bhamu & Sangwan, 2013, p. 877). According to Shoeb (2015, p. 41), lean manufacturing is about techniques and philosophies used in order to minimise waste and enhance the value of product offerings. Lean management has a holistic approach and focuses on improving efficiency in the use of available resources (Jedynak, 2015, p. 52). Longoni et.al. (2013, p. 3301) define lean management as:

> “a manufacturing system whose objective is to streamline the flow of production while continually seeking to reduce the resources (e.g. direct and indirect labour, equipment, materials, space, etc.) required to produce a given set of items; any slack in the system is referred to as waste.”

Lean management seeks to meet the demand qualitatively and quantitatively instantly with no waste (Slack & Lewis, 2017, p. 99). According to Shoeb (2017, p. 41), lean management is about continuous improvement, employee involvement, reducing inventory and resources needed to meet customer needs.

2.11.2 Lean Management Principles

Below is a brief analysis of some of the critical lean management principles, which are Just-In-Time, 5s, Total Production Maintenance, Waste Elimination, Continuous Improvement, Poka-Yoke, Value Stream Mapping, Material Requirement Planning and Jidoka.

2.11.2.1 Just-in-time

Just-In-Time (JIT) is commonly applied in the manufacturing and services sector. It includes the provision of the required material in the right quantities and quality at the right time and place (Al Haraisa, 2017, p. 159). The JIT concept is closely linked to the concept of pull production which reduces waste by eliminating inventory (Kootanaee, Babu & Talari, 2013, p. 9).

Suppliers are a critical component of JIT. Franco and Rubha (2017, p. 15) contend that a number of businesses want to minimise excessive inventory and cut down on costs associated with storage and management and carry only inventory that meets immediate and current customer needs. It allows for companies to have long term contracts with suppliers. The proper use of JIT has yielded enormous benefits in the production and manufacturing sectors such as improved productivity, product or service quality, efficient use of material and resources and improved communication whilst decreasing operational costs and waste (Kootanaee, Babu & Talari, 2013, p. 8). The system has many benefits but there are risks that can impact negatively on the production processes such as failure to deliver on time, inadequate or lack of integration in the information management systems and natural disasters.

2.11.2.2 5s

5s is a basic lean principle and entails the concepts of sort, set in order, shine, standardise and sustain. Its objective is to ensure that the work environment is properly laid out, clean and that the equipment is logically stored to reduce search time with adequate visual information (Filip & Marascu-Klein, 2015, p. 1-2). Quality can only be achieved in a clean environment. According to Filip and Marascu-Klein (2015, p. 1), 5s involves separating or removing unnecessary tools, putting in a logical order items that

are frequently used and maintaining deep cleaning in order to eliminate dirt. It involves developing procedures for storage areas, having clear visual access and signage, training of employees to adhere to set standards and reducing search time. The 5s is a systematic housekeeping process that allows for a serene environment where all the employees are involved and committed to implement housekeeping. This helps to uncover problems, which is a critical step towards continuous improvement. The 5s gives rise to continuous improvement and is a critical step in the implementation of TPM (Wakjira & Singh, 2012, p.26)

2.11.2.3 Total productive maintenance

Total Productive Maintenance's (TPM) primary objective is to maximise the efficiency and effectiveness of production equipment. This is done by employing preventative, predictive, corrective and reliable-centred maintenance (Jain, Bhatti & Singh, 2013, p. 295-296). TPM requires employee involvement in maintaining infrastructure in order to achieve optimal output, reduce breakdowns, improve product quality and customer satisfaction (Jain et al., 2013, p. 297). TPM has eight pillars of implementation: "autonomous maintenance; focused maintenance; planned maintenance; quality maintenance; education and training; office TPM; development management; and safety, health and environment" (Wakjira & Singh, 2012, p.26). These pillars increase employee productivity, reduce costs of maintaining infrastructure and reduce downtime.

2.11.2.4 Waste elimination

Waste elimination looks at the entire value chain of the production system. Waste is one of the critical components of a lean philosophy and involves elimination activities that do not add value in the production processes (Slack & Lewis, 2017, p. 102). Waste can emanate from transportation as a result of unwarranted movement of materials and people and waiting time which often emanates from time spent in between the different processes, breakdowns and bottlenecks in the production system. Bernestein (2014, pp.7-8) cites eliminating excessive inventory, defects, unnecessary movement of people, equipment and material, tracking time of the production processes and employees, eliminating overproduction and over-processing and providing employee training, as integral steps in waste elimination.

Slack and Lewis (2017, p. 102) consolidate waste into four main categories: waste from irregular flows, waste from inexact supply, waste from inflexible response and waste from variability. Waste from irregular flows and inexact supply can be eliminated through perfect synchronisation. Production processes should be flexible to accommodate any variation in customer needs but variations in quality must be eliminated as they create a barrier to achieving synchronised supply (Slack & Lewis, 2017, p. 102). Jedynak (2015, p.54) identifies some of the steps towards waste elimination as; identifying all the activities that do not add value, identifying all the activities that add value and ensure that the activities that create value are optimised, without any interruptions, waiting periods, detours and backflows, removing waste as it is uncovered and producing what will be pulled by customers.

2.11.2.5 Continuous Improvement /kaizen

Continuous Improvement (CI) is one of the lean management cornerstones. CI is defined as a philosophy with an emphasis on progressive initiatives that seek to promote improvements and success whilst minimising and eliminating failures (Sundar, Balaji & SatheeshKumar, 2014, p. 1880). It is a process, or a culture, of incremental and sustained improvements aimed at eliminating waste in all the production or manufacturing processes and systems (Mora, 2014, p. 121).

Employees are an integral part of CI; hence training, change management and developing employee commitment and communication are key in lean management (Coetzee, van der Merwe & van Dyk, 2016, pp.79-80).

CI includes continuous learning, participation and involvement of all employees in the organisation, ability to identify new opportunities, create space for all employees to share ideas and empower them to test and experiment their ideas (Mora, 2014, p. 124). CI opens up new opportunities and encourages continuous learning by empowering employees and stakeholders to be creative and to innovate through experiments.

Some of the qualitative benefits include improvement in productivity, cycle times, product or service quality, lead time and equipment effectiveness (Bhamu & Sangwan, 2013, p. 877). CI as a lean imperative is critical for the overall performance of the organisation including quality and productivity. It creates space for proactive ways of resolving bottlenecks and business risks that hinder production and customer satisfaction.

2.11.2.6 Poka-yoke

Lazarevic, Mandic, Sremcev, Vukelic and Debevec (2019, p. 454) argue that mistakes are inevitably part of any business environment and that companies are striving for quality in their production processes by reducing mistakes in order to maintain their competitive edge. Poke-yoke, sometimes referred to as mistake proofing, is a Japanese improvement strategy to prevent defects arising from the production processes. Kumar, Dwivedi and Verma (2016, p. 363) define Poka-yoke as a preventative approach which seeks to identify and eliminate variations that could cause defects in the production processes. Poka-yoke places emphasis on preventing defects at source and is an important CI strategy.

Kumar et al. (2017, p. 363) argue that to remain competitive in the market, organisations must adopt new strategies and catalytic technological advances that seek to eliminate defects in the production processes. Defects are a waste of time and money and must be avoided at all cost. Poka-yoke is a technological solution that avoids mistakes before they are made, or makes it easier to identify them. Technological solutions are a key components of the fourth industrial revolution, which allows for catalytic technologies such as Artificial Intelligence (AI) to transform operations, and as argued by the World Economic Forum (2018, p.7), artificial intelligence relies largely on machine learning through the Internet of Things and can provide a context to collect and analyse historical data in order to make certain predictions in relation to infrastructure development, revenue management and maintenance.

As described by Prester et al. (cited by Lazarevic et al., 2019, p. 454), using technological tools can help minimise mistakes by detecting sources of abnormalities, hence Poka-yoke.

2.11.2.7 Value stream mapping

Gupta and Jain (2014, p. 245) define Value Stream Mapping (VSM) as a graphical tool which analyses production work-flows in order to identify value adding and non-value adding steps and activities in the production process. It observes information and material flow in all the production processes and summarises that data in order to forecast the future state of the production processes and to ensure improved performance (Manjunath, Shivaprasad, Keerthesh Kumar & Deepa, 2014, p. 477). One of the benefits of VSM is to reduce lead time, waiting times and the flow of material and information,

highlighting opportunities to improve the production processes (Singh, Singh & Garg, 2015, p.9). VSM guides improvements, communication, transactional mismatches and inefficiencies in the production process (Manjunath et al., 2014, p. 477). VSM does not only highlight non-value added activities or process inefficiencies, it also provides guidance on the areas that need improvement (Singh et al., 2015, p.9).

2.11.2.8 Material requirement planning

According to Gupta and Jain (2013, p. 246), Material Requirement Planning (MRP) is a tool that uses the production requirements to develop a schedule of raw material required for production. This is linked to the JIT lean principle, as materials are driven by demand. MRP is a technique to plan and control inventory and it consists of three components: bills of materials, master production schedules and inventory files of different components of the material that will be needed to produce a final product (Sarkar, Das, Chakraborty & Biswa, 2013, p.58).

Gupta and Jain (2013, p. 246) argue that any inaccuracies in material planning can halt production, leading to a decrease in human and machine productivity, and MRP ensures that inventory requirements are estimated correctly (Rajeev, 2008 cited in Gupta & Jain, 2013, p.246). This will inform the JIT material orders and deliveries.

2.11.2.9 Jidoka

Jidoka has two pillars: building quality in the production and manufacturing process and intelligent or autonomous automation (Deuse, Dombrowski, Nhring, Mazarov & Dix, 2020, p.4). Jidoka is a lean management technique that entails highly automated systems and design principles, and it seeks to separate machine cycles from human activities creating space for employees to operate and manage multiple machines (Romero, Gaiardelli, Powell, Wuest & Thurer, 2019, p.900). This means that with limited human capacity, employees can multi-task and ensure that production is running efficiently. The purpose of Jidoka is to create control cycles to monitor the production or manufacturing processes in order to identify defects (Deuse et al., 2020, p.5).

It is a device in the machine that uses sensors to autonomously detect any abnormality and provide feedback. It allows for the machine to stop on its own to correct the abnormality or send a warning signal to the operator. According to Deuse et al. (2020, p.5), the automated stop in the production processes as a result of a defect does not only minimise waste; it further allows employees to monitor multiple production processes

simultaneously. Stopping the process automatically puts pressure on employees or operators to act and assist in creating faultless production processes. Jidoka has evolved with Information and Communication Technology from the first industrial revolution and is currently embracing the fourth wave of the industrial revolution. According to Romero et al. (2019, p.900):

> "currently, with the emergence of the Industry 4.0 technologies (viz. IoT, CPS, Edge), a Fourth Generation Jidoka Systems, or 'Jidoka 4.0 Systems', has started to arrive on the shop floors characterised by diverse software and hardware components such as sensors, actuators, controllers and advanced analytic capabilities able now to early-detect and diagnose a problem, and in some cases correct it before it actually occurs."

From the above it is clear that water is a universal challenge and that interventions are necessary to conserve this scarce resource and manage the demand.

2.12 SUMMARY

This chapter surveyed the relevant literature on water management exploring global, national and district contexts. There is general consensus that water is a scarce resource that must be managed properly. Globally water demand exceeds the supply. Challenges in relation to water management range from poor water quality, high water losses due to leaks and ageing infrastructure, poor infrastructure maintenance, climate change and greenhouse warming; hence a concerted effort from all stakeholders is required to conserve and manage the demand. Literature on lean management revealed tools and techniques that can be used to transform water utilities. These tools have been used largely in the private sector and companies such as Toyota that have adequately and properly implemented these tools have managed to transform their organisations. Lean management principles as discussed, present benefits for the public sector and can be adopted by WSA to help address water challenges and manage water as a scarce resource more successfully. The next chapter will provide a detailed analysis of the research methodology that was used in conducting this research.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter provides a detailed analysis of various elements of the research methodology that were used in conducting the research. The research paradigm, research approach, sampling design and sampling technique, how the respondents were recruited, data collection, data quality, data reliability, data validity and ethical considerations, are all covered.

3.2 METHODOLOGY OF THE STUDY

3.2.1 Research Paradigm

There are three types of research paradigm, interpretivism, positivism and critical social science. Considering that the research was based on a qualitative research design, the interpretivism research paradigm was adopted. Interpretivism is based on the belief that social reality is highly subjective as it is constructed on individual perceptions (Collis & Hussey, 2009, p. 56). It is emphasising “meaningful” social action, socially constructed meaning, and value relativism” (Neuman, 2011, p. 101). Interpretivism is about constructing a world view using multiple perspectives.

According to Collis and Hussey (2003, p. 57), contrary to interpretivism, positivism seeks to discover theories based on scientific and empirical research and is constructed on the belief that social reality is independent of individual perceptions. According to the positivism paradigm, knowledge is drawn from ‘positive information’ due to the belief that any rationally justifiable assertion must be based on scientifically verified information and must be logical with mathematical proof (Collis & Hussey, 2003, p. 57). Positivism relies heavily on experiments, standardised tests, surveys using closed ended questionnaire, and the numerical data generated using any of these methods is subjected to descriptive and inferential statistical analysis (Rehman & Alharthi, 2016, p. 54). Positivism relies only on quantifiable observations that can be statistically analysed to draw conclusions in a way that is trustworthy. The role of the researcher in a positivism paradigm is limited to data collection and interpretation in order to draw conclusions that are reliable and allow for generalisation or inferential data.

Critical social science, which is another research paradigm is understood as “emphasising combating of surface-level distortions, multiple levels of reality, and value-based activism for human empowerment” (Neuman, 2011, p. 108). According to Henning (2004, p. 23), critical theory seeks to promote critical consciousness, and eliminate oppressive ideologies and social inequalities by breaking down the institutional arrangements that produced those ideologies.

3.2.2 Research Approach

According to Hancock (2002, p. 6 cited in Salvador, 2016, p. 111), a case study can be used in both qualitative and quantitative research. It is defined as an exploration of a subject matter (Salvador, 2016, p.111). The research adopted a case study approach in a form of a bounded organisation which was Harry Gwala District Municipality. Empirical evidence suggests that restricting the scope of a case can prevent the researcher from going too broadly and becoming unfocused in the research (Yin, 2003; Stake, 1995 cited in Maree, 2016, p. 82). The study analysed water management by examining the current practices and deficiencies that are hindering its success. Considering that the study was based on a qualitative research method, an interpretive approach, which is associated with inductive reasoning (qualitative), was used.

Secondary data was used to corroborate and to contrast the views of the respondents. This was useful in ensuring the validity and trustworthiness of the findings.

3.2.3 Population

The population was composed of Senior and Middle Managers at the Harry Gwala District Municipality.

3.2.4 Sampling Unit

This comprised individual Senior and Middle Managers at Harry Gwala District Municipality.

3.2.5 Sample

Senior and Middle Management at Harry Gwala District Municipality were chosen as a sample based on the judgmental sampling technique. According to Jawale (2012, p. 188), judgmental sampling allows the researcher to select items considered as representative of the population. The employees identified had in-depth understanding of the different variables of the research study and were involved in water provision at Harry Gwala District Municipality. They had experience in their positions and were deemed to be experts in their fields. They were knowledgeable about the current operations and provided credible insights. Though the respondents were identified during in-depth personal interviews, they were not identified by name. The interview guide did not require their personal details, which means that their responses remained anonymous.

Secondary data was collected from secondary sources, the approved budget and the audited AFS. The budgets were approved by Council and the AFSs are audited by the Auditor General South Africa.

3.2.6 Sample Size

Twelve respondents were interviewed. The key employees selected as respondents worked in various departments, with the majority being in the Water Services and Infrastructure Departments. They were responsible for certain key performance areas that are critical in the provision of water. The participants were chosen because of their experience in the water and municipal sector and were indeed knowledgeable about the current state of water in the District. Maree (2016, p. 83) points to the importance of data saturation to achieve excellent qualitative work.

The sample size was largely determined by the research questions in terms of what the researcher wanted to know. Maree (2016, p. 84) agrees that sample size is dictated by the purpose of the enquiry, what is at stake, what will be useful, credible, timeous and low cost. Bertaux (1981 cited in Maree, 2016, p. 84) argues that fifteen is the smallest acceptable sample size in qualitative research, whilst Guest, Bunce and Johnson (2006, p. 74 cited in Maree, 2016, p. 84) argue that in their studies data saturation occurred after 12 interviews. Other researchers argue that even a sample of four individuals can

produce good results with a confidence interval of .999. For the purposes of this research twelve respondents were interviewed.

The secondary data was based on the analysis of fourteen sets of approved budgets and audited AFSs representing data accumulated over 144 months. The following variables were assessed - capital expenditure to total expenditure, collection rate, current ratio, repairs and maintenance as a % of the property plant and equipment total and water distribution losses.

3.2.7 Sampling Technique

A judgmental sampling technique which falls under the non-probability sampling method was used. According to Collis and Hussey (2009, p. 213), in a judgmental sampling technique, respondents are selected based on their experience in relation to the phenomenon under investigation. Judgmental sampling allows the researcher to make informed decisions about the respondents to be surveyed before the commencement of the study and does not allow for further respondents during the study (Collis & Hussey, 2019, p. 213). The reason for choosing a judgmental sampling technique is that the required respondents were those carrying the responsibility of water management processes, providing leadership and those tasked with providing support services to ensure successful water management at Harry Gwala District Municipality. The respondents had knowledge and experience on water management, financial management, budgeting and monitoring expenditure on water provision. The targeted respondents all worked for the District Municipality whose main function is to provide an uninterrupted supply of water throughout the District.

3.2.8 Recruitment Strategy

A list of targeted employees was developed using a judgmental sampling technique. A gatekeeper letter was granted by the Municipality. After the gatekeeper letter and ethics approval, appointments were made with all the identified respondents. Several respondents preferred online interviews instead of face-to-face interviews due to COVID-19. During the interviews, information was shared with all the respondents including the written information given to participants before participating and the informed consent form. This information was presented to all the respondents, clearly outlining the details of the research, voluntary participation, confidentiality and anonymity.

3.3 DATA COLLECTION

Information was collected from eight respondents through in-depth online Zoom interviews and four respondents using face-to-face interviews. There are different methods of collecting primary data from respondents such as group administration of questionnaires, postal or email surveys and face-to-face surveys. Other methods include focus groups, observations, protocol analysis and critical incident analysis. For the purposes of this research, primary data was collected from the respondents using online and face-to-face interviews. Maree defines face-to-face interviews as a process where the interviewer asks respondents questions and records the responses (2016, p. 177). In this process "a long questionnaire can be used" and the interviewer can assist the respondent with any issue that may be unclear during the interview session (Maree, 2016, p. 177). Noting the risks associated with interviewer bias, the information collected was corroborated and contrasted with the secondary data.

A descriptive statistical analysis was based on information drawn from the budget and audited AFSs, therefore secondary data analysis. This analysis covered capital expenditure to total expenditure, water losses, repairs and maintenance and current ratios. The selection of documents was informed by the research questions.

3.4 QUALITY OF DATA

From a positivism perspective "high-quality data are reliable and valid; they give precise, consistent measures of the same objective'" and from the interpretivism point of view "instead of assuming one single, objective truth, members subjectively interpret experiences within a social context" (Neuman, 2011, p. 454). Based on interpretivism, high quality data is about understanding and capturing diverse viewpoints and experiences systematically (Neuman, 2011, p. 454). According to Wegner (2016, p. 9) data quality is influenced by the type, source, data collection method and analysis.

Information was also drawn from the approved budgets and audited AFSs to corroborate qualitative research findings and providing assurance that the quality of data is good and credible. Qualitative data was sourced from twelve respondents and due care was exercised in analysing that data, as themes and categories were formed. The selection of Senior and Middle management was also informed by the desire to get quality and credible responses.

3.4.1 Data Reliability

Reliability refers to how accurately an empirical measure reflects the real meaning of the concept under study (Babbie. 2014, p. 154). Neuman (2011, p. 455) differentiates between internal and external consistencies. Internal consistencies are defined as data that is credible with no human deception and external consistency refers to data verification against divergent sources (Neuman, 2011, p. 455). He further argues that reliability includes what is not being done but is expected. Reliability depends on insight, level of awareness and the type of questions asked and as argued by Neuman (2011, p. 455), to check credibility the researcher must assess if the respondent has any reason to lie, whether he or she is knowledgeable about the phenomenon under research and how the respondents' values are likely to shape their responses.

The respondents had no reason to lie as they occupy positions of leadership, are experts in water provision and have in-depth knowledge about the phenomenon under investigation. Reliability looks at the measurement tool used, and in this case an interview guide was used which ensured stable and consistent results (Carmines and Zeller, 1979 cited in Taherdoost, 2016, p.33).

The questions in the interview guide were interlinked and iterative making it easier to identify inconsistences in the responses. Furthermore, the same questions were asked of respondents who work in the same environment, organisation and departments and who are experts in their field. The respondents had a minimum of two-years' experience in the water sector. The number of respondents and the positions held were chosen to ensure high levels of reliability of the findings. Golafshani (2003 cited in Olabode, Olateju & Bakare, 2019, p.30) points to consistency of sampled research results over time and the accurate representation of the population under study.

Furthermore, respondents' subjectivity was considered in ensuring reliability of information. About twelve respondents were interviewed, the majority being in the same Departments. The number of respondents was to ensure reliability in terms of the responses, and to be able to identify responses that could potentially be different from other responses. According to Olabode, Olateju and Bakare (2019, p.30), to ensure internal reliability, a researcher will use as many repeat sample groups as possible in order to minimise unusual sample groups that could potentially create unwarranted outliers and subsequently skew the research findings. For example, if three groups

replicate samples for each analysis, and one generates completely different results from the others, then there may be something wrong with the data collated.

The secondary data analysis as a technique to corroborate qualitative research findings, was based on the secondary data, inclusive of approved budgets and audited AFSs. AFSs were audited by the Auditor General and are deemed to be credible and reliable.

3.4.2 Data Validity

There are four types of validity as stated by Taherdoost (2016, p. 29): criterion validity, face validity, content validity and construct validity. The researcher used face validity and content validity. Validity explains the closeness of the collected data to the actual area of investigation (Ghauri and Gronhaug, 2005 cited in Taherdoost, 2016, p. 28). Validity "measures what is intended to be measured" (Field, 2005 cited in Taherdoost, 2016, p.28).

In assessing face validity, the researcher drafted an interview guide to ensure that questions were relevant to the research questions, readable and consistent. Face validity includes the feasibility, readability, consistency of style and formatting of the questionnaire, as well as the ease of understanding the language (Taherdoost, 2016, p.29). Content validity "involves evaluation of a new survey instrument in order to ensure that it includes all the items that are essential and eliminates undesirable items to a particular construct domain" (Lewis et al., 1995; Boudreau et al., 2001 cited in Taherdoost, 2016, p.30). In line with the judgemental approach, content validity involved literature reviews, drafting of the interview guide and interviewing the experts. The questions were clear, readable and the interview style was the same throughout the research. The questions in the interview guide were reasonable and relevant to the research problem and research questions.

In conclusion, Guba (in Shenton, 2004, p. 63) proposes four key constructs that must be considered by qualitative researchers to ensure trustworthiness of the research:

a) Credibility (in preference to internal validity);

b) Transferability (in preference to external validity/generalisability);

c) Dependability (in preference to reliability);

d) Confirmability (in preference to objectivity).

Table 3.1: *Validity Criteria*

Construct	Provision made by researcher
Credibility	Adoption of appropriate, well recognised research methods Development of early familiarity with culture of participating organisations Random sampling of individuals serving as informants Triangulation via use of different methods, different types of informants and different sites Tactics to help ensure honesty in informants Iterative questioning in data collection dialogues
Transferability	Provision of background data to establish context of study and detailed description of phenomenon in question to allow comparisons to be made
Dependability	Employment of “overlapping methods” In-depth methodological description to allow study to be repeated
Confirmability	Triangulation to reduce effect of investigator bias Admission of researcher’s beliefs and assumptions Recognition of shortcomings in study’s methods and their potential effects

Source: Shenton (2004)

Data was collected from the employees of the Municipality, who are involved in the day to day running of the municipality. The researcher works in the same municipality and was familiar with the culture of the participating organisation whilst being mindful of creating a space for the respondents to be honest in their approach. Triangulation was done by reviewing relevant literature (Chapter 2) and documents from the Municipality. Also, the interviews with twelve respondents sought to achieve triangulation. Shenton (2004, p.66) argues that individual inputs can be confirmed against others to establish a more credible picture about those under scrutiny. Respondents as part of the consent form and information shared before the interview, were informed that their participation was entirely voluntary, and they had the right to withdraw from the study. This was done to ensure that data collection involves only those that were willing to participate. The respondents were also requested in the same documents to be honest in their responses.

3.5 ETHICS CLEARANCE

The researcher went through a rigorous process of applying for ethics clearance from the Nelson Mandela Business School. The ethics approval was granted on 1st of October 2020. In order to comply with the ethics considerations in the approved ethics clearance, a gatekeeper's letter was sought and granted by Harry Gwala District Municipality. In fulfilling the requirements of the study, all prospective respondents, selected using a judgemental sampling technique, were informed that their participation in the research study was voluntary and they reserved the right to withdraw from the study.

The information sheet was presented to the respondents prior to the commencement of the interview. The information sheet provided details about the nature of the study, its objectives and the contact details of both the researcher and the supervisor to allow the respondents to confirm the validity of the research.

Prospective respondents were further presented with the informed consent forms covering confidentiality and anonymity. No respondent names were required on the interview guide. The interview guides were given unique numbers as names of the respondents were not required in the questionnaire. All the respondents had signed consent forms as proof that they agreed to participate voluntarily in the research.

3.6 SUMMARY

The research was done using a qualitative research approach which relied on the interpretivism research paradigm. Respondents were selected using the judgemental technique. Every endeavour was done to ensure quality data in terms of data validity and data reliability. The next chapter, chapter 4, will present the research findings in relation to the research questions.

CHAPTER 4: DATA ANALYSIS AND PRESENTATION OF RESULTS

4.1 INTRODUCTION

This chapter presents the data analysis and findings about the role of lean management principles in achieving successful water management with a focus on the Harry Gwala District Municipality. The study sought to examine the role played by lean management principles in promoting successful water management at the institution. To achieve this goal, the study adopted a thematic analysis with the aid of NVIVO version 10 in analysing the qualitative data. The qualitative data analysis process started with the transcription of interviews followed by the determination of main themes and subthemes from the interviews. The code labels were then assigned to the main themes to aid the researcher in triangulating the study findings with the previous literature. Secondary data analysis as a tool to corroborate qualitative research findings was done using secondary data in the form of the approved Municipal Budget and the audited AFSs. The descriptive analysis was aimed at comparing the different financial and budgeting ratios under investigation. The information was analysed and presented using tables and graphs. Below are the research questions:

I. Is the municipal financial planning geared towards successful water management?
II. What is the condition of water infrastructure and how are water production processes structured?
III. What are the strategies implemented by the municipality to address water conservation and demand management?
IV. Describe the current human resource capacity and how the organisational culture is responding to successful and lean water management and lean management in the provision of water?

4. 2 DATA ANALYSIS AND PRESENTATION OF QUALITATIVE RESULTS

4.2.1 Descriptive Statistics - Demographic Analysis

In this study, 12 participants who held various leadership positions from the Harry Gwala District Municipality, were interviewed. The distribution of study participants by various demographic characteristics are shown in the following subsections.

The study sought to determine the distribution of employees with respect to gender. This information was considered as it helps management to evaluate the importance of gender participation in the implementation of lean management principles in the municipality. Table 4.1 below shows the distribution of the participants by gender.

Table 4.1*: Distribution of Participants by Gender (N=12)*

	Frequency	Percent	Valid Percent	Cumulative Percent
Male	7	58.3	58.3	58.3
Females	5	41.7	41.7	100.0
Total	**12**	**100.0**	**100.0**	

Source: Author's compilation from IBM SPSS Statistics v25

Age distribution was used to determine the age group which had greater participation in the study. Determining the age distribution would assist in projecting the composition of middle and senior management at the HGDM who implemented the lean management principle for successful water management. The distribution of the participants by age is illustrated in Table 4.2 below.

Table 4.2: *Distribution of Participants by Age (N=12)*

	Frequency	Percent	Valid Percent	Cumulative Percent
35 - 39 years	2	16.7	16.7	16.7
40 - 44 years	5	41.6	41.6	58.3
45 - 49 years	3	25	25	83.3
60 years and above	2	16.7	16.7	100.0
Total	**12**	**100.0**	**100.0**	

Source: Author's compilation from IBM SPSS Statistics v25

The results in Table 4.2 show that 16.7% of the study participants were between 35 and 39 years of age and another 41.6% of the participants were between 40 and 44 years of age. The results also show that 25% of participants in the study were between 45 and 49 years, and 16.7% of the study participants were 60 years or above. These results

indicate that most of the middle and senior management employees at HGDM who participated in the study, are aged between 35 and 44 years.

The study sought to determine the educational qualifications of the middle and senior management at HGDM. The job requirements in terms of qualification are increasing day by day especially for management positions. Table 4.3 below shows the distribution of participants by their highest educational qualifications.

Table 4.3: *Distribution of Participants by Educational Qualifications (N=12)*

	Frequency	Percent	Valid Percent	Cumulative Percent
Diploma	3	25.0	25.0	25.0
Degree	9	75.0	75.0	100.0
Total	**12**	**100.0**	**100.0**	

Source: Author's compilation from IBM SPSS Statistics v25

The results in Table 4.3 indicate that of the 12 sampled middle and senior management employees, 25% of them were diploma holders while 75% were bachelor's degree holders and none of the sampled participants had a PhD. The results show that most of the employees in middle and senior management positions at Harry Gwala District Municipality were graduates with degrees.

Table 4.4: *Distribution of Participants by Section worked under (N=12)*

Department	Frequency	Percent	Valid Percent	Cumulative Percent
Finance	1	8.33	8.33	8.33
Infrastructure Services	3	25	25	33.33
Water Services	7	58.33	58.3	91.63
Corporate Services	1	8.33	8.33	100.0
Total	**12**	**100.0**	**100.0**	

Source: Author's compilation from IBM SPSS Statistics v25

These respondents were chosen based on the judgmental sampling technique which was largely driven by the fact that the research is about successful water management; hence the majority of the respondents (58.33%) came from the Water Services Department. The Water Services Department is responsible for Planning and Design of Water Infrastructure, Operations and Maintenance of Infrastructure and Water Governance which is responsible regulation, compliance, by-law enforcement and customer care. One quarter (25%) of the respondents were from the Infrastructure Department which is responsible for project implementation and serves as an implementing agent for Water Services Department. One (8.33 %) of the respondents was from the Financial Services Department. The Department deals with budget processes and reporting, which is inclusive of the preparation of budget monitoring reports and the Annual Financial Statements. The Corporate Services Department is responsible for Human Resources, Skills Development and Information and Communication (ICT) with 8.33% of the respondents.

The race grouping of the study participants was also investigated, and the results are presented in Table 4.5 below.

Table 4.5: *Distribution of participants by race (N=12)*

	Frequency	Percent	Valid Percent	Cumulative Percent
Black African	12	100.0	100.0	100.0

Source: Author's compilation from IBM SPSS Statistics v25

The sample findings in Table 4.5 show that of the 12 participants in the study, all (100%) of them were black Africans. This finding shows that the Municipality prioritises employees of the black African race in their middle and senior management positions.

4.2.2 Thematic Analysis of the Qualitative Research

Thematic analysis (TA) is one of a cluster of analytic approaches used to identify patterns of meaning across a qualitative dataset. The widely used version of TA outlined in this chapter is fairly unique in the canon of qualitative analytic approaches in that it offers the researcher analytic tools to make sense of data.

Table 4.6: *Thematic Analysis*

Process	No.	Criteria
Transcription	1	The interview data was transcribed to an appropriate level of detail, and the transcripts were checked for consistency and accuracy against the tapes
Coding	2	Each data item has been given enough attention in the coding process
	3	Themes have been generated from a thorough, inclusive and comprehensive coding process
	4	All relevant excerpts for each theme have been collated
	5	Themes have been checked against each other and the original data set
	6	Themes are internally comprehensible, consistent, and distinctive
Analysis	7	Data have been analysed, interpreted and made sense of
	8	Analysis has been matched with the interview data to illustrate the analytic claims
	9	Analysis gives a substantial story about the topic
Overall	10	Enough time has been taken to complete all stages of the data analysis adequately
Written report	11	The assumptions about thematic analysis are clearly explained
	12	The method and reported analysis are consistent
	13	The researcher is placed as active in the study process and themes do not just ‘emerge’

Table 4.7 below shows the assigned interviewee names (pseudonyms) that were used in the study with respect to the interview order.

Table 4.7: *Participant Pseudonyms*

Name	
Interviewee 1	LM01
Interviewee 2	LM02
Interviewee 3	LM03
Interviewee 4	LM04
Interviewee 5	LM05
Interviewee 6	LM06
Interviewee 7	LM07
Interviewee 8	LM08
Interviewee 9	LM09
Interviewee 10	LM10
Interviewee 11	LM11
Interviewee 12	LM12

Table 4.8: *Themes*

Item	Sources	References
Efficiency of the production processes	0	0
B1. Implementation and maintenance of water projects	0	0
Successes		
Failures		
Factors contributing to failure in the implementation and maintenance	0	0
B2. Structure of the production processes		
B3. Waste elimination strategies		
B4. Procurement and storage of materials		
Procurements of materials		
Storage of water materials		
B5. Addressing water quality and water losses		
B6. Production processes and water interruptions		
Attending breakdowns		
Recording breakdowns		
Water conservation and demand management	0	0
C1. State of water metering infrastructure		
C2. Conserving water and managing demand		
Water conservation		
Demand management		
Human resources and organisational development	0	0
D1. Adequacy of the workforce		

D2.1. Workforce discipline D2.2 Workforce productivity D3. Leadership and organisational culture Innovation Successful water management		

Source: Author's compilation from NVIVO 10

4.2.3 Efficiency of the Production Processes

Water production processes were analysed using information received from the respondents in relation to eight questions that were carefully crafted to give an indication of the state of water infrastructure and how the production processes at Harry Gwala District Municipality are structured.

4.2.3.1 Subtheme 1: Implementation and maintenance of water infrastructure

All the respondents (100%) agreed that there are successes that have been achieved by the municipality in the implementation and maintenance of water infrastructure. Respondents further acknowledged the improved infrastructure coverage and access to water in both urban and rural areas that previously did not have access.

In relation to the failures, 83.33% of the respondents revealed that poor planning, project management and monitoring during implementation of water projects are some of the major challenges in project implementation and management at Harry Gwala District Municipality. The study revealed that the municipality has several small and localised water schemes with no tap water due to poor planning. LM07 is quoted verbatim:

"When implementing water projects, you start from abstraction to purification and then to reticulation, but at Harry Gwala District Municipality, the implementing department starts anywhere, sometimes they start with reticulation and reservoirs before confirming the adequacy and sustainability of water sources."

The municipality does not look at the adequacy of water sources to sustain its water projects; hence some of the schemes were reportedly dysfunctional and partially functional. The study revealed that this often leads to the communities vandalising the infrastructure because there is no value derived from that infrastructure investment.

The study also revealed that the implementation of water projects takes too long to complete due to the complexity of infrastructure required and variations in the different

assets that are required to complete a scheme; moreover incompetent contractors exacerbate the situation.

According to LM02 this means that "*at the time the project is finally completed, the pipes have been underground for too long, and the defects in the process of implementation are not able to be detected early enough because of the time it takes to complete the project."* With that infrastructure not being utilised, the municipality is not deriving any benefit and at the time the asset is brought into operation, it is technically old resulting in leaks and breakdowns and costing the municipality money to repair and maintain, owing to poor project implementation and monitoring.

LM04 stated that:

"Most of the projects that we implement are not completed on time resulting in high project overruns."

The majority of the respondents questioned the competency of contractors entrusted with the responsibility of implementing these projects. LM04 pointed out that:

"Water projects are not easy; they are one of the most complicated areas of engineering that require really committed and competent people to construct."

Almost half (41.7%) of the respondents cited the appointment of service providers without experience. Respondents LM11 and LM05 argued that due to a lack of experience, consultants and the contractors fail to provide accurate and credible project costing which further compromises the quality of projects and resulting in incomplete projects.

Inadequate resources (human resources and funding) was raised by 75% of the respondents as another major challenge in the implementation and maintenance of water projects. Respondent LM06 said that:

"*There is a shortage of staff or personnel. Our teams are overstretched and employees end up running around and not being effective."*

LM03 revealed that:

"The funding stream that we are getting from national government and also what we are collecting from our customers is not sufficient for us to implement bulk projects."

One third (33%) of the respondents revealed that the infrastructure at Harry Gwala District Municipality is ageing and dilapidated. The study revealed that the state of infrastructure results in continuous pipe bursts, water leaks, water losses and wastage, creating an

undesirable position for a municipality that has financial and human resources constraints.

LM04 expressed this verbatim:

"The other failure that we have, is ageing infrastructure, most of the infrastructure is dilapidated, especially in urban areas, where you find that the system does not cope with the demand, the infrastructure is quite stressed, because the demand is very, very high." Ageing infrastructure requires replacement especially if it has reached the end of its useful lifespan. Replacing ageing infrastructure also requires funding; hence budgeting for impairment of assets is necessary for the municipality.

The majority of the respondents (67%) revealed that there is poor maintenance of water infrastructure at Harry Gwala District Municipality. Budgetary constraints were cited as one of the reasons contributing to poor maintenance. Respondents revealed that the district is vast, making it difficult to manage and supervise employees who are expected to operate and maintain water infrastructure. The movement between the localised schemes is costly in terms of the deployment of resources such as personnel (employees and security guards).

The municipality does not have infrastructure maintenance systems in place to provide breakdown alerts. One respondent cited lack of technological infrastructure such as leak detectors, sensors of water levels and pressure management tools as the municipality is still far behind in terms of the fourth industrial revolution. The study revealed that the municipality has developed maintenance plans though they have not been implemented by the municipality yet and as such there are no routine or scheduled maintenance activities. LM02 said verbatim:

"*The municipality is performing maintenance on a reactive basis, rather than on a preventative approach, resulting in a poor state of project maintenance."*

4.2.3.2 Subtheme 2: Structure of the production processes

All the respondents (100%) understood the production processes broadly as being composed of three major stages: abstraction, purification or treatment and distribution to consumers. The study revealed that water is abstracted raw directly from the rivers, dams and weir to the WTP. This is done using high capacity pumping systems or gravity feed depending on the topography of the area. The municipality uses both electric pumps

where there is electric power and diesel pumps where there is no electric power. Water goes through the flocculation process, sedimentation, clarification and filtration processes at the WTP before it reaches clear water reservoirs. It is then distributed to consumers. At certain intervals water samples are taken for assessment. The findings of the study revealed that the conventional system lacks the technological and automated systems to manage these processes efficiently and as a result depend on human capacity.

In purifying water, 75% of the respondents confirmed that the municipality is using both the conventional system and package plants, except for water drawn from the boreholes and springs which falls under the rudimentary programme. The conventional system refers to a combined systematic layout design process of water purification that encompasses mixing, flocculation, sedimentation, filtration and disinfection. Each component of the process is designed to take larger volumes of processed raw water. Package plants are smaller water treatment facilities with pre-manufactured installation that may not necessarily cover the full conventional water treatment process. They may not be centralised or fixed in one position as it may be necessary to dis-assemble the structure and reposition. According to the respondents these are efficient systems for a rural water scheme.

The findings of the study also revealed that the municipality uses both surface and under-ground water, as the main sources of water supply. Surface water entails rivers, dams and springs. Underground water is in the form of boreholes. LM10 pointed that the municipality is not implementing boreholes correctly, as boreholes cannot be pumped continuously without an allowance for the water table to recover.

LM03 indicated that:
“Boreholes are located all over the district and you can appreciate that it can be very difficult for the municipality to make sure that in every station of the district we have dedicated personnel to look after each and every borehole.”

Water abstracted from the dams and rivers should be able to provide an uninterrupted supply of water; however, the study revealed challenges that are a hindrance to that.

Some of these hindrances include inadequate water resources and illegal connections especially in rural areas.

LM01 said verbatim:

“inadequate water resources negatively affect the production processes; water is scarce, and we are unable to abstract enough water that we can supply to our consumers.”

Throughout these three major water purification stages as discussed above, there are often mechanical interruptions, electrical and mechanical breakdowns. One respondent, LM07, indicated that:

“*Due to limited resources, in many abstraction points the municipality does not have standby generators, if a pump fails there is no alternative to keep the system running.”*

The supply is then reinstated when the pump has been repaired. If there is no pumping, that means the entire team at the WTP will stand idle, a wasted resource in terms of time and money.

The findings of the study revealed that there are illegal electricity connections as well in the municipal Transformers, as well as theft of water assets and electrical cables from the Municipality’s pump stations, especially in the remote rural areas. This challenge does not only affect water supply in terms of interruptions; it increases the cost of electricity, asset replacement and repairs.

4.2.3.3 Subtheme 3: Waste minimisation strategies

In relation to strategies to minimise waste in the municipal production processes, 50% of the respondents pointed out that there are no strategies to minimise waste at Harry Gwala District Municipality and 50% of the respondents agreed that there is no strategy but appreciated some adhoc activities implemented by the municipality to reduce waste.

Half (50 %) of the respondents who believed that the municipality does not have a strategy cited reactive maintenance on water infrastructure due to funding constraints, water losses owing to an insufficient metering system and internal deficiencies in the management of inventory. One respondent, LM02, said verbatim:

“Leaks do contribute to a lot of waste in terms of chemical usage to treat water and electricity.”

The findings of the study showed that the municipality does not have by-law enforcement officers to manage illegal connections. The study revealed that illegal electricity connections to the transformer by some consumers result in the municipality absorbing a higher electricity bill. Respondents raised the issue of poor recycling in the production processes, especially of backwashed water due to a lack of infrastructure. The study

revealed that the production processes are not highly automated; and time and effort are wasted performing activities that can be done using technology.

4.2.3.4 Subtheme 4: Procurement and storage of material

Most (75%) of the respondents agreed that the materials for operating and maintaining water infrastructure and the procurement of chemicals for water purification are procured using the municipal Supply Chain Management processes. The respondents further pointed out that the municipality has two to three-year contracts with three suppliers for material and chemicals. The study revealed that there is no standardised procedure on how to order and replenish the material. This is left to the discretion of the Satellite Managers. One respondent, LM07, indicated that:

"*When making orders, we sit with all the Plumbers and the Senior Process Controllers, we make a list of material that we need. We order what we are going to use for a period of three months."*

All the respondents (100%) raised lack of proper storage for material as a major challenge. The study revealed that the municipality does not have central command stores, where all the material is received and dispatched to the relevant sites. The material is ordered by the user department from the annual contracts and the material is also delivered by the service provider to the user department.

LM03 said verbatim:

"*We are really bad in terms of storage. We must make sure that there's storage and put systems in place to safeguard the material."*

LM10 further said that:

"*Where I have a serious issue is the material for plumbing. I think we need to do something about it. I don't think it is managed well. At Harry Gwala, I could go and order material and take it home and nobody will know and for me we cannot have a system like that. I look at the invoices we sign off; it is quite a lot of money and it needs to be managed well."*

The study revealed that it is difficult for the Satellite Offices to issue the material due to inadequate capacity, while there is no dedicated personnel to manage inventory. This study showed that inventory is managed on an adhoc basis by employees who are not qualified to perform inventory management activities. As a result of this capacity

deficiency, accountability on how the material or stock is received and dispatched remains a challenge.

Owing to poor storage facilities at Harry Gwala District Municipality, the study revealed that material is stored in the Satellite Offices which are located in some of the towns within the District. The respondents revealed that chemicals are stored in pump houses which are not safe storage facilities. This is done in order to minimise travelling from the Satellite Offices to these small localised schemes located in the vast rural area of Harry Gwala District Municipality and to improve the turn-around time. The participants further indicated that stock taking is not done, and that without a proper inventory management system in place to align job cards with the material dispatched, everything is done manually without any accountability.

4.2.3.5 Subtheme 5: Addressing water quality and water losses

With regard to water quality, about 66% of the respondents placed emphasis on taking water samples at certain intervals in order to assess the quality at the WTP and to ensure that water is compliant with the drinking water standards as prescribed in the SANS 241-1 of 2015. The respondents further pointed to the external support that the Municipality is receiving from Umgeni, a water board that has more infrastructure than the Municipality in terms of conducting water quality tests. The research revealed that the main challenge associated with using Umgeni Water for water quality tests is the distance from the Water Treatment Plants, located in different towns and villages of Harry Gwala District Municipality, to the Umgeni offices.

The research pointed to water quality tests that are also done by the Municipality's Development Planning and Social Services Department. This is done by the Environmental Health Practitioners in accordance with the National Health Act. During this process samples are taken at the consumer end point and not in the WTP. The findings of the study revealed that the water samples taken by the Municipality's Environmental Health Practitioners are not taken to Umgeni Water but to independent laboratories for testing, again due to a lack of infrastructure in-house to test all the components of water quality. The laboratories used by the Environmental Health Practitioners are also far from the District which affects the efficiency of performing this function.

The study further revealed that the Municipality does not have enough Process Controllers at the WTP, whose main responsibility is to purify water by administering chemicals and checking if the quality of water is safe for human consumption. The above notwithstanding, respondents acknowledged the significant strides that have been made by the Municipality since 2019 to employ qualified Process Controllers.

The findings of the study revealed that reliance on Umgeni Water for water quality is due to the fact that the Municipality does not have adequate equipment to test all the microbiological components listed in the SANS drinking water standards. This was confirmed by 41.7% of the respondents who raised the issue of a laboratory that should be owned by the Municipality in order to ensure that all the tests are conducted in-house and to allow for the implementation of the remedial actions should the results be above the acceptable range and minimise time wasted transporting water samples.

On water losses, respondents agreed that the Municipality is challenged in addressing water losses as a result of pipe bursts owing to ageing infrastructure and non-revenue water which is not adequately measured. There are two reasons that were cited by the respondents which are contributing to water losses at Harry Gwala; lack of technology and metering infrastructure. The majority (67%) of the respondents cited inadequate metering infrastructure in the form of bulk and domestic meters. There was a general appreciation from the respondents that the Customer Care Call Centre where leaks are reported and recorded, makes it easier for the Municipality to respond; however, the vastness of the area and inadequate capacity owing to vacancies in the organisational structure make it difficult to attend to water leaks timeously as a result of pipe bursts.

The findings of the study also revealed that leaks are common in a number of households which are billed on a flat rate or whose billing is based on estimations. These are largely unmetered households, or where meters are not functional, and customers are largely not paying their bills. Hence 67% of the respondents proposed smart meters for the consumers and bulk meters for the WTP. The respondents also commended the Municipality for the installation of smart meters in order to minimise water losses and increase revenue.

The research further revealed that the installation of smart meters controls consumption levels to the extent that consumers are cautious about their consumption levels which then minimise water losses. Research also revealed that credit meters in a number of areas have contributed immensely to water losses with increased consumption especially

by indigent consumers and in low income housing areas. These are largely consumers who cannot afford to pay for water consumed.

Moreover, the study revealed that the lack of technology in the municipal production processes to minimise water losses is a major challenge. LM02 said verbatim:

"*At the moment the municipality doesn't have technology to detect water leaks, as well as to detect water levels in the reservoirs."* LM02 further indicated that *"the municipality is lacking in terms of detecting water losses, the technology such as the telemetry will be the technology that is needed, had the municipality had adequate financial strength to acquire that technology."*

Only 25% of the respondents cited awareness campaigns and public education as a strategy used by the municipality to reduce water losses.

4.2.3.6 Subtheme 6: Production processes and water interruptions

Regarding attending to recording problems and attending to breakdowns, the results from the study showed that the Municipality has a Customer Care Centre which is responsible for recording all the customer complaints, including breakdowns in the production processes. Most of the respondents (91.6%) revealed that the Customer Care Centre has a system called Reasebetsa where all the complaints regarding breakdowns and water interruptions are recorded. The respondents mapped the process as follows:

A complaint is received by the Call Centre attendant. It is captured on the system. It is then assigned to the relevant Area Manager who assigns a plumber using a job card. The plumber then attends to the complaint and updates the system on progress. When the complaint has been completely attended to, the plumber must close the job card on the system. An automated message is then sent to the customer.

Most (91.6 %) of the study confirmed that the system is good, but its effectiveness needs to be improved. One third (33%) of the respondents cited that there is resistance from employees, especially the plumbers. The study revealed that this can be attributed to overtime which employees were previously claiming based on manual job cards. The system that is being used is able to record when the complaint was recorded, the time the plumber started working on it and the time it was finished. Since the system is automated, employees can no longer claim overtime fraudulently. The study revealed that supervisors can analyse time taken by the employees to attend to and complete a

job card. Such reports are available on the system in order to improve supervision and ensure efficiency and productivity in the work force.

In trying to establish the reason why employees are resisting using the system, LM02 said verbatim:

"*What did not happen from my own point of view is change management processes that should have been implemented by the municipality in terms of ensuring buy-in from those employees, because as we know, every time when there is a change, people will always resist change."*

4.2.4 Water Conservation and Demand Management

4.2.4.1 Subtheme 1: The state of metering infrastructure

The majority of the respondents (75%) agreed that the metering infrastructure at Harry Gwala District Municipality is inadequate. There was only one respondent (8.33%) who was of the view that the Municipality has a proper metering infrastructure.

The respondents cited areas that are not metered resulting in estimated billing which is not in line with the what the Municipal Systems Act dictates, that a service that is measured should by all means be measured when it is provided to the communities. More than half (58%) of the respondents cited that the meters at Harry Gwala are faulty and are not calibrated, because the Municipality does not have a meter management programme. As a measure for consumption, billing and as source of revenue the Municipality is failing to manage these critical assets.

The findings of the study indicated that consumers do not have adequate metering infrastructure and question the accuracy of the statement and the readings therein. This is more common because the majority of the metering infrastructure is still credit meters, where you consume water, and the Municipality takes the reading manually from the credit meter. A statement is then sent to the consumer for payment.

One respondent, LM04, said verbatim:

"Inadequate domestic metering infrastructure is a major issue in the district, the old credit meters, they are not reliable. Some were never calibrated, and some are still buried underground. Even the readings from the meters are questionable."

The study showed that in many areas, especially low income housing areas, there are no domestic meters and the biggest water users are not metered and as such, waste water. Leaks are not attended to because there are no repercussions.

4.2.4.2 Subtheme 2: Conserving water and managing demand

The study confirmed the Municipality is not doing well in terms of Water Conservation and Demand Management, citing a lack of a comprehensive strategy with actions and deliverables and the inadequacy of the water metering infrastructure as one of the programmes that is critical in conserving water and managing the demand. The majority of the respondents (58%) noted the awareness campaigns that are conducted by the Customer Care Unit to make sure that the communities are aware that water is a commodity that must be conserved. In these campaigns, communities are taught to attend to internal leaks and not leave their taps running. They are also encouraged to report any leak or breakdown in the system to the Customer Care Unit, using the Call Centre.

The findings of the study revealed that the Municipality lacks technological means such as leak detectors, sensors and telemetry to conserve water. There is also no pressure management technology. These are critical in conserving water, especially in an area that has ageing infrastructure.

The findings of the study revealed that the demand at Harry Gwala District Municipality is higher than the supply, and as such noted that the Municipality is engaging DWS to assist with the development of water resources to meet the demand. The study further revealed that the population is growing and there is enormous pressure from the business sector and investors for a sustainable water supply.

A need to appoint hydrologists by the Municipality was identified by one respondent as a priority. In line with the appointment of a hydrologist, another respondent, LM02, said:

“The municipality must confirm scientifically the volume of water that is required by the communities at Harry Gwala, this must be studied and documented so that the municipality is able to establish the appropriate water resources required to meet the demand.”

There was appreciation by some respondents of the rivers that are running through the District which could be alternative resources to draw water from in order to meet the demand. The establishment of the Research and Design Unit and prioritisation of water

resource development as a catalytic project in the IDP was seen by many as a deliberate strategy to respond to the demand. One respondent was skeptical about these rivers, citing that the topography and terrain will determine if it will be cost effective to draw water from these rivers from Engineering and Hydrological points of view.

4.2.5 Human Resources and Organisational Development

4.2.5.1 Subtheme 1: Adequacy of workforce

The majority of the respondents (75%) indicated that the Municipality does not have an adequate workforce. They cited vacancies in the municipal structure and priority being given to the unskilled labour force at the expense of the skilled workforce such as Process Controllers and other important functions such as the establishment of a Water Quality Department and the establishment of a Laboratory. About 16% of the respondents provided a contrary view in that the workforce is adequate, citing that it is the commitment from workers that is more important than numbers.

The findings of the study revealed that the small localised water schemes are a major cost driver in the Municipality. The schemes require the same workforce in terms of skills and there are production costs associated with each plant. The study revealed that having a few bulk regional schemes will save costs in terms of personnel and production costs. It will be easier to adequately equip fewer WTPs than the small localised schemes.

The respondents acknowledged the skills development programme in the form of training that the Municipality offers to upskill the employees. LM02 said:

"*People are sent to training centres where they are able to get training and in some instances the training companies are brought to the municipality to reduce costs."*

4.2.5.2 Subtheme 2: Workforce discipline and productivity

In relation to workforce discipline and productivity, 41.7% of the respondents were of the view that the majority of the workforce is not disciplined, which also affects productivity, while 16% of the respondents were of the view that 50% are disciplined and productive and the other 50% are not. Only one respondent (8.3%) saw the workforce as disciplined and productive. The respondents pointed out that there are still good employees in the Municipality, who are dedicated and committed in fulfilling their tasks.

One respondent said verbatim:

“We are not doing enough, people work as they please, if they don’t want to work they don’t come to work.”

The study revealed that there is a lack of supervision because the areas to be covered are vast and supervisors cannot be at all sites at the same time, leaving other water schemes without day to day supervision.

The findings of the study also pointed to the political positions that some of the employees are holding that are affecting productivity and discipline.

4.2.5.3 Subtheme 3: Leadership and organisational culture

The research further revealed that the Municipal Leadership does not promote innovation but noted a few interventions in relation to establishing multi-disciplinary teams to address water challenges. This was confirmed by 75% of the respondents. Moreover, 16.7 % of the respondents appreciated the effort by management though it is not enough to create an environment that promotes innovation within the Municipality. One respondent saw the political leadership as promoting innovation, with few senior managers in the Municipality who allow employees to innovate.

4.2.6 Summary of the Qualitative Findings

Harry Gwala District Municipality is engaging communities in the service delivery programmes. The municipality continues to extend its service delivery footprint and ensuring that communities which previously did not have water now have some level of access notwithstanding the significant challenges that have been noted. There is poor project planning, project management and monitoring in the Municipality which has led to project overruns as projects are not completed on time. The inadequacies in project planning have led to water projects not producing water as required owing to inadequate water resources and poor design by consultants who lack the required competencies. This has led to some assets being vandalised by communities. A number of deficiencies in the production processes were reported by the respondents due to lack of technology and backup infrastructure.

The research further revealed that water infrastructure is ageing and dilapidated and there is inadequate maintenance of this infrastructure. The Municipality has illegal connections due to water leaks and lack of adequate metering infrastructure. Water quality is poor due to inadequate numbers of qualified Process Controllers. There is no inventory management system in place. There is no strategy to conserve water and

manage the demand which was reportedly far above the supply. The findings of the study revealed an inadequate workforce, lack of discipline and poor productivity with negative repercussions on water provision. The organisational culture is generally not favourable to innovation.

From the above qualitative analysis, it is clear that the Municipality is not providing water efficiently, and there are serious challenges hindering successful management of water.

4. 3 SECONDARY DATA ANALYSIS AND PRESENTATION OF RESULTS

In responding to the first research question, secondary data analysis was performed, based on the approved budget and audited AFSs for the past fourteen years. The approved budgets were used to assess whether the municipal financial planning is geared towards successful water management. Harry Gwala District Municipality is expected in terms of the Local Government: Municipal Systems Act, No. 32 of 2000 to coordinate the processes of preparing an annual budget considering the Municipality's IDP. As a WSA, the priorities in the IDP should support the provision of potable water in a sustainable way and ensure that the Municipality is able to fulfill its legislative mandate as articulated in chapters 1 and 2.

4.3.1 A Summary of the Municipal Budget and Expenditure

Harry Gwala District Municipality is largely dependent on the national fiscus to fund its operations. The Municipality funds its capital infrastructure using conditional grants and an operating budget using the unconditional grants such as the Equitable Share and to a lesser extent, its own revenue generated from water sales.

For the purposes of the research the analysis of the budget was limited to the budget appropriations in relation to water infrastructure, and water conservation and demand management.

Table 4.9: *Budget Summary*

Financial Year	Total Budget	Operating Budget	Capital Budget
2007/2008	R125 088 175	R102 744 674	R147 584 830
2008/2009	R282 359 753	R138 460 981	R138 732 021

2009/2010	R496 608 216	R219 701 763	R188 704 623
2010/2011	R518 387 578	R260 736 929	R170 679 023
2011/2012	R516 543 294	R313 839 381	R149 074 751
2012/2013	R500 491 864	R339 156 167	R207 857 000
2013/2014	R538 827 341	R372 661 059	R194 733 191
2014/2015	R568 321 610	R386 333 831	R241 082 623
2014/2016	R588 983 283	R462 465 003	R242 817 184
2016/2017	R667 807 559	R460 495 991	R195 183 021
2017/2019	R729 090 658	R495 742 102	R220 398 889
2018/2019	R750 791 317	R533 973 671	R266 785 397
2019/2020	R739 695 478	R560 546 079	R234 339 402

Source: Harry Gwala District Municipality, Annual Financial Statements (2007/2008-2019/2010)

During the 2007/8, 2013/14, 2014/15, 2015/16, 2018/19 and 2019/20 financial years the municipal budget had a deficit which was caused by the non-cash items (the provision for bad debts and depreciation). The depreciation was not cash-backed during the budgeting processes and had a negative impact in terms of creating reserves for replacement of assets as well as refurbishing assets and ageing infrastructure. For the other financial years (2008/2009, 2009/2010, 2010/2011, 2011/2012, 2012/2013, 2016/2017) the budget had a surplus which was caused by lower budget appropriations for the provision of bad debt and depreciation as non-cash items. This was largely a misrepresentation of the truthfulness of the budget requirements. The implications for this were the same as the budget deficit as outlined above.

The Municipality is over-budgeting on capital infrastructure due to the conditional grants from the National fiscus. On average the capital budget against the total budget was 36.4% for the past thirteen financial years. The negative side of this investment is that the Municipality is unable to generate income and unconditional grants to maintain this infrastructure at the level that is commensurate with the pace of new investments on capital infrastructure. Largely the capital expenditure/investment is in the rural areas which generates no income to operate and maintain the infrastructure. The Municipality does not have a dedicated budget for water conservation and demand management. These are serious deficiencies for successful water management.

4.3.2 Descriptive Analysis of the Annual Financial Statements (AFSs)

The Municipality is required in terms of the Local Government: Municipal Finance Management Act, No.56 of 2003 to prepare AFSs consisting of a statement of financial position, financial performance and cash-flows. In responding to the research question, four ratios that relate to water management were analysed using information extracted from the audited AFS. These ratios are prescribed by National Treasury, and include Capital Expenditure to Total Expenditure, Current Ratio, Repairs and Maintenance as a % of Property, Plant and Equipment and Investment Property (Carrying Value) and Water Distribution Losses.

For the Municipality to be successful in managing water, financial resources are required to invest in new water infrastructure, build sustainable water resources, refurbish dysfunctional and partially functional water schemes and to operate and maintain the existing ageing infrastructure. According to Madumo (2015, p.162), municipalities need funding to function effectively. Further to that, local governments across South Africa deal with many challenges, some of which are the inability of municipalities to financially sustain themselves and the inability to deliver constant and regular services (Madumo, 2015, p. 162). He further argues that financial challenges to remain sustainable are mostly created by poor collection mechanisms (Madumo, 2015, p. 162).

Annual Financial Statements are different from the budget in that the budget is a plan based on projections and forecasts in relation to the allocation of funds. This includes estimations over a certain period of time. AFSs provides an account of the financial position, financial performance and cash-flow statement of the municipality.

The figures in the budget and AFS may differ significantly as they are based on two different assumptions. Furthermore, a budget is a plan based on estimations of what is likely to be spent. The AFS depicts the actual expenditure and how the budget was implemented. The analysis of the AFS is based on four ratios. These ratios are related to water management and will indicate if the municipality's spending trends are oriented towards ensuring successful water management. As indicated above, municipalities need funding in order to discharge their legislative mandates.

Below is the analysis of how the Harry Gwala District Municipality is performing on capital expenditure, and whether the Municipality is investing in new water infrastructure as a requirement for successful water management.

Table 4.10: *Capital Expenditure to Total Expenditure*

Year	Total operating expenditure	Total capital expenditure	Ratio
2006	-	-	-
2007	R 66 002 367	R 83 717 515	55.92
2008	R 102 744 674	R 108 705 622	51.41
2009	R 138 460 981	R 118 025 954	46.02
2010	R 219 701 763	R 212 425 257	49.16
2011	R 312 794 245	R 207 351 625	39.86
2012	R 313 839 381	R 163 407 970	34.24
2013	R 339 156 167	R 163 219 887	32.49
)2014	R 372 661 059	R 194 405 106	34.28
2015	R 386 333 831	R 241 082 623	38.42
2016	R 467 023 719	R 242 585 397	34.19
2017	R 449 982 624	R 195 183 031	30.25
2018	R 495 742 105	R 220 392 889	30.78
2019	R 533 973 671	R 266 785 397	33.32

Source: Harry Gwala District Municipality AFS (2007-2020)

The purpose of the total capital expenditure to total expenditure ratio is used "to assess the level of Capital Expenditure to Total Expenditure, which indicates the prioritisation of expenditure towards current operations versus future capacity in terms of Municipal Services" (South African National Treasury, 2014, p.2). The formula used to calculate the ratio is Total Capital Expenditure / Total Expenditure (Total Operating Expenditure + Capital Expenditure) x 100. The norm as prescribed by National Treasury ranges between 10% (lower norm) and 20% (higher norm). A ratio below 10% reflects lower spending on infrastructure. The ratio above 20% indicates higher spending on infrastructure and accelerated service delivery but can also be a risk if such investment does not generate revenue (South African National Treasury, 2014, p.3).

On average, the capital expenditure to total operating expenditure over the past fourteen years was 39.3%, which was significantly above the norm and the average budget as

reported above was 36.4%. In 2007 the ratio went as high as 55.9 %, declining to 51.41% in 2008 and gradually decreasing to 30.25% in 2017 and 33.3% in 2019. This means that the Municipality has been aggressive about capital spending. This could be attributable to water backlogs as reported in Chapter 2. Whilst investing in new infrastructure is critical to successful water management, National Treasury (2014, p.2) warns that higher spending could hold financial risks if the infrastructure does not include economic (revenue generating) and social infrastructure.

The current ratio assesses the ability of the municipality to pay back short-term liabilities (South African National Treasury, 2014, p.7). The current ratio is calculated by dividing the current assets by current liabilities. The norm as set by National Treasury is between1.5 to 2:1. According to South Africa National Treasury (2014, p. 23) "the higher the current ratio, the more capable the Municipality or Municipal Entity will be to pay its current or short-term obligations and provide for a risk cover to enable it to continue operations at desired levels." A financial ratio under 1 suggests that the Municipality would be unable to pay all its current or short-term obligations.

Table 4.11: *Current Ratio*

Year	Current assets	Current liabilities	Ratio
2006	-	-	-
2007	R 107 010 803	R 80 522 426	1.33
2008	R 136 115 106	R 91 063 286	1.49
2009	R 174 772 638	R 94 374 918	1.85
2010	R 124 405 719	R 129 253 592	0.96
2011	R 46 965 761	R 121 257 517	0.39
2012	R 17 123 942	R 89 331 358	0.19
2013	R 79 381 201	R 129 397 956	0.61
2014	R 90 804 651	R 120 615 647	0.75
2015	R 68 952 453	R 161 589 169	0.43
2016	R 52 729 736	R 217 520 990	0.24
2017	R 74 771 371	R 200 813 170	0.37
2018	R 162 321 829	R 229 053 706	0.71
2019	R 102 402 897	R 164 147 156	0.62

Source: Harry Gwala District Municipality, Annual Financial Statements (2006-2019)

For the past thirteen years the municipality's ratio was lower than the norm with the exception of 2009 with a ratio of 1.85. The average, or mean current ratio over the past thirteen years, was 0.8, well below the norm. From 2010 the ratio was below 1 and hitting

a low of 0.19 in 2012 and 0.62 in 2019. Successful water management is largely dependent on the ability of the Municipality to pay its suppliers, contractors and other production (chemicals, electricity) and distributions costs. Inadequate cash flow is likely to affect working capital negatively with negative implications on water quality, water provision and successful water management. It is difficult for any organisation to sustain its operations without adequate finances. This demonstrates that the Municipality has not been able to cover its current and short-term obligations with the available resources for the past 12 years. The analysis of the AFSs also revealed that for the past fourteen years revenue collection from water sales was far below the norm of 95%. Poor revenue collection will inevitably affect the current ratios, rendering the Municipality financially unsustainable.

In this case, National Treasury proposes that current assets be increased in order to cover liabilities and avoid the risk of liquidating non-current assets to settle current liabilities. The current ratios at Harry Gwala District Municipality indicate a lack of funding to operate effectively.

Repairs and Maintenance as a percentage of Property, Plant and Equipment (PPE) (carrying value) falls under asset management. The ratio is used to assess the financial position of the municipality. The formula used to calculate the ratio is Total Repairs and Maintenance Expenditure / Property, Plant and Equipment and Investment Property (Carrying Value) x100. According to the South Africa National Treasury (2014, p. 4), the purpose of this ratio is to “measure the level of repairs and maintenance to ensure adequate maintenance to prevent breakdowns and interruptions to service delivery.” From the literature review, maintenance of infrastructure is critical in ensuring a sustainable supply of water. Repairs and maintenance of water assets are critical in ensuring a continued and uninterrupted water supply.

Table 4.12: *Total Repairs and Maintenance as % of PPE Carrying Value*

Year	Total repairs and maintenance expenditure	PPE at carrying value	Ratio
2006	-	-	-
2007	R 6 585 269	R 43 306 074	15.21
2008	R 5 618 827	R 8 066 352	69.66
2009	R 6 913 768	R 503 640 954	1.37
2010	R 20 769 998	R 785 573 486	2.64
2011	R 14 507 585	R 864 147 769	1.68
2012	R 32 903 448	R 1 014 369 197	3.24
2013	R 34 026 060	R 1 150 386 586	2.96
2014	R 23 474 333	R 1 278 955 886	1.84
2015	R 22 131 829	R 1 470 186 113	1.51
2016	R 26 938 721.00	R 1 672 336 416.00	1.61
2017	R 25 559 768.00	R 1 802 821 001.00	1.42
2018	R 10 811 270.00	R 1 968 798 196.00	0.55
2019	R 37 241 370.00	R 2 170 542 330.00	1.72

Source: Harry Gwala District Municipality, Annual Financial Statements (2006-2019)

The norm is 8% of the total carrying value of property, plant and equipment. From the analysis of the audited AFSs, the ratios were below the norm of 8% from 2009 to 2019. From 2014 to 2019 the percentage was below 2% with a low of 0.55% in 2018 and 1.7% in 2019. The ratio below the norm is indicative of insufficient spending on repairs and maintenance and an increase on the impairment of the useful lives of the assets. From the above it can be concluded that the Municipality is not making enough provision for maintaining its water infrastructure, this despite the investment in new infrastructure being significantly above the norm. This can be attributable to the current ratios discussed above that are significantly below the norm, an indication that the Municipality is not financially sustainable.

According to the South African National Treasury (2018, p.32), municipalities that are in financial distress resort to cutting down expenditure on repairs and maintenance; thus the impact is not immediately obvious. National Treasury further cites the implications of underspending on repairs and maintenance as “deteriorating reliability and quality of services; a move to more expensive crisis maintenance rather than planned maintenance; increased future cost of maintenance and refurbishment; and shortened

useful lifespan of assets, requiring earlier replacement than would otherwise have been the case" (2018, p.32).

The last ratio is water distribution losses. The purpose of the water distribution losses ratio is "to determine the percentage loss of potential revenue from water services through kilolitres of water purchased but not sold as a result of losses incurred through theft (illegal connections), non-or incorrect metering or wastage as a result of deteriorating water infrastructure" (South African National Treasury, 2014, p.13). The formula used to calculate the ratio is number of kilolitres water purchased or purified – number of kilolitres water sold / number of kilolitres water purchased or purified x 1000. The norm is between 15% and 30% (South African National Treasury, 2014, p. 14). A ratio that is within the norm indicates that water infrastructure is well managed, and a ratio above the norm indicate serious challenges in relation to repairs and maintenance of infrastructure.

Table 4.13: *Water Distribution Losses*

Year	Number of kilolitres purchased and or purified	Number of kilolitres sold	Total water stock losses	Ratio
2006	-	-	-	-
2007	-	-	-	-
2008	-	-	-	-
2009	-	-	-	-
2010	3 850 033	2 381 164	1 468 869	35.00
2011	3 850 033	2 381 164	1 468 869	35.00
2012	3 850 033	2 381 164	1 468 869	38.00
2013	5 459 092	3 253 161	2 205 931	40.05
2014	1 228 602	915 201	313 401	25.51
2015	10 367 653	7 371 401	2 996 252	28.9
2016	8 966 620	4 440 798	4 525 822	50.47
2017	5 459 092	3 253 161	2 205 931	40.41
2018	3 850 033	2 381 164	1 468 869	38.15
2019	4 004 130	2 725 299	1 278 831	31.94

Source: Harry Gwala District Municipality, Annual Financial Statements, 2006-2019

The lower bound norm is 15% and the higher bound norm is 30%. The average or mean water distribution loss at Harry Gwala District Municipality over the past ten years was

36.3%, which is above the norm. Water distribution losses were on the rise from 2009 to 2013. In 2014 there was a huge decline from 40% to 25.5 %. There was a huge increase on water losses from 28.9% in 2015 to 50% in 2016. From the above data it can be concluded that the municipality's water distribution losses are fluctuating. These fluctuations can be attributed to a lack of adequate water balancing infrastructure. A decrease in water distribution losses, though still above the norm, was observed in 2019 at 31.94% depicting a positive improvement.

4.3.3 Summary of the Secondary Data Analysis Findings

The Municipality is investing a lot of money, far above the norm on capital infrastructure. This puts more pressure on the maintenance of infrastructure which is significantly below the norm. The Municipality is not financially sustainable; the current ratios indicate that it has been struggling to fulfill its financial obligations for the past nine years. Water losses are high, fluctuating on a yearly basis and above the norm.

4.4 OVERALL SUMMARY OF FINDINGS

From the above analysis of findings, it can be deduced that the Municipality is challenged in fulfilling its legislative mandate. The qualitative findings are corroborated by the secondary data analysis. To address some of the findings, the municipality needs to have a plan and resources. The municipality must prioritise waste elimination and continuous improvement in all its production processes.

CHAPTER 5: DISCUSSION OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

This chapter consolidates all the insights and best practices from the literature reviewed and the outcomes of the research and data analysis. Both the literature review and the qualitative data analyses provided deeper insights based on the analysis and interpretation of the secondary data and views and perceptions held by the respondents in relation to the variables that were under investigation with regard to successful water management.

In order to fulfil the requirements of the study, four research questions were developed and the findings in relation to each research question, including recommendations, are discussed in this chapter. As outlined in chapter 1 of the study, the research sought to understand how water provision at Harry Gwala District Municipality is structured and to develop a plan to ensure successful water management using lean management principles. In order to achieve the primary objective of the study, it was critical for the researcher to understand the financial position and sustainability of the Municipality and the extent to which it prioritises water provision adequately, including the structuring of water production processes and the extent to which it eliminates waste and encourages continuous improvement. Further to that was understanding the strategies implemented by the Municipality to conserve water and manage demand in order to meet the current and future demand. Lastly, the study aimed at assessing human resources capacity, productivity and organisational culture and the extent to which the municipal leadership collectively promotes innovation.

5.2 DISCUSSION OF FINDINGS

5.2.1 Effectiveness of the Production Processes

The effectiveness of the production processes is dependent on the efficient abstraction, purification and distribution of quality and uninterrupted water supply within the required resources with no waste. One of the strengths of the Municipality is to engage communities during the implementation of projects and to extend service delivery coverage in relation to water infrastructure to communities that previously did not have access. Such investment is critical to successful water management. The Batho Pele

principles allow for consultation with communities and setting of service standards. According to the Batho Pele principles, citizens should be made aware through adequate consultation processes about the level, standard and quality of service to expect from government (South Africa Department of Public Service and Administration, 1997, p. 8). Furthermore, the Budget and audited AFSs reveal that capital budget and expenditure have been significantly higher than the National Treasury norm, an indication that the Municipality is indeed aggressive in infrastructure development.

Notwithstanding the above, from the research a number of failures were noted. Such failures outweigh by far the successes. The Municipality's project planning, project management and monitoring are poor. This has led to projects not being finished on time resulting in project overruns, which can be classified as a financial loss. According to Khalid (2019, p.8), delays in the construction projects are caused by poor planning, poor site planning, inadequate contractor experience and cash flow challenges. At Harry Gwala District Municipality, the major challenges relate to the appointment of consultants and contractors who lack the necessary experience and competency, conflicts with subcontractors, poor site management and cash flows to complete the projects on time.

The above findings were confirmed in the monthly reports from the Infrastructure Services Department to the Portfolio Committee of Council where extensions of completion time were granted to almost all the contractors responsible for the implementation of water projects. Project success can only be achieved when projects are implemented within the approved budget (cost) and project duration (time) which is possible if monitoring and evaluation are done efficiently (Callistus & Clinton, 2019, p. 577).

When the projects are finally completed, on many occasions there is no reliable water supply. This, according to the research, is due to poor design during the project planning stages, failure to scrutinise the designs and to develop a reliable water source before project implementation. Without sustainable benefit derived by the communities from the projects, water infrastructure is often at risk of being vandalised with some assets being susceptible to theft. This becomes a financial loss to the Municipality, especially when such assets are replaced or repaired.

The Municipality's cash inflows are limited resulting in financial constraints. Without adequate funding the Municipality is unable to invest in water resource development and additional personnel. The municipal budget revealed that the Municipality is dependent on grants with very limited own revenue from its consumers.

Water infrastructure at Harry Gwala District Municipality is ageing, dilapidated and costly to maintain. There are no maintenance systems in place. There is poor maintenance of water infrastructure. The Municipality lacks technological systems that can be used to monitor challenges in the production processes. Though the Municipality has maintenance plans in place, there are no scheduled and routine maintenance programmes. Rather, the Municipality's maintenance programmes are reactive. The budget for repairs and maintenance, as previously reported, is far below the norm of 8%, meaning the Municipality does not have adequate budget to operate and maintain the ageing and dilapidated infrastructure.

There are inefficiencies in the production processes from abstraction, purification to distribution. The Municipality does not have automated technology to perform some of the production processes. Any breakdown in the abstraction, purification and distribution phases is only picked up either by Process Controllers or community members. The World Economic Forum (2018, p.7) places emphasis on the role of artificial intelligence in providing credible data that can be used to predict potential infrastructure risks, revenue and operating costs and inform infrastructure replacements in real time.

Boreholes at Harry Gwala pump throughout without due consideration for the water table to recover. Underground water sources are not infinite, they must be preserved. Moreover, illegal connections in relation to water and electricity, and theft of municipal water assets are a challenge at Harry Gwala. The Municipality does not have adequate back-up infrastructure such as generators and pumps. If one component fails it affects the entire water supply network, resulting in idle time until it is brought back into operation. Borehole projects are not implemented properly.

The Municipality does not have a Waste Minimisation Strategy, except for ad hoc interventions such as the installation of smart meters. Illegal connections are not being managed and the enforcement of by-laws is poor. Recyclable waste is not recycled. Kumari and Singh (2016, p.78) put emphasis on water re-use to conserve water and minimise waste.

With regard to procurement and storage of material, the Municipality does not have an inventory management system. There are no well-defined procedures to place and deliver orders. The Municipality does not have proper storage facilities for the material. As a result, the material is prone to thievery, breakages and financial losses. According to Priniotakis and Argyropoulos (2018, p.1), it is crucial to determine accurately appropriate inventory levels in order to avoid excessive inventory and associated financial

implications. It is further noted that too much inventory reduces working capital with negative implications for the company's liquidity.

The Municipality is challenged in relation to water quality and water losses. At Harry Gwala there is no technology to assess water quality or to even send an alert if water is not safe for human consumption. There is a shortage of qualified Process Controllers. Testing equipment is inadequate. There is no laboratory in-house. These challenges hinder efforts to improve water quality. The WHO (2006, p.4) contends that poor water quality and failure to ensure water safety for human consumption is a major health risk and a major cause of waterborne and intestinal diseases. Water quality controls are extremely weak at Harry Gwala and will hinder successful water management.

On water losses, bulk and domestic metering infrastructure are inadequate. Water losses cannot be measured accurately and with precision without this infrastructure. The ageing infrastructure and associated water leaks are a challenge at Harry Gwala and a major contributor to water losses. Deducing from the analysis of the repairs and maintenance ratio which is below the norm of 8%, the future does not look bright for the Municipality which does not have any technology whatsoever to detect water losses. There are no water leak detectors, sensors and telemetry etcetera to signal a failure in the storage tanks or water distribution networks. This makes it difficult to attend to underground water leaks. The audited AFS fluctuating water losses over the past financial years indicate a challenge of accuracy and reliability of measuring instruments in relation to water losses.

With regard to water interruptions the Municipality has made good progress in developing and implementing an automated system to record breakdowns and complaints; however, the usage of Reasebetsa needs to be enhanced. The system can enormously assist the Municipality with successful water management through saving costs claimed on unverified overtime claims, improved reporting, efficient communication and providing feedback to consumers on complaints received. The main challenge is resistance by employees to utilise the system.

5.2.2 Water Conservation and Demand Management

The Municipality does not have an approved Water Conservation and Demand Management Strategy. Water demand is significantly higher that supply. The available water resources are not adequate to satisfy the demand; hence the Municipality is still dealing with a backlog of 37.9 % according to the latest survey by Statistics South Africa. The Municipality is endowed with large rivers that could assist in providing water

resources in the form of dams. Well managed metering infrastructure can play an important role in terms of conserving water and managing the demand. A number of meters at Harry Gwala are faulty and are not calibrated.

Due to the challenges stated above, the meter readings are likely to be unreliable. According to du Plessis and Hoffman (2015, p.197), ensuring the accuracy of water metering infrastructure is critical towards sustainability of WSA. Domestic connections provide a link between consumers and the Municipality's distribution network and further provide data on the actual consumption for billing purposes and to maximise revenue collection. (du Plessis & Hoffman, 2015, p.198). It is therefore paramount for the Municipality to ensure that the metering infrastructure is fully functional. Adequate meters can be used to control consumption.

Further to that is the provision for bad debt in the Municipal budget, which was higher than usual, an indication that the Municipality appreciates the risk of customers not paying for the services rendered. According to Harry Gwala s71 reports in the Finance Department, the average collection rate in 2019 was 64.9 %. Getting the metering infrastructure in good working order and knowing whom to bill is critical for revenue management, especially in areas where credit meters are still in use.

As part of water conservation, awareness campaigns to educate the communities to conserve water are being held by the Municipality. Moreover, the Municipality is rolling out smart meters as a means to improve revenue, conserve water and manage the demand. Determining the current and future demand is critical for the Municipality in order to manage the demand. The Municipality must also explore aggressive strategies on how to conserve water as a scarce resource and how to manage the demand.

5.2.3 Human Resources and Organisational Development

The Municipality does not have an adequate workforce. The Municipality has 133 small, localised water schemes. The majority of these water schemes are spread across the vast rural areas and require some level of capacity to operate and maintain. The municipality has an approved Organisational Structure which cannot be implemented effectively due to a lack of funding as evident in the current ratio of the financial analysis.

On workforce discipline and productivity, the majority of the workforce is not disciplined and productive. There is generally a lack of supervision which is a contributing factor as some of the schemes do not have day to day supervision owing to capacity constraints.

The municipal leadership and organisational culture do not create a space for the workforce to be innovative.

5.2.4 Financial Planning and Management

The Municipality is commended for its aggressive investment in capital infrastructure considering the backlogs. The main risk is when such investments are not supported with the required repairs and maintenance budget as is the case at Harry Gwala District Municipality. The Municipality is not financially sustainable due to poor current ratios. Under-budgeting for repairs and maintenance at Harry Gwala District Municipality will compromise the quality of infrastructure, making it extremely difficult to address current water challenges, water conservation programmes and managing the current and future water demands. The current percentage water loss is still a major challenge in the Municipality. In a municipality characterised by backlogs and generally inadequate financial resources, water losses will hinder successful water management.

Based on the above analysis it can be concluded that financial planning and management at Harry Gwala District Municipality are not geared towards successful water management.

5.3 RECOMMENDATIONS - PROPOSED WATER MANAGEMENT PLAN

From the literature review, water scarcity, access to drinking water, polluted water resources, inadequate treatment of wastewater, water losses, ageing infrastructure and poor maintenance are some of the global challenges facing water utilities. Based on the analysis of findings it can be concluded that the Harry Gwala District Municipality can benefit from the implementation of lean management principles in order to ensure successful water management.

5.3.1 Summary Table of the Proposed Plan

Below is the table with lean management recommendations that the Municipality can implement in order to ensure successful water management.

Table 5.1: *Summary Table of the Proposed Plan*

FINDING	LEAN MANAGEMENT RECOMMENDATIONS
Efficiency of the production processes	
Poor planning, project management and monitoring	• Build capacity (human resources and training) • Contract management • Water resource development and bulk regional schemes • Develop a service standard charter
Deficiencies in the production processes	• Implement 5s • Value Stream Mapping and synchronise workflow • Use of technology and automated infrastructure
Ageing and dilapidated infrastructure and inadequate maintenance of water infrastructure	• Total Production Maintenance • Maximise revenue collection and increase budget for maintenance • Perform routine maintenance • Refurbishment of schemes
Waste minimisation	• Develop waste minimisation strategy • Smart metering infrastructure and meter management • Recycling and public education to communities
Lack of inventory management	• Undertake Material Requirement Planning (MRP) • Just-in-Time inventory management system
Poor water quality	• Water quality improvement plan (continuous improvement) • Develop a well-equipped laboratory • Build capacity (training, innovation) • Technology – Mistake proofing (Poka-yoke)
Water Conservation and Demand Management	
Inadequate Metering infrastructure and Inadequate Water Conservation and Demand Management	• Develop an integrated water meter management plan • Artificial Intelligence technologies • Public education, pressure management, infrastructure management, speed and quality of repairs • Rainwater harvesting
Human Resource and Organisational Development	
Inadequate workforce; lack of discipline and	• Recruit talented, honest, innovating and adaptive employees • Implement a Performance Management System

productivity and poor organisational culture	• Encourage worker engagements, teamwork and sharing of ideas and innovation and organisational renewal • Continuous training
Financial Planning and Management	
Insufficient financial resources, inadequate budget for repairs and maintenance, high water losses	• Develop a credible and affordable tariff structure • Ensure that all water consumers are metered to improve revenue and minimise waste (water loss). • Engage National Departments and Provincial Department for funding to implement water resources (dams)

5.3.2 Details of the Proposed Plan

5.3.2.1 Increase efficiency of water production processes

In relation to poor planning, project management and monitoring, the Municipality should conduct a work study in order to assess the capacity of project planning, project implementation and management. The work study will guide management to optimise the human and material resources available to ensure completion of projects (Sookdeo, 2016, p. 229). This should be followed by a cost-benefit analysis in order to determine the best option of providing these three critical services.

Depending on whether to outsource or perform these activities in-house, the Municipality should build capacity and ensure continuous training in order to improve project planning, implementation and monitoring. Where the Municipality is outsourcing, there must be full enforcement of the General Conditions of Contract and Service Level Agreements in order to ensure that projects are completed on time. Contract Management must be strengthened, and penalties imposed where necessary and service terminations where appropriate. The Municipality must have a Contracts Manager who will be responsible for administering the Service Level Agreements and General Conditions of Contract and ensuring full compliance with the contractual terms and conditions and that the final product meets the requirements (Mutua et al., 2014, p. 27).

Due diligence must be done by the Supply Chain Management bid committees during the appointment of service providers (consultants and contractors) to ensure that they

appoint competent service providers. Supply Chain Management must look at the capacity of the contractors and the ability to complete the project and where necessary, engage in contract negotiations to arrive at the most optimal arrangement for the successful implementation of projects (Mutua et al., 2014, p. 27).

Priority must be given to the implementation of regional bulk water schemes to minimise waste associated with small, localised schemes. From the literature review and research findings, it is clear that the Municipality does not have adequate water resources; hence the agreements with the private sector to draw water. This inevitably hinders successful water management. Capital investment either by DWS or the Municipality in the construction or development of adequate water resources in the form of dams is critical to reduce backlogs and to ensure an uninterrupted supply of water.

Harry Gwala District Municipality must develop a service standard charter for implementation and maintenance of water projects. It must ensure that all water projects adhere to the set standards in term of quality / workmanship and eliminate project overruns. This will assist in managing and responding to the increasing demand. Also ensuring value for money and improved service standard to customers would help the Municipality's image.

In relation to the deficiencies in the production processes, the Municipality must analyse its water production processes from source to end user. The artificial intelligence technologies and internet of things can analyse the production processes in order to identify bottlenecks. Kolinska and Domanski (2017, p. 111) argue that all bottlenecks in the production system must be eliminated as "an hour lost in a bottleneck is an hour lost in the entire system."

Another critical lean management principle for successful water management at Harry Gwala relates to the 5s, meaning set in order, sort, shine, standardise and sustain. A clean and organised workplace helps to uncover problems, which is a critical step in waste elimination (Wakjira & Singh, 2012, p. 26). The abstraction area and WTP must always be kept clean and orderly. This will improve productivity, efficiency and eliminate waste. Harry Gwala District Municipality must separate and remove unnecessary tools in its WTP and must ensure that inventory, especially chemicals that are currently stored in pump houses are properly stored especially the frequently used; furthermore, the

municipality must maintain deep cleaning in order to eliminate dirt. WTP must have adequate information signage which must be designed to minimise unnecessary movement and set up times as these create unwarranted waste.

The assessment of the production processes using Value Stream Mapping (VSM) will assist in identifying production processes that do not add value. This analysis should be extended to the production infrastructure (property, plant, and equipment) and human capacity. WTP must be adequately resourced in a way that supports productivity and eliminates waste from transportation, unused or under-utilised employees, waiting times and unnecessary processing. The analysis of the production processes will help in ensuring that the available personnel focuses only on value adding activities as non-value adding activities or steps are eliminated from the processes. This will also help in identifying bottlenecks, allow for the analysis of bottlenecks and mapping a more synchronised flow of activities.

Regarding the ageing infrastructure, the Municipality should consider reprioritising capital budget towards refurbishment of schemes that are dysfunctional and partially functional. To avoid the state of dilapidation, upon refurbishment, the schemes must be maintained as per the maintenance plan and replaced when they have reached their useful life.

With regard to inadequate maintenance of water infrastructure, this relates more to the repairs and maintenance which are discussed later on in this chapter. An increase in the repairs and maintenance budget is dependent on the improvement in the current ratio of the Municipality and financial sustainability. The Municipality should implement revenue collection strategies to improve its cash flow. The Municipality should consider increasing its repairs and maintenance budget in line with National Treasury norms. This will allow for routine maintenance to be done as per the maintenance plans. Furthermore, the Municipality should also develop an infrastructure maintenance system that will send alert signals on breakdowns and routine maintenance. The Municipality should utilise the Total Productive Maintenance approach. According to Ireland and Dale (2001); Shamsuddin et al. (2005); Rodrigues and Hatakeyama (2006) (all cited in Wakjira & Singh, 2012, p. 26) the Municipality can benefit from “autonomous maintenance; focused maintenance; planned maintenance; quality maintenance; education and training” which are some of the key components of TPM. Thus, the Municipality must maximise the effectiveness of its water infrastructure

With regard to waste elimination, the Municipality must develop a Waste Minimisation Strategy based on the VSM to identify prevalent waste and develop strategies to minimise such waste. The Municipality must consider recycling wastewater, and backwashed water in order to meet the demand. It must further accelerate installation of smart meters to reduce water loss, conduct public education for consumers on how to conserve water and enforce by-laws to address illegal water and electricity connections. Kumari and Singh (2016, p. 78) propose that emphasis by WSA must be on the no drop policy, re-using water as much as possible, changing consumer attitudes, using production processes and adopting technologies that will minimise water waste, maintaining infrastructure to reduce leaks and educating the public on the need to conserve water.

On inventory management, Harry Gwala District Municipality should adopt Material Requirement Planning (MRP). Understanding the production processes will allow for the Municipality to plan its inventory requirements accurately. This includes chemicals used to purify water and material required to repair pipes and pumps. According to Rajeev (2008 cited in Gupta & Jain, 2013, p. 246), MRP can correctly estimate inventory requirements and raw materials. The Municipality can benefit from the Just-In-Time principle, especially on chemicals and repair equipment. The Municipality does not have stores and qualified personnel to manage inventory, there is no inventory management system and as such its inventory is susceptible to theft and vandalism. Having suppliers locally and ensuring that information technologies are aligned to place orders with suppliers will eliminate the risk of theft and breakages which carry huge replacement costs.

In order to improve the quality of water the Municipality should develop Water Quality Improvement Plan taking into consideration the entire water catchment. According to the WHO (2011, p.8), prevention is the best approach in ensuring water is safe for human consumption and should take into account the characteristics of the supply catchment area. The WHO proposed water quality from the source to the consumers.The Municipality should invest in establishing an in-house laboratory and ensuring that it is equipped with the relevant and efficient equipment. The Municipality should also ensure that all the WTPs have qualified Process Controllers who are continuously trained to improve efficiency. Technological systems should also be explored that will indicate out of the range results. As described by Prester et al. (cited in Lazarevic et al., 2019, p. 454), using technological tools can help minimise mistakes by detecting sources of abnormalities. Poka-yoke is another artificial intelligence device which is sometimes

referred to as mistake proofing. Poka-yoke can identify variations and abnormalities at source. This can assist in detecting water quality variations, as Poka-yoke is a technological solution that avoids a mistake before it is made or makes it easier to identify it. Its approach is more preventative.

The use of Jidoka, which has evolved from the first industrial revolution and is currently embracing the fourth industrial revolution can benefit Harry Gwala District Municipality. According to Romero et al. (2019, p.900), the fourth generation Jidoka Systems, or 'Jidoka 4.0 Systems', have started to arrive on the shop floors characterised by diverse software and hardware components such as sensors, actuators, controllers and advanced analytic capabilities able now to early-detect and diagnose a problem, and in some cases correct it before it actually occurs. This will prevent water waste and saves on operational costs, as the system reacts in a fraction of the time it would take a human engineering crew to observe, find and fix the problem unaided.

5.3.2.2 Water conservation and demand management

Harry Gwala District Municipality must develop a Water Conservation and Demand Management Strategy. The Municipality must implement an integrated domestic and bulk water meter management plan to reduce water losses and conserve water. Rainwater harvesting, improved designs and water efficiency are some of the strategies that the Municipality can implement (Kumari & Singh, 2016, pp. 75-76). The municipality must further implement some of the catalytic technologies of the fourth industrial revolution inclusive of artificial intelligence, as they provide better conservation of water throughout the system and can accurately assess water demand (Stankovic, Hasanbeigi & Neftenov, 2020, p. 12). Stankovic et al. (2020, p.12) further argue that AI is a critical tool in combatting waste, with technologies that can analyse water flows and send alerts whenever an anomaly is detected. This will help achieve lean management principles of waste elimination and continuous improvement and improve efficiency in conserving and managing the demand.

Harry Gwala District Municipality must implement a suitable, reliable and automated metering system that will allow for automated remote reading and transmission of data to the billing system. This will increase efficiency, reduce human errors, improve credibility of billing, water sales and revenue collection. The Municipality should have a water meter maintenance plan with adequate budget to maintain, repair and replace metering infrastructure.

Harry Gwala District Municipality must consider grey and wastewater re-use (recycling). Using reclaimed water for industrial and agricultural purposes is being done in a number of countries and as argued by Ghernaout (2018, p. 1), this is not common for domestic use but countries such as Singapore, Australia, California and neighbouring Namibia are already using reclaimed water for domestic use.

The Municipality should manage its infrastructure effectively and attend speedily to water leaks and repairs. The Municipality must use pressure management in order to conserve water and meet the demand. Pressure management was implemented in the City of Cape Town with visible benefits in relation to lowering consumption levels, controlling water flows, reducing leaks and pipe bursts. Charalambous, Foufeas and Petroulias (2014, p.26) argue that water losses can be reduced by applying the following four strategies: Pressure Management, Infrastructure Management, Speed and Quality of Repairs. The city of Teplice implemented an automated and web-based system to run and prepare outputs during specific intervals and the system interfaced with leak control, network repair, leak identification and pressure optimisation tools. A novel leak monitor was also acquired. The city further implemented an integrated asset management, water pressure management, reduction of non-revenue water, real-time online monitoring and real-time leakage management systems. With these interventions there was a reduction of 43% in water leaks in six months (Eminger, 2011, p. 1).

The application of artificial intelligence and smart sensors to reduce water losses can be used to detect water leaks as soon as they occur (Stankovic, Hasanbeigi & Neftenov, 2020, p. 5). According to Stankovic et al. (2020, p.13), in Brazil a technology called Fluid which uses sensors and vibrations from water flows in the pipeline, was developed in order to detect leaks and illegal connections in its water distribution systems.

5.3.2.3 Human resources and organisational development

In order to attend effectively to an inadequate workforce, Harry Gwala District Municipality should conduct a work study to guide its recruitment in order to achieve maximum output and efficiency and avoid excessive personnel. This will help reduce expenditure on unnecessary personnel. In accordance with the work study, the Municipality should recruit and select in all vacant positions innovative, adaptive, honest, productive and committed labour with the requisite skills. Harry Gwala District Municipality should continue to empower and train its workforce in order to inculcate lean management principles.

Leadership must instill good governance. This helped Phnom Penh in Cambodia to transform its water utility. Leadership must create an organisational culture that encourages teamwork, sharing of ideas and a culture where good performance is rewarded, as this will improve productivity. Harry Gwala must embark on organisational renewal to build an organisational culture that allows for productivity, discipline and continuous improvement. To improve productivity, the Municipality must consider implementing a Performance Management System with measurable targets and reward good performance. Riddle (2010) (cited in Sookdeo, 2016, p. 229) states that management must focus on increasing employee productivity and must develop a statistical tool to measure employee productivity.

There is empirical evidence that suggests that work engagements, acquisition of talent in recruitment, two-way communications, allowing employees to share ideas about anything that may affect productivity and providing resources has a significantly positive effect on employee productivity (Hanaysha, 2016, p. 76).

A workplace that encourages productivity, teamwork, sharing of ideas and rewarding good performance will be more successful in successful water management and creating space for continuous improvement. Al-Najem et al. (2012, p. 126) describe a key strategy in adopting lean culture as focusing on employee involvement, empowerment and motivation.

The above recommendations will create an organisational culture that values employees and subsequently promotes innovation. According to Adelekan (2016, p.163), innovation requires an appropriate organisational culture, norms and support systems.

5.3.2.4 Financial planning and management

Financial viability is one of the critical elements in achieving successful water management. The following are some of the interventions that Harry Gwala needs to implement to ensure that financial planning is geared towards successful water management.

It is recommended that the Municipality must ensure credible credit control and revenue management. This can be achieved by reviewing the tariff structure in line with the provisions of the Local Government: Municipal Systems Act, 32 of 2000. The Act provides a guideline for developing a tariff policy and levying of fees for services rendered. In

reviewing the tariff structure, the Act prescribes that municipalities must consider costs reasonably associated with rendering the service.

The costs should take into consideration capital, operating, maintenance, administration, replacements and interest charges. As part of this process the Municipality must assess the affordability of the tariffs charged. The Municipality should have a credible data base of its consumers and must ensure that consumers are aware of the tariff structure, how it has been set and what it intends to achieve. A smart metering infrastructure should be implemented, especially in areas where revenue collection is poor. This will improve the financial sustainability of the Municipality which is below the norm as was evident in the analysis of the current ratios.

The budget for operations and maintenance must be increased to 8% of the total carrying (book) value of assets. This can only be achieved if the Municipality's current assets are increased. The number of partially functional and dysfunctional schemes goes against successful water management. Inadequate budgets for operations and maintenance and poor budgeting on capital projects could potentially be the reason some water schemes are partially functional and dysfunctional. The Municipality must perform conditional assessment of assets in line with GRAP 17 (Generally Recognised Accounting Practice) standards as an integral part of asset management. This will inform impairment of assets and routine maintenance.

The above interventions will help improve water provision, reduce service interruptions, build adequately functioning infrastructure, improve asset management, ensure credible budgeting for infrastructure depreciation, repairs and refurbishments, reduce backlogs and improve financial loss. Demand Management will improve the ability and agility of the Municipality to plan and to perform forecasts, reduce costs, eliminate waste and improve inventory planning and enhanced customer service.

5.4 LIMITATIONS OF THE STUDY

A limitation is defined as "a weakness or deficiency in the research" (Collis & Hussey, 2009, p. 125). This study only focused on Harry Gwala and as a result the findings cannot be generalised to other municipalities that are WSAs and are experiencing the same challenges as Harry Gwala District Municipality.

The interviews were initially planned as face-to-face which was not fully possible due to COVID-19. Most respondents were interviewed via Zoom. This limited the ability of the

researcher to identify non-verbal cues and gestures and other body language that may have provided a better understanding of the questions asked and responses given.

The other limitation related to those respondents interviewed face-to-face, is in relation to fear of identification and victimisation as the researcher works for the same organisation as the Accounting Officer. This may have potentially limited the respondents in responding honestly to some of the questions.

5.5 FUTURE RESEARCH

Future research can be done in the Province of KwaZulu-Natal and the country on how lean management principles can be used to deliver water to our communities successfully. This might be necessary as water scarcity is a universal challenge.

5.6 CONCLUSION

Water is a scarce resource and enormous challenges exist in a number of water utilities globally, nationally and provincially. The challenges relate to water demand that is growing when the supply is shrinking owing to natural and man-made actions such as drought, climate change (natural), water losses due to leaks, unacceptable water quality and polluted river stream and catchment areas (these being man made). Water is life and preserving this resource is paramount. Harry Gwala is not immune to these challenges and the research findings showed the Municipality is extremely challenged in delivering water to the consumers. To ensure successful water management from source to distribution, lean management principles can transform the Municipality into achieving its legislative mandate. The recommendations above call for a new service delivery and water production philosophy for the Municipality which cannot apply the same level of thinking that created the problems, in order to solve them. A new approach is required. Lean Management, where implemented properly, has yielded many benefits in relation to production efficiencies and customer satisfaction. Lean Management can transform Harry Gwala towards achieving successful water management from abstraction to distribution.

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ANNEXURE 1: INTERVIEW GUIDE COVERING LETTER

Dear Respondent

As part of my Masters in Business Administration research treatise at the Nelson Mandela University, I am conducting a research that investigates the role of lean management principles in achieving successful water management at Harry Gwala District Municipality.

I will appreciate if you can respond honestly to the questions below. Your participation remains voluntary and your identity will be anonymous.

Your views and experiences will help us understand the current situation on the ground about water management. The survey will take no more than 20 minutes to complete.

Regards,

Adelaide Nomnandi Dlamini

ANNEXURE 2: THE MEASURING INSTRUMENT

A: DEMOGRAPHICS *(Please tick [√] or circle the appropriate box)*

A01	Section	Office of the Municipal Manager [1]	Finance Department [2]	Infrastructure Services Department [3]
		Water Services Department [4]	Corporate Services Department [5]	Other [6]

A02	Gender	Male [1]	Female [2]

A03	**Age**	<24 yrs [1]	25-29 yrs [2]	30-34 yrs [3]	35-39 yrs [4]	40-44 yrs [5]	45-49 yrs [6]	50-54 yrs [7]
							55-59 yrs [8]	60+ yrs [9]

A04	**Highest qualification**	Matric and below [1]	Certificate [2]	Diploma [2]	Degree [3]

A05	Race	African [1]	White [2]	Indian [3]	Coloured [4]	Other [5]

B: MEASURING THE EFFECTIVENESS OF THE WATER PRODUCTION PROCESSES *(Please fill in the given space)*

B1	What are the major successes and failures in the implementation and maintenance of water projects?

B2	What are the factors, if any, contributing to the failures in the implementation and maintenance of water projects?

B3	How are the production processes structured in providing uninterrupted supply of water to communities?

B4	Describe the systems used in the production of water in the Municipal Water Treatment Plants?

B5	What are the strategies, if any, to minimize waste in the municipal production processes?

B6	How is the material for operations and maintenance including production processes procured and stored?

B7	How is the municipality addressing water quality and water losses?

B8	How is the municipality recording and attending to breakdowns in the production processes and water interruptions?

C: WATER CONSERVATION AND DEMAND MANAGEMENT *(Please fill in the given space)*

C1	What is the current state of water metering infrastructure?

C2	How is the municipality addressing water conservation and demand management?

D: HUMAN RESOURCES AND ORGANISATIONAL DEVELOPMENT *(Please fill in the given space)*

D1	What is your opinion on the adequacy of the workforce in the municipal water department?

D2	What is your opinion on the workforce discipline and productivity in the municipal water department?

D3	To what extent does leadership and organizational culture promote innovation and successful water

E: GENERAL COMMENTS *(Please fill in the given space)*

E2	Any suggestions on how to ensure successful water management, waste elimination and continuous improvement in the Municipality?

Thank you for your time and cooperation

ANNEXURE 3: ETHICS CLEARANCE LETTER

NELSON MANDELA
UNIVERSITY

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

Chairperson: Research Ethics Committee (Human)
Tel: +27 (0)41 504 2347
sharlene.govender@mandela.ac.za

NHREC registration nr: REC-042508-025

Ref: [H20-BES-BUS-081] / Amendment]

1 October 2020

Prof C Arnolds
Faculty: BES

Dear Prof Arnolds

THE ROLE OF LEAN MANAGEMENT PRINCIPLES IN ACHIEVING SUCCESSFUL WATER MANAGEMENT: THE CASE OF HARRY GWALA DISTRICT MUNICIPALITY

PRP: Prof C Arnolds
PI: Ms A Dlamini

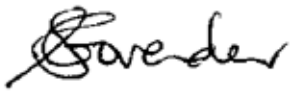
The request for an amendment to the above-entitled application served at the Research Ethics Committee (Human) for approval. The study is classified as a medium risk study. The ethics clearance reference number remains **H20-BES-BUS-081** and approval is subject to the following conditions:

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

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

We wish you well with the study.

Yours sincerely



Dr S Govender
Chairperson: Research Ethics Committee (Human)

Cc: Department of Research Capacity Development
Faculty Manager: BES

Appendix 1: Acknowledgement of conditions for ethical approval

APPENDIX 1

ACKNOWLEDGEMENT OF CONDITIONS FOR ETHICS APPROVAL

I, **PROF C ARNOLDS** (PRP) of the study entitled **[H20-BES-BUS-081] THE ROLE OF LEAN MANAGEMENT PRINCIPLES IN ACHIEVING SUCCESSFUL WATER MANAGEMENT: THE CASE OF HARRY GWALA DISTRICT MUNICIPALITY**, do hereby agree to the following approval conditions:

1. The submission of an annual progress report by myself on the data collection activities of the study by 15 November this year for studies approved in the period October of the previous year up to and including September of this year, or 15 November next year for studies approved after September this year. It is noted that there will be no call for the submission thereof. The onus for submission of the annual report by the stipulated date rests on myself. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the submission of the annual report.

2. Submission of the relevant request to RECH in the event of any amendments to the study for approval by RECH prior to any partial or full implementation thereof. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the requesting for any amendments to the study.

3. Submission of the relevant request to RECH in the event of any extension to the study for approval by RECH prior to the implementation thereof.

4. Immediate submission of the relevant report to RECH in the event of any unanticipated problems, serious incidents or adverse events. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the reporting of any unanticipated problems, serious incidents or adverse events.

5. Immediate discontinuation of the study in the event of any serious unanticipated problems, serious incidents or serious adverse events.

6. Immediate submission of the relevant report to RECH in the event of the unexpected closure/discontinuation of the study (for example, de-registration of the PI).

7. Immediate submission of the relevant report to RECH in the event of study deviations, violations and/or exceptions. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the reporting of any study deviations, violations and/or exceptions.

8. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of RECH. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the active monitoring of a study.

Signed:  Date: 08/10/2020

ANNEXURE 4: TURNITIN REPORT

MBA TREATISE

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ANNEXURE 5: EDITING LETTER

Editing Service: Lee Kemp

14 Carlisle St

Mount Croix

Port Elizabeth

6001

02 December 2020

082 723 5408

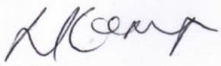
TO WHOM IT MAY CONCERN

EDITING OF TREATISE: Ms Adelaide Nomnandi Dlamini

This serves to confirm that I edited Ms Dlamini's MBA Treatise.

.The editing covered all aspects of language, punctuation, and layout. I also crosschecked the in-text references against the reference list, as well as editing the reference list.

Yours faithfully



Ms L. Kemp

B. A. (Hons English); MBA

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