A STUDY TO REDUCE UNACCOUNTED FOR WATER

(A CASE OF NZOIA WATER AND SANITATION SERVICES COMPANY)

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ABSTRACT

Water is an important natural resource, indispensable for life and also the backbone of growth and prosperity for mankind. Kenya is a water scarce country with renewable fresh water per capita at 647m^3 against the United Nations recommended minimum of 1,000m^3. Despite the efforts made by the Government of Kenya, Unaccounted-for-Water (UFW) is still high, currently standing at 49%. The overall objective for this study was to assess the strategies for reducing UFW in water supply systems. The scope focused in identifying areas for improving the water supply systems at NZOWASSCO. The target population was 148 employees. Data was collected through questionnaires and analyzed using Statistical Package for Social Sciences (SPSS). Descriptive and inferential statistics were used to present the results. The research findings indicate that majority of employees working in water supply systems are in operations level, considering that majority are diploma holders, their capacity should be enhanced. The research confirmed that on average, the level of Unaccounted-for-Water at NZOWASSCO was at 45%, this is in concurrence with the 2010 Impact Report by WASREB. It was further established that implementation of appropriate strategies to reduce UFW enables water supply systems to serve more customers for longer periods and thus WSPs realize high revenue. It is recommended that; WSPs should put in place measures to reduce levels of illegal water connections, vandalism and customer billing errors. Therefore, sustainable resource utilization, monitoring and control measures and improvement of existing regulatory mechanisms were found to be instrumental in enhancing efficiency of water supply systems.

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DECLARATION

I declare that this project is my original work and has not been presented for any degree of masters" award in any other institution.

Signature:……..Date……

SULUNGAI GLORIA NAFULA

(GMB/NBE/0225/01/13)

This research project has been submitted for examination with my approval as University Supervisors.

Signature:……Date……

DR. ZACHARY MOSOTI

Signature:……Date……

MR. JOASH MBOGA

DEDICATION

I dedicate this work to my family for their support has given me the zeal to press on.

ACKNOWLEDGEMENT

I foremost wish to acknowledge God for taking me through to this point in my education. My regards go to my parents who have struggled to provide for me nevertheless. My brothers and sister whose support has been of tremendous influence to my performance.

I would like to acknowledge the tireless assistance offered to me by Dr. Mosoti and Mr. Mboga my supervisors for their time, guidance and patience as they guided me through the process. Their assistance has been a blessing. I also wish not to forget all my lecturers for their excessive assistance and inspiration to make life in Kabarak University a big success.

Lastly, I want to acknowledge my friends, colleagues and staff at Kabarak University for being there for me. God Bless you.

LIST OF ACRONYMS AND ABBREVIATIONS

KeWI : Kenya Water Institute

LVNWSB : Lake Victoria North Water Service Board

MDGs : Millennium Development Goals **MoWI**

: Ministry of Water and Irrigation **NZOWASSCO**: Nzoia

Water and Sanitation Services Company **NIB** :

National Irrigation Board

NRW : Non-Revenue Water

NWCPC : National Water Conservation and Pipeline Corporation

NWSS : National Water Services Strategy

RDT : Resource Dependency Theory

UFW : Unaccounted-for-water

WAB : Water Appeal Board

WASREB : Water Services Regulatory Board

WHO : World Health Organization

WRMA : Water Resources Management Authority

WSPs : Water Service Providers

WSTF : Water Services Trust Fund

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CHAPTER ONE: INTRODUCTION

1.1. Background

Water is an indispensable resource, which is vital to enable sustenance of life and fostering economic and social development in a country. When provision is too much or too little, it can bring destruction, misery or death (ROK, 2007). Irrespective of its availability, if appropriately managed, water can be an instrument of economic growth. The WHO/ UN-Water Global Annual Assessment of Sanitation and Drinking Water report (WHO, 2010) indicates that diarrhoea, a water borne disease is the second leading contributor to the global burden of disease rated higher than heart diseases, HIV/AIDS and military conflicts. Unaccounted-for-Water (UFW) is a major component of the problem; it is certainly a significant challenge in various developing countries.

Unaccounted-for-water (UFW) may be defined as the difference between the total amount of water leaving treatment facilities and the total amount of water measured at customers' meters (Denver water, 2011). The terms Unaccounted-for-Water (UFW) and Non Revenue Water (NRW) have been used by experts interchangeably. The International Water Association (IWA) recommends the use of NRW. There are a number of elements which contribute to UFW which include; leakages, inaccurate meters, water consumed but not metered, unbilled metered water, improper meter reading and billing errors (Krohne, 2010). Non-revenue water (NRW) therefore includes both physical/real losses and commercial losses/non-physical losses (Wyatt, 2010). Liemberger *et al* (2006) define Non Revenue Water as the difference between the volume of water put into a water distribution system and the volume that is billed to customers. They go ahead to purport that NRW comprises three components: physical (or real) losses, commercial (or apparent) losses, and unbilled authorized consumption.

Water scarcity is defined by UN-Water (2013) as the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully. Though Kenya is a water scarce country, the little that is available is not efficiently managed; a lot of the water goes to waste or is siphoned away and thus Water Service Providers lose huge

amounts of money that would otherwise be registered as income. Currently, the level of UFW in Kenya is 49% (ROK, 2010) against an apparent acceptable economic level of 10% to 12% (Thornton *et al*, 2008). To date, the Government of Kenya has made numerous efforts in facilitating access to water since the enactment of the 2002 Water Act which enabled introduction of reforms in the water sector. The reforms were aimed at addressing the policy, regulation and service provision weaknesses in the previous set-up (ROK, 2007). However, despite these positive developments millions of Kenyans are still underserved. Vision 2030 recognizes that efficient water management can contribute to long-term economic growth since all the three pillars (social, political and economic) which forms its foundation have water dimensions (ROK, 2007).

The benefits of reducing UFW lead to the need for less water to be produced, treated, and pumped, translating into cost savings on operations and maintenance, as a result of savings in energy and treatment overheads. In order to resolve the UFW puzzle, water services and sanitation institutions need to review what UFW is in their system, identify areas of UFW and purge the system to remove as much UFW as possible. Veerabhadra and Vignewwar (2009) argue that the reduction of UFW is a crucial step to improvement of the water supply and financial soundness of water utilities. Indeed, no water supply can be kept at a reasonable and affordable level if the income from the customers does not cover the costs of providing a good service (Biswas and Tortajala, 2010).

1.2. Water Sector in Kenya

Kenya is located in the equatorial region where it is expected that the availability of water should be more reliable than other countries in Africa; however, it is ironical that access to water in Kenya is way below the accepted levels and thus worse off in comparison to other countries with more harsh climatic conditions for instance Namibia, Egypt and Botswana. Currently, it is estimated that nationally piped water coverage in Kenya is between 42% and 59%, which leaves millions of citizens without easily accessible water (World Bank, 2009).

Nzoia Water and Sanitation Company covers four schemes namely: Kitale, Webuye, Bungoma, Kimilili and Malaba- Kocholia. Out of a population of 356, 210 in the service area, the WSP serves a total of 268,723 people as at June 2013. It produces a monthly average of 475,744m^3 of water and sells a monthly average of 280,199m^3 during the reporting period. This translates to an unaccounted-for water of 41.2% (ROK, 2013).

The Government of Kenya recognizes the central role that water and sanitation plays in poverty alleviation, this is in concurrence with the Millennium Declaration by the UN General Assembly of September 2000 which noted that fighting poverty and sustainable development cannot be achieved without substantial improvements in water and sanitation (UN Water, 2012).

The responsibility of water supply management in Kenya is vested on the Ministry of Water and Irrigation (MoWI) which provides policy & strategy direction. The Ministry"s services are complemented by seven other water sector institutions that play the role of regulation, training, research, mobilization of funds, coordination and monitoring; these are WSTF, WASREB, WRMA, WAB, NWCPC, NIB and KeWI (ROK, 2002).

In order for Kenya to achieve the MDGs, it is imperative that water must be made available, accessible and affordable. This explains the need for increased coverage; reduction of consequent high water losses; rehabilitation and expansion of existing schemes; sustainable demand management; construction of new water supply schemes; transparency, accountability and good water governance; efficiency; clear institutional framework; and encouraging pro-poor focus, strategies and programmes (ROK, 2007).

Kenya"s Vision 2030 acknowledges the fact that Kenya is a „water scarce" country and it underscores the central role that water plays in the performance of key sectors of the economy and the livelihoods of Kenyans. Under the economic and social pillars of the Vision, improved access to safe water and sanitation has been given prominence with the rehabilitation and expansion of water supply and sanitation services in urban centres and construction of water storage dams identified as some of the flagship projects (ROK, 2007).

1.3. Statement of the Problem

Despite the fact that Kenya is considered as a „water-scarce" country, a significant amount of the available water goes to waste. The 2006-2015 Strategic Plan for LVNWSB identifies UFW reduction for NZOWASSCO as a major challenge to expansion of service provision in the area; indeed 50% of the potential customers are not reached. The Strategic Plan further recognizes that NZOWASSCO"s Unaccounted-for-Water is at 41.2%. In addition, the WASREB Impact Report (2010) indicates that at the national level, UFW in Kenya stands at 49%.

Globally, the acceptable level of UFW is 10% to 12% (Thornton *et al*, 2008). UFW can be reduced by developing and systematically implementing appropriate strategies to resolve the problem and thereafter sustain the desirable level. The savings realized from UFW reduction can be re-invested in the supply systems and thus ensure continual improvement in water access and infrastructure upgrade. (Ndiran"gu et al, 2008)

For the period ended July 2012 to June 2013, NZOWASSCO recorded a total annual revenue billing of Ksh. 227,114,103 and revenue collection of Ksh. 230,842,089. The WSP, however, spent a monthly average of 66.3% of all its monthly revenue collections on chemicals (6.3%), Energy (14.1%) and personnel (44.8%). This brought its total expenses to Ksh.231, 431,662 which translated to Ksh. -590, 572 as net revenue. This is very disturbing since working at a negative value is enough to show that the WSP is on the fall, basically there is no ultimate future (ROK, 2013).

1.4 Research Objectives

Main Objective

The core objective for this study was to assess the effectiveness of strategies for reducing UFW in NZOWASSCO.

Specific Objectives

The specific objectives for this study were to:

i. Identify areas of sustainable resource utilization to facilitate reduction of UFW.
ii. Assess monitoring and control measures for reduction of UFW.
iii. Identify ways of improving the existing regulations to facilitate efficiency of water supply systems.

1.5 Research questions

The following research questions were used against the objectives of the study;

i. How can available resources be utilized sustainably to facilitate reduction of UFW?
ii. Which monitoring and control measures can be applied to reduce UFW?
iii. How can the existing regulations for water supply systems be made more efficient?

1.6 Justification of the study

The study attempted to prevent some of the pitfalls that Water Suppliers in Kenya used to face during provision of water and sanitation services. It was beneficial to those individuals or entities that possess ambitions of reducing UFW to economically acceptable levels. Therefore, it was immensely useful in contributing to a body of knowledge that assisted the Water Sector institutions in Kenya in implementing UFW reduction strategies and thus improved their efficiency. The output of this study is an important source material that NZOWASSCO can assimilate and it can also be replicated in other WSPs. The study was generally of great benefit to many stakeholders.

1.7 Significance of the Study

This research was important to policy makers in the Water Industry at the local level to input the recommendations offered and also aid the incumbent managers of governmental positions related to the Ministry of Water in policy making.

Management of Nzoia Water and Sanitation Services Company NZOWASSCO were expected to use the information accrued from this research to give excessive emphasis to the new UFW reduction mechanisms to curb revenue loss in the firm.

It was also expected that this was to be a basis for further research by researchers who want to pursue the same line in a bid to come up with more suggestions and opinions in the area.

1.8 Definition of operational terms

Apparent/commercial Losses: These are the non-physical losses that occur in utility operations due to customer meter inaccuracies, systematic data handling errors in customer billing systems and unauthorized consumption. (Hannah, 2008).

Authorized Consumption: This is the annual volume of metered and/or non-metered water taken by registered customers, water suppliers, and others who have implicit or explicit authority to do so for residential and commercial purposes (Winarni, 2009).

Monitoring measures: These are the supervision of activities in progress to ensure they are on-course and on-schedule in meeting the objectives and performance targets (Business Dictionary, 2011). The measures will be used to monitor the water distribution systems" performance.

Control measures: This refers to keeping close watch over and adjusting to a requirement (Collins, 2010). These are the processes and procedures that will be used to control wastage in the water distribution systems.

Non-Revenue Water: This is the difference between system input volumes and billed authorized consumption, and it consists of the following: unbilled authorized consumption (usually a minor component of water balance), apparent losses, and real Losses (Winarni, 2009).

Real Losses: These are the physical losses of water from the distribution system, including leakage and storage overflows. These losses inflate the water utility's production costs and stress water resources since they represent water that is extracted and treated, yet never reaches beneficial use (Hannah, 2008).

Regulatory Framework: This is to bring into conformity with the rule in a structural plan (Collins, 2010). A set of interrelated conditions such as legal, organizational, fiscal, informational, political, and cultural that impact on development and sustenance of water systems.

Sustainable Resource utilization: Make worthwhile use of a resource that is maintained at a steady level without exhaustion (Collins, 2010). It involves examining resources available to ensure appropriate allocation and subsequent optimal output.

Unaccounted-for-Water: This is the difference between the total amount of water leaving treatment facilities and the total amount of water measured at customers' meters. Besides system losses, it also includes beneficial uses such as unmetered fire fighting and water used in system maintenance, along with meter under-registration (Denver Water, 2011).

Unbilled authorized consumption: This includes water used by the utility for operational purposes, water used for firefighting, and water provided for free to certain consumer groups (Winarni, 2009).

1.9 Limitations and delimitations of the study

One major limitation the researcher faced was time constraints. Usually, most researches need more time to gain conclusive results. However, according to the academic requirements, this time is reduced. In this case, the researcher fast tracked the study process to fit the required time.

The other limitation was lack of enough resources which came by due to cost elements related to conducting the study as a whole. The researcher cut on the costs through running the data collection process personally rather than hire assistants.

Logistical issues also arose during the research in terms of execution challenges to the research site. To deal with this, the researcher communicated to the research site early enough and ensured she gets a letter of introduction from the University.

1.10 The scope of the study

This research assessed the strategies to reduce Unaccounted for Water in NZOWASSCO.
The study Context was Bungoma County, Western Kenya .The study evaluated strategies that were to be adopted in Bungoma"s area covered by NZOWASSCO. The target population was the staff working in the WSP within a three year period.

1.11 Summary

The above chapter presents the background of the topic in question. It goes ahead to offer a statement of the problem, the research Objectives, the justification of the research as well as the significance of the research. This introductory chapter is followed by the literature review which gives supportive information in terms of publications relating to the problem in discussion.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The study delved into the strategies to be adopted for reducing UFW. It analyzed the strategies within the contexts of the variables identified in the conceptual framework. They included; sustainable resource utilization, monitoring and control measures, as well as the regulatory framework. This chapter presents a systematic analysis and review of documentation (empirical studies, historical records, and government reports) containing relevant information relating to the strategies for reducing UFW elsewhere and those in Kenya as well as past studies in the area.

2.2 Overview of Unaccounted-for-Water

Information on water resources, their availability and use is fundamental considering the emergence of water shortages and the need to efficiently improve water use (Mohd *et al*, 2009). The technical capacity of a water supply system is determined by the physical infrastructure of the system that enables access, availability, and adequacy of water to the users. Management of the water system depends on proper operation and maintenance of the infrastructure. Consequently, this ensures uninterrupted delivery of safe water (Ramesh, and Narayanasamy, 2010). Since water is considered as a free gift of nature, the tendency to use it lavishly is widely evident. According to an empirical study in Tamil Nadu, India, the amount of water wasted in the studied villages was found to be 35% (Ramesh, and Narayanasamy, 2010).

A country is categorized as 'water stressed" if its annual renewable freshwater coverage are between 1,000 and 1,700 cubic metres per capita, and „water scarce" if its renewable freshwater supplies are less than 1,000 cubic metres per capita (United Nations Environment Programme, 2002). Kenya is in the „water scarce" category and thus concerted efforts are required to alleviate the situation. In addition to conserving water catchment areas to increase availability of water resources, the already available water must be utilized sustainably with special emphasis on UFW reduction.

NZOWASSCO was working on the named strategies among others in a bid to reduce UFW realized within the WSP. UFW in NZOWASSCO at the time of study stood at 41.2%. This value was too much with a gap of close to 20% against the global accepted rate of 10% to 12%. This was enough to show that the strategies in place were not effective enough. It was therefore significant that the existing strategies be assessed and recommendations forwarded that would enable reduce the current UFW rate (ROK 2013).

The diagram below is a representation of the chronology or rather the trend of UFW recorded in NZOWASSCO between the periods of 2012 to 2013.It is noted that the rates range from 40% to 43%.

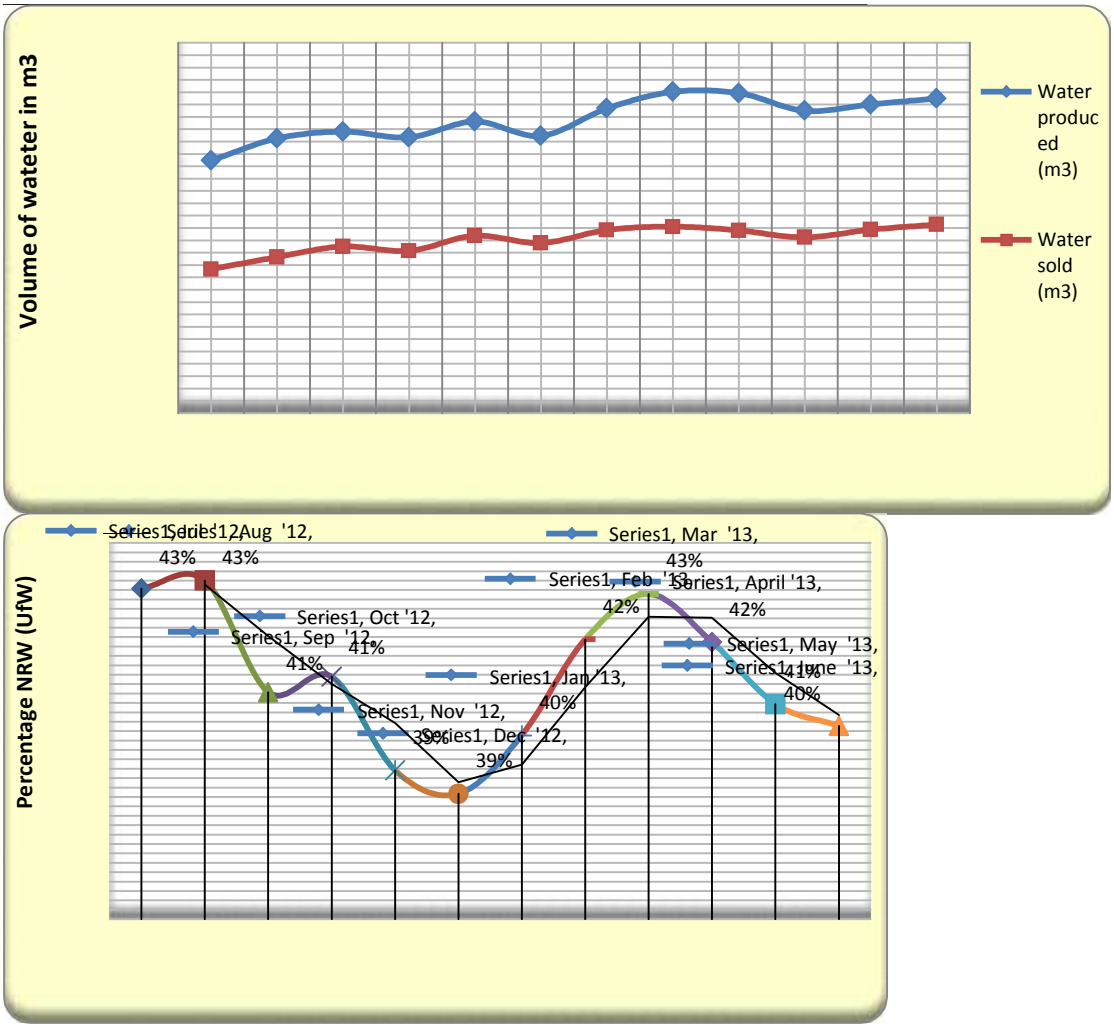


Figure 2.1: Comparison of water produced and water sold, m³Percentage NRW

Source: ROK 2013

The table below gives a preview of the readings that relate to financial capability relating to NZOWASSCO'S management. These figures are enough to indemnify the current struggling nature of the WSP and thus gave impetus to the need to come up with best recommendations whatsoever.

Table 2.1

Nzowassco Revenue Collection Data

Schemes: Kitale, Webuye, Bungoma, Kimilili and Malaba- Kocholia
Population served: 268,723 Registered connections: 27,304,
Water production: average of 475,744 m^3/ month Water sold: average 280,199m^3/ month
Annual revenue billing: Ksh. 227,114,103 Annual revenue collection: Ksh. 230,842,089.
Average monthly expenditure (out of revenue collected): 66.3 % UFW: average 41.2%.

Source: ROK 2013

With a net revenue of Ksh. -590, 572, NZOWASSCO is actually in dire need of restructuring and strategic management.

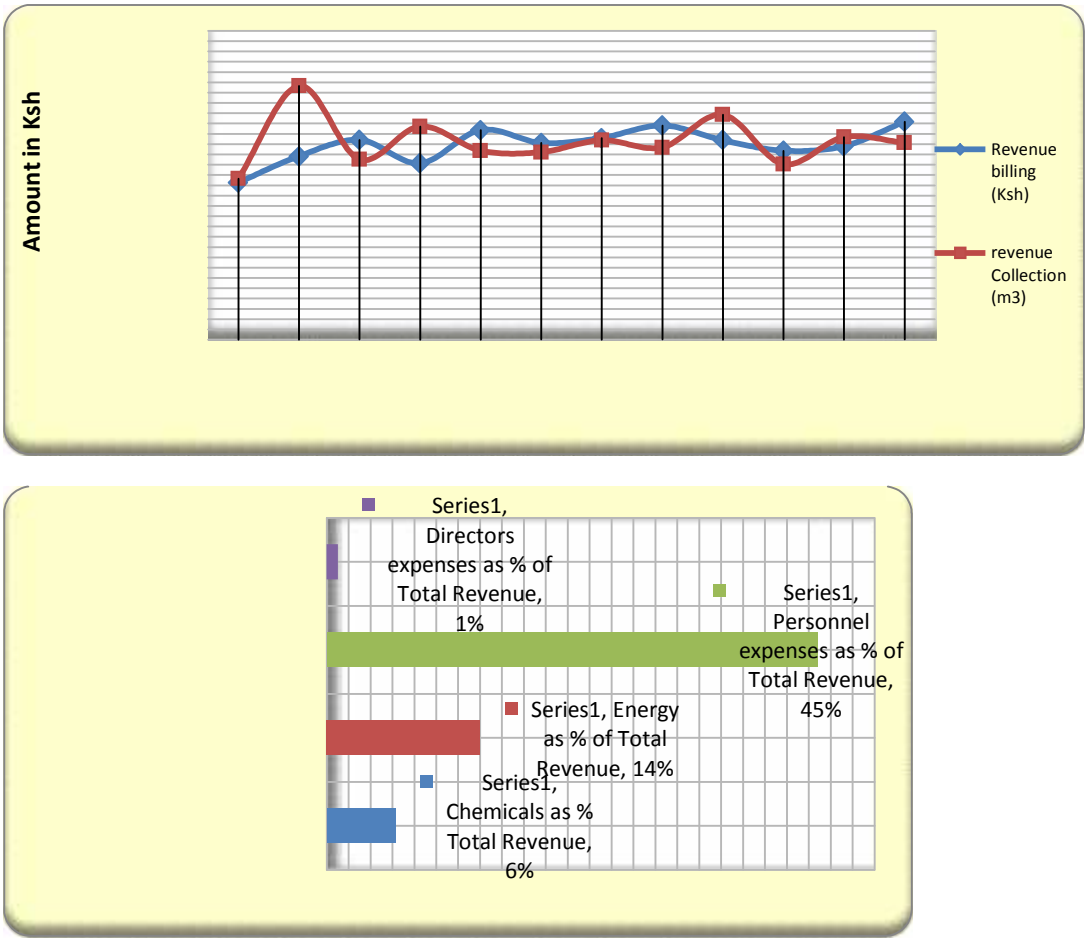


Figure 2.2: Revenue billing and revenue collection (Ksh) Comparison of Expenses as % of total revenue collected

Source: ROK 2013

2.3 UFW Reduction and the Millennium Development Goals

The importance of improved water supply, sanitation and hygiene has been recognized and is an inclusion as one of the specific targets in the framework of the Millennium Development Goals. It is among the 2015 targets set for these goals. That is, a commitment to reduce by half the proportion of people without sustainable access to safe water and sanitation. Indeed; equitable access to water supply is a common thread to achieving all the MDGs and poverty reduction. Therefore UFW reduction is a major component in mitigating the prevailing water scarcity condition in Kenya (ROK, 2007).

Linkages with Poverty Reduction

Water supply is a key driver for development, a condition for productive and healthy lives, and therefore contributes towards poverty eradication. Water is multi-functional and it"s various functions are complementary and synergistic. All these functions, including productive uses, should be taken into account when reducing UFW to support sustainable livelihoods and local economic development (ROK, 2007).

It is worth to note that high levels of Unaccounted for Water come from leakages, poor accounting among others. The latter affects heavily the financial status of Water Service Providers. It has been proven over time that resorting to reduce water losses yields a number of direct benefits. Such benefits may include an increase in cash flow, a reduction in consumption of energy, cost of production of water among others. It is therefore easily recognizable that with low income for water suppliers it translates to increased poverty passé (UN, 2006).

The World Bank actually approves the linkage of high levels of Unaccounted for water to increased poverty levels due to a number of their discussions. In 2006 for instance, an excerpt from a discussion paper approves the same (Rao Vijayendra, 2006).

"The global volume of non-revenue water (NRW) or water losses is shocking. Each year more than 32 billion m3 of treated water is lost through leakages from the distribution networks. An additional 16 billion m3 per year is delivered to consumers but not invoiced because of theft, poor metering, inadequate billing systems, or illegal use. A conservative estimate of the total annual cost to water utilities worldwide is US$14 billion. In some low-income countries this loss represents 50 -60% of water produced, with a global average estimated at 35%. Saving this amount would emanate to an increase in supply of water to an additional 100 million people without further investment in water production and distribution systems" (World Bank, 2006).

2.4. Strategic Management of the Water Resource

The almost limitless reach of water requires a strategic focus on establishing the parameters of integration that will allow for better management of the resource, as there is a fine balance between effective integration and creating unmanageable complexity (GWP Technical Committee, 2004).

According to the UN Water Annual Report 2012, one of the core strategies of the institution is to ensure that UN-Water continues seeking avenues that will ensure an improvement in its services for members as well as partners access at the country level.

As it stands, it has been approved with a number of scholars that water as a utility only goes through a viscous cycle that ends up not solving the problem as it stands. Rather, it is expected that every water Supplier should ensure the utility undergoes a virteous cycle that ends up giving back pleasant returns (Liemberger et al 2006).

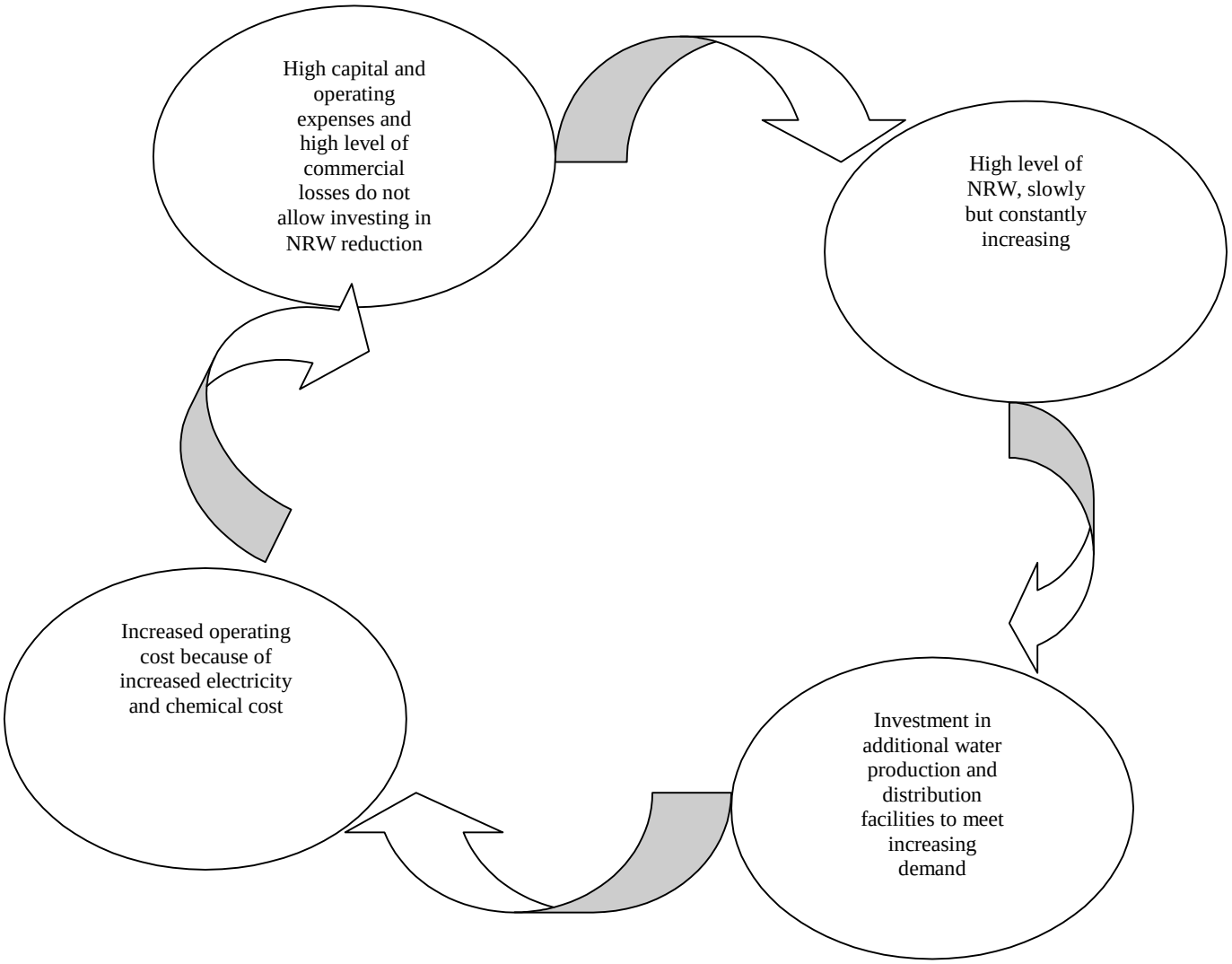


Figure 2.3: The vicious NRW cycle

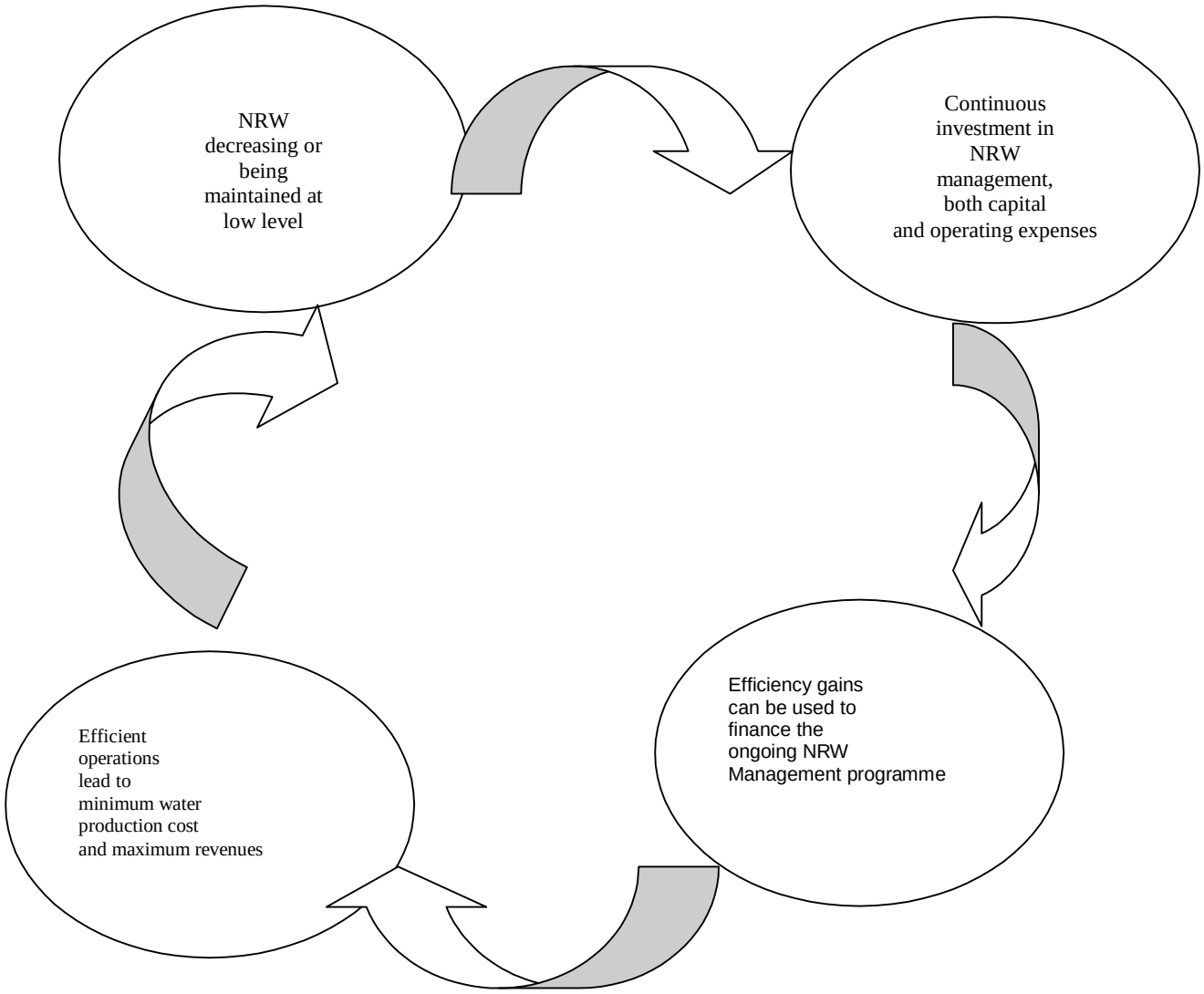


Figure 2.4: The virtuous NRW cycle

Strategic management is a set of managerial decisions and actions that determine the long term performance of a corporation. It includes environmental scanning (internal and external), strategic formulation, strategic planning, strategic implementation and strategic evaluation (Hungar and Wheelen 2007).

Chandler (1962) divided Strategy into four. He first and foremost looked at strategy as a process. This is where it is looked at as a management activity used in the shaping of expectations and goals. As a competitive position, Simon describes strategy as the way firms compete in their markets through differentiation. He also gave the business level strategy as the way a firm competes in a given business and lastly positions itself among competitors. Lastly as Corporate level, strategy is viewed as competing effectively through the allocation of scarce resources.

UFW reduction strategy should put into place measures that will ensure that all components of UFW are covered and that the proposed strategy is feasible in terms of physical application and financial requirements. There is need to come up with a team which should comprise members from each operational department, including production, distribution, and customer service. It may also include members from the finance, procurement, and human resource departments. Choosing the right members promotes ownership by the utility"s various departments involved in the strategy"s implementation, and also ensure consensus by senior management. The UFW challenge can only be properly understood after the NRW and its components are quantified, the appropriate performance indicators calculated, and the lost water volume is translated into its corresponding economic value (Liemberger et al 2006).

2.5 Theoretical Reviews

This section deals with review of theories relevant to the area of study, two major theories were identified; the Resource Dependency Theory and Crossing the Structuration Theory.

2.5.1 Resource Dependency Theory

Resource Dependence Theory (RDT) is the study of how the external resources of organizations affect the behavior of the organization. The proponents of this theory are Pfeffer and Salancik. The argument of Resource Dependence Theory is that; Organizations are dependent on resources, these resources ultimately originate from the environment of organization and the environment to a considerable extent contains other organizations. The resources one organization needs are thus often in the hand of other organizations and the resources are a basis of power. Legally independent organizations can therefore be dependent on each other and power and resource dependence are directly linked (Pfeffer, 1978).

Pfeffer and Salancik (1978) utilized the previous environmental literature to develop Resource Dependence Theory which is based on the notion that environments are the source of scarce resources and organizations are dependent on these finite resources for survival. Lack of control over these resources thus acts to create uncertainty for firms operating in such an environment. Therefore, organizations must develop ways to exploit these resources, which are also being sought by other firms, in order to ensure their own survival. Resource Dependence Theory suggests that a firm"s strategic options are determined to a great extent by the environment. Since firms are dependent on the environment for resources, they need to enact strategies that would allow them to acquire these resources. However, those who support the notion of managerial choice argue that some organizations are more effective than others in the same environments, thus proving that strategic choice does exist (Pfeffer, 1978).

The Resource Dependency Theory in this case is applicable in institutions vested with management of water supply systems. The WSPs acquires resources from the external environment therefore, they need to map up strategies for acquisition of the requisite resources competitively. Consequently, the choices made in management of the acquired resources determine sustainable utilization or lack thereof (Pfeffer, 1978).

2.5.2 Theory of Structuration

The theory of structuration, proposed by Anthony Giddens (1984) is an attempt to reconcile theoretical dichotomies of social systems such as agency/structure, subjective/objective, and micro/macro perspectives. The approach does not focus on the individual actor or societal totality but social practices ordered across space and time (Giddens 1984). Its proponents adopt this balanced position, attempting to treat influences of structure and agency equally.

The theory of structuration holds that all human action is performed within the context of a pre-existing social structure which is governed by a set of norms and/or laws which are distinct from those of other social structures (Giddens 1984). Therefore, all human action is partly predetermined based on the varying contextual rules under which it occurs. However, the structure and rules are not permanent and external, but sustained and modified by human action (Giddens 1984).

In organizations, structures are rules and resources organized as properties of social systems. The theory employs a recursive notion of actions constrained and enabled by structures which are produced and reproduced by those actions. Consequently, this theory has been adopted by those with structuralist inclinations, but who wish to situate such structures in human practice rather than regard them as an ideal type or material property.

The performance of water supply systems of WSPs is dependent on the regulatory mechanisms which are enforced by WSBs, WASREB and WRMA. The institutional structures of the WSPs and the cultural beliefs of the communities being served as well affect performance of the water supply systems. Some cultural beliefs inhibit efforts towards commercial exploitation of water as a resource and thus become a major bottleneck in attempting to reduce UFW.

2.6 Empirical Review

2.6.1 Sustainable Resource Utilization

The management of water resources presents numerous challenges to decision makers in developing countries and it requires a comprehensive approach for any meaningful results to be

achieved (Weng, 2009). A sustainable water supply system requires responsible management of resources putting into perspective meeting the needs of the public at large. Though resources are usually limited, optimal utilization would yield remarkable improvements and thus contribute significantly to reduction of UFW. The available resources need to be examined and optimally allocated to the various areas as per the planned activities. Kumar (2008) argues that in some Indian cities UFW is more than half of the water produced and thus benchmarking is necessary where utilities with reduced UFW and improvements in service delivery are credited. A strong and proactive management team to motivate and supervise the work force in order to reduce the large volumes of water lost annually is necessary (Kumar, 2010). Plessis Du argues that, with water supply systems under pressure due to staff shortages, there is need for benchmarks to assist them with the planning process of their water infrastructure (Du Plessis, 2007).

According to Biswas and Tortajada (2010), the level of UFW in Phnom Penha Water Supply Authority, in Cambodia was well over 70% in 1993. The staff was demoralized due to poor governance, miserable pay, indiscipline, lack of motivation, and persistent corruption. A strict regime with interrelated components were designed and implemented. The work culture was fundamentally changed by enforcing strict discipline. This was an uphill task since the rest of the public sector employees in Cambodia were in a similar situation. During the 15-year timeframe of transformational change management, Phnom Penh Water Supply Authority experienced a transmutation with enlightened management, dedicated and competent staff. This resulted to reduction of UFW from 72% to 6.19% (Biswas and Tortajada, 2010).

2.6.2 Monitoring and Control Measures

Monitoring involves supervising activities in progress to ensure they are on-course and on-schedule in meeting the objectives and performance targets (Business Dictionary.com, 2011). Monitoring helps stakeholders to track the progress in the achievement of the water and sanitation targets, reduction in water leakages in the supply systems contributes significantly to achievements of the targets. Leak detection techniques for pipelines include secondary containment with interstitial monitoring, vapor monitoring, groundwater monitoring, statistical inventory reconciliation, and tightness testing. Pressurized piping should also have an automatic

line leak detector. Advancement in metering expertise has shifted the focus to monitoring and systems management. Monitoring of water flow in the supply systems, leakage reduction and apt billing are important aspects of UFW reduction (Krohne, 2010.) According to Alexander Krohne, (2010), using telemetry data offers a distinct advantage especially when monitoring night flow and leak detection. This is because the readings are taken at the same time, making comparisons and trends easier to comprehend.

Krone (2010) argues that since mechanical bulk meters are the most widely used metering devices by local authorities, water providers and water boards monitoring of leakages should be done on a continuous basis using the bulk meters. The meters should be installed at strategic points in the supply system and the readings compared with the sum of domestic water meters in that specific area.

Leakage occurs in all water supply systems, as noted by Hope (1892) pp 2005, "there is no water supply in which some unnecessary waste does not exist and there are few supplies, if any, in which the saving of a substantial proportion of that waste would not bring pecuniary advantage to the Water Authority". The amount of water leaked in water supply systems varies widely between different countries, regions and systems, from as low as 3-7% of distribution input in the well maintained systems in The Netherlands (Beuken *et al*. 2006) to 50 plus % in some undeveloped countries and less well maintained systems.

Leakages cause inefficient energy distribution through the network and also may affect water quality by introducing infection into water distribution networks in low pressure conditions (Puust *et al*, 2010). It is crucial that monitoring of water system leakages is done efficiently to ensure that timely remedial measures are taken. The monitoring devices particularly leak detectors guide the repair and maintenance teams to exact problem areas making their work easier and efficient (Puust *et al*, 2010).

Control measures are the physical efforts (hardware) aimed at improving information flow and network visibility that will enhance control of the water supply systems. The success or lack

thereof is identified; risk prone areas are also mapped and targeted for improvement. UFW is not only due to the status of the infrastructure but also as a result of poor approaches in management and monitoring.

Administrative causes range from illegal connections, lack of measuring devices, inaccurate meters, mistakes in billing, laxity in meter reading and poor record keeping. Usually, improvement of UFW of infrastructural nature would require investment levels that may not be available to a typical WSP within the required time frame. On the other hand, collection efficiency depend largely on how well a water utility has put measures towards ensuring that as much revenue as possible is collected during each billing event (ROK, 2010). The current inefficiencies in the water supply systems resulting to high UFW emanate from poor control systems. With the new tools of detecting water loss, the water industry underwent a paradigm shift toward sounder water loss management. Water utilities provided accountability operations by auditing their operations and then implemented controls to keep system losses to reasonable minimal levels (Deborah, 2009).

According to the empirical study conducted in Tamil Nadu, India, there is a cost in feeding the piped water supply system with water and thus UFW adds on to operations and maintenance costs (Ramesh and Narayanasamy, 2010). This is in addition to the serious issue of water sources becoming increasingly exhausted. Consumers should be unacquainted with the cost of water wasted unnecessarily without anybody benefiting. Applying appropriate control measures to reduce water loss can contribute significantly in improving efficiency of the water supply systems. Bahrain, a Gulf State reduced its levels of unaccounted-for-water (UFW) from nearly 32% in 1993 to just over 23% in 2001. The reduction was made possible due to a leakage detection and control programme involving the replacement of old pipeline systems. (Global Water Intelligence, 2003).

2.6.3 Regulatory Framework

This refers to a set of interrelated conditions such as legal, organizational, fiscal, informational, political as well as cultural factors that impact on development and sustenance of water systems.

According to the Baltimore Charter for Sustainable Water Systems (2007), regulations have been written set standards for large, centralized systems in separate parts of the water cycle. Although governance assessments in most Water Supply and Sanitation (WSS) generally focus on the relationships between the agencies responsible for WSS services and those who receive the services, consideration is given to individuals, households and settlements that have no relationship with these formal agencies. Osinde, (2007) argues that enhancing water governance goes beyond ensuring that policies and institutions are in place, and captures issues of water access to water resources and information.

In Kenya, the MoWI is mandated to provide an enabling working environment to WSBs and the WSPs; this is done in collaboration with various autonomous institutions in the water sector. Inadequate enforcement of the stipulated regulations and ambiguity/overlap of mandate of the various water sector institutions results to challenges in management of water supply systems. WSBs do not enforce regulations as required and thus some WSPs do not comply fully particularly on reporting and thus an impediment to development of a sector investment plan (ROK, 2010). The ROK (2010) performance report further states that WSB submits limited information on water supply and sanitation, investments undertaken and subsidies received in the sector. In order to fulfill the criteria for the human right to water and sanitation, the sector need to enforce the provisions of the Water Act 2002 that oblige all water service provision to be regulated.

2.7 Conceptual Framework

Conceptual framework is a group of concepts that are broadly defined and systematically organized to provide a focus, a rationale, and a tool for the integration and interpretation of information (Mosby, 2009). The interconnection of these concepts completes the framework for certain expected outcomes. A conceptual framework explains the relationship between the independent and dependent variables. In this study, the conceptual framework indicates the relationship between the dependent variable which is reduction of UFW and the independent variables which are; sustainable resource utilization, monitoring measures, control measures,

technology advancement and regulatory framework. These variables affect the output of a water supply system. The following is a diagrammatic representation of the above relationship;

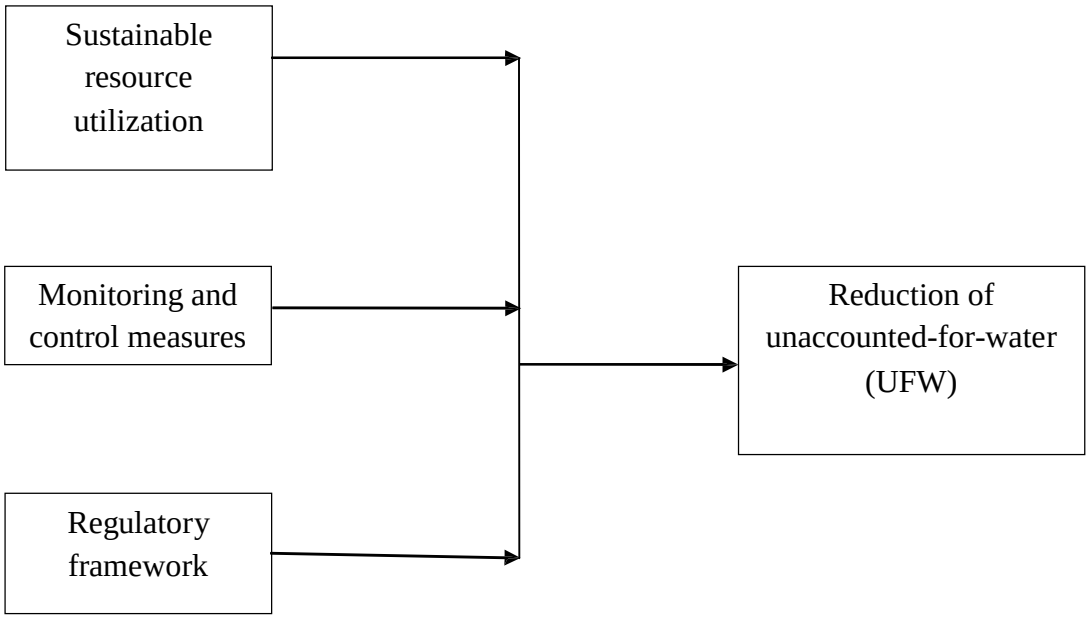


Figure 2.5 Conceptual Framework
Source: Author

The three independent variables are important in addressing the challenges of high UFW levels in water supply systems.

2.8 Critique of the Existing Literature

The existing literature indicates the emphasis in most of the studies is mainly on components of UFW and the implications of water wastage; the aspect of strategies to reduce UFW is not conclusively covered. An example is the poverty reduction strategy paper which indicates that the deterioration in the water supply situation has been as a result of poor management of water supply schemes and rampant destruction of water catchment areas, however there are no strategies identified to surmount the challenge. The information is not conclusive and where available it is scanty (ROK, 2010).

2.9 Research Gaps

The literature reviewed from journals publications and research materials address issues on components of water loss, governance, water resource management, the cost and percentages of UFW, deficiencies in water distribution systems, challenges of reducing UFW, and political constraints to water demand management, water loss determination and causes of UFW. Such studies are scientifically skewed. A move to the management perspective was advisable. Knowing the problem was not enough but handling it was better. There was little information regarding solutions to UFW in Kenya particularly in NZOWASSCO. Therefore it was necessary to undertake a comprehensive study on strategies for reduction of UFW. It was expected that a significant reduction in UFW will improve access to available water and cost savings made would be utilized to improve the existing water supply systems.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter articulates the methodology and procedures that were used for collecting and analyzing data relevant to the research on the strategies to reduce UFW for water supply systems. Explicitly it describes the research design, target population, sample and sampling procedures, research instruments, their reliability and validity, data collection and data analysis procedures.

3.2 Research Design

This is a descriptive research design. The simple random sampling technique was used to aid data collection in this study. The technique was suitable for the research since it is one organization with a small population under study. The technique also works in the instance that finding all the staff at once may be hectic. The research design on the other hand was suitable because it secured chance of observation ,it also provided for accurate descriptive analysis of characteristics of a sample which were used to make references about population (Popham1967).

3.3 Research Location

In this study, NZOWASSCO Bungoma branch was chosen as the study area, it is located in Bungoma town. The intended region where the research was to be done was quite large. NZOWASSCO is mandated to manage water services in Bungoma municipality through a signed service provision agreement with LVNWSB. NZOWASSCO"s water supply network covers about 65% of the Bungoma municipality (Owuor and Foeken, 2009).The selection of NZOWASSCO was because the researcher had established that the company could only supply approximately half the water demand in Bungoma municipality (WHO, 2009) . Therefore, improvement in its water supply system through reduction of UFW significantly contributed towards improved water accessibility.

3.4 Target Population

A population refers to the entire group of people, events or things of interest that the researcher wishes to investigate(Orodho 2002).

The target population was all the 148 NZOWASSCO"s employees. The sample was selected using the formulae method where sample size is computed at a 95% confidence level. The formulae is denoted as:

$$\frac{}{}$$

Where n is the sample size

N is the population size

e the precision level.

3.5 Sampling Design and Sample Size

A sample is a small portion of a target population **(**Orodho, 2002**)**. Sampling means selecting a given number of subjects from a defined population as a representative of that population. The simple random sampling technique was used to select the subjects. Using the formulae method outlined below the researcher picked a sample of 108 in size at 95% confidence level ,at 0.05 level of precision(e).

$$\frac{}{}$$

n=108

3.5.1 Sampling Procedure

The researcher got a complete list of employees from NZOWASSCO. The researcher assigned each employee a number in the list and then drew a set of random numbers from the list which identified the 108 employees sampled.

3.6 Research Instruments

To enhance the value of the research, the researcher used questionnaire method for data collection. A questionnaire is a preformulated written set of questions to which respondents

record their answers. To ensure the survey was done in the required timeline, the questionnaire was administered face to face.

The items in the questionnaire were developed to address the specific objectives of the study. The questions were both close-ended and open-ended.

3.7 Validity and reliability of the Instruments

Mugenda and Mugenda (2003), define validity, as the accuracy and meaningfulness of inferences, which are based on the research results while reliability measures the extent to which certain research instruments yield steady outcomes or results every other time they are administered. The researcher ascertained instrument validity by comparing the pilot study responses to the expected responses. The reliability analysis involved 10 respondents where for each respondent; there were 20 main items that required their responses. Discrepancies were addressed by relevant adjustments, corrections and rephrasing of statements where necessary. Content validity was used to examine whether the questionnaire answered the research questions. The supervisors also checked for validity and reliability of the instrument used and advised accordingly.

3.8 Data Collection Method

Face to face administration method of the questionnaires was used. This method allowed for probing and clarification of any other issues during the data collection. The researcher"s tasks in data collection were to provide focus, observe, give direction, being sensitive to clues given by respondents, inquiring, questioning, listening and combining statements.

3.9 Data Analysis and Presentation

Data analysis is the process of gathering, modeling and transforming data with the goal of highlighting useful information, suggesting conclusions and supporting decision making. To ensure that the data was appropriate, accurate and reliable for further analysis, the researcher did data editing, data coding and data entry.

Data cleaning involves inspecting and correcting erroneous entries to ensure there is completeness of data. Data coding involves assigning numbers to the open ended questions. Data entry involves entering the data into the computer program ready for statistical manipulation.
The researcher used (SPSS) Statistical Program for Social Scientists. The analysis involved descriptive statistics such as mean and frequencies. The study also involved inferential statistics and correlation analysis as well as regression analysis in particular. To present the information, the researcher used figures and tables. Additionally the researcher made interpretive commentary about trends and issues coming out of the data.

3.10 Ethical Issues

Ethics deals with values relating to human conduct, with respect to the rightness and wrongness of certain actions and to the goodness and badness of the motives and ends of such actions (dictionary.com, 2014). Ethics in research is used to gauge the appropriateness of the researcher"s behavior in relation to the rights of those who become the subject of the research or are affected by it. It is also code of conduct or behavior appropriate to academic and conduct of research.

On the part of the participants, this research put into practice a number of ethical considerations including upholding the privacy of participants through non-inclusion of participant"s names in the questionnaires. The consent and possible deception of participants was also be approved by the researcher in course of the process.

4.0 CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter is comprised of data analysis, presentation and interpretation of the findings. The data presented includes the response rate, reliability analysis, background information of the respondents, areas of sustainable resource utilization to facilitate reduction of UFW, appropriate monitoring and control measures for reduction of UFW and assessment of possibilities of improving the existing regulations to facilitate efficiency of water supply systems and inferential Analysis. The data analyzed and presented was based on responses to the items in the questionnaires administered. Descriptive statistics as well as inferential statistics were used in analyzing the findings of this research project.

4.1.1 Response Rate

In the study, 108 questionnaires were administered to 108 employees of NZOWASSCO. 96 questionnaires were successfully filled. This represented a response rate of 88.9 percent which was favorable. Mugenda and Mugenda (2003) asserts that a 50% response rate is adequate, 60% good and above 70% rated very good. This implies that the sample was a very good representation of the entire population.

4.1.2 Reliability Analysis

The reliability analysis involved questionnaires from 10 respondents, for each respondent; there were 20 main items that required their responses. Based on the responses, Cronbach"s alpha was calculated by application of SPSS. The following is a table representing the results of the reliability analysis.

Table 4.1 Reliability Results

Variable	Cronbach alpha	No of items
Sustainable Resource Utilization	0.737	4
Monitoring Measures	0.794	4
Control Measures	0.915	4
Regulatory Framework	0.625	4
Overall	**0.767**	**20**

Reliability of the scale for the constructs describing the variables was 0.767; this is a reliable coefficient since Cooper & Schindler (2008) argues that; scales of 0.7 have an acceptable reliability coefficient. From the researcher"s perspective, the instruments had an acceptable reliability coefficient and were appropriate for the study. This implies that the results of the study were reliable and can be generalized on the entire population.

4.2 Background Information

In order to achieve the main purpose of this study, the researcher found it vital to get the background information of the respondents, the information sought included: gender, position in the institution"s hierarchy, highest level of education attained, areas of specialization, department deployed, alignment of duties and responsibilities with the job description and years of experience.

4.2.1 Gender of Respondents

This research sought to find distribution of workers in Nzoia Water and Sanitation Services Company by gender. The Study findings indicated the distribution of the respondents by gender. There were 96 respondents in total. The distribution is as shown in the figure below, 73% male and 27% female. On its own, this implies that gender parity is yet to be achieved in the study area.

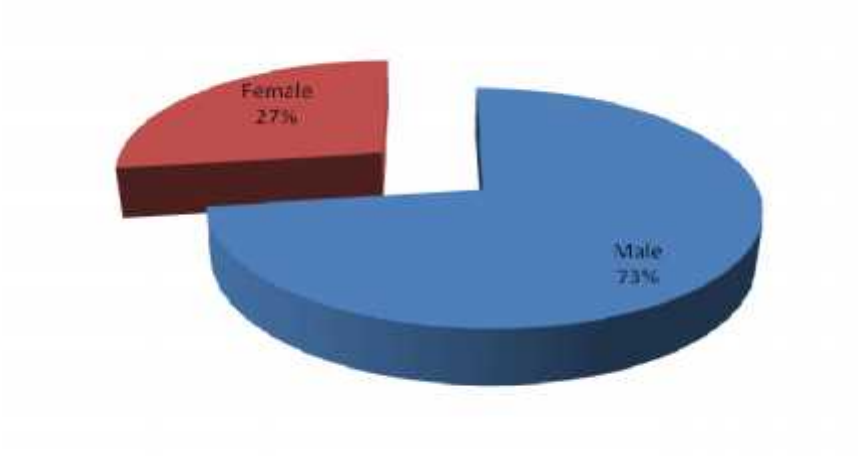


Figure 4.1 Gender of the Respondents
Source: Author (2014)

This suggests that there was a fair gender distribution. In the researchers view, most of the tasks in WSPs on operations are suited for male staff whereas the responsibility of ensuring that water is available in most households is vested on women; the gender distribution is in favour of the institution studied as well as the beneficiaries.

4.2.2 Background of the Organization

This section is comprised of questions in regard to background of the organization; hierarchy in the organization, level of education, areas of specialization, department deployed, responsibilities and years of experience.

4.2.2.1 Levels of Seniority of Respondents

The question sought to establish the levels of seniority of respondents in their respective institutions; the graph below shows the hierarchy of the respondents;

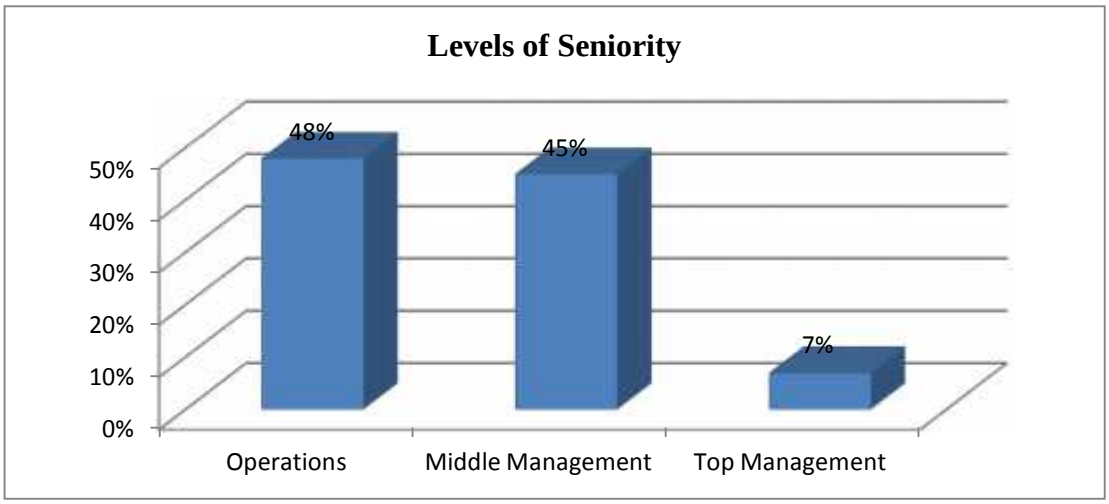


Figure 4.2 Hierarchy in the Organization

Source: Author (2014)

As expected, the study indicates that operations department had the majority of staff at 48%; middle management had 45% whereas top management had only 7%. This suggests that majority of the staff are involved in operations of the water supply systems, they interact with consumers regularly and thus understand the various aspects of UFW. According to the researcher, the findings confirms that, there are adequate staff in the respective departments to undertake the required monitoring and control measures; however efficient staff management is required for optimal results to be realized.

4.2.2.2 Highest Level of Education Attained by Respondents

The Study sought to investigate distribution of workers in Nzoia Water and Sanitation Service Company by academic qualification. The results were as indicated in the below.

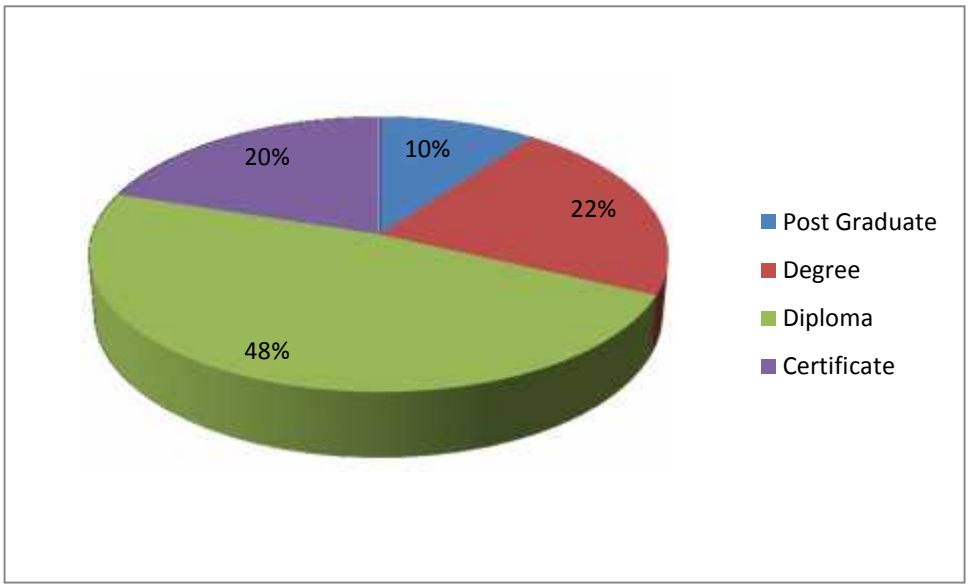


Figure 4.3 Highest Level of Education Attained
Source: Author (2014)

From Figure 4.4 above, the study established that diploma was the highest level of education for majority of the staff at 48%, the staff who had attained the first degree were 22%; those with basic certificates were 20% whereas only 10% had attained post graduate qualification. This suggests that majority of the staff may be deficient of modern skills in operations and management and thus continuous capacity building should be undertaken to inculcate a culture of learning and as such equip them with the requisite skills and knowledge to facilitate efficient management of the water systems.

4.2.2.3 Areas of Specialization of Respondents

The question aimed at establishing the areas of educational specialization of the respondents; the following is a graph indicating the respondents" areas of specialization;

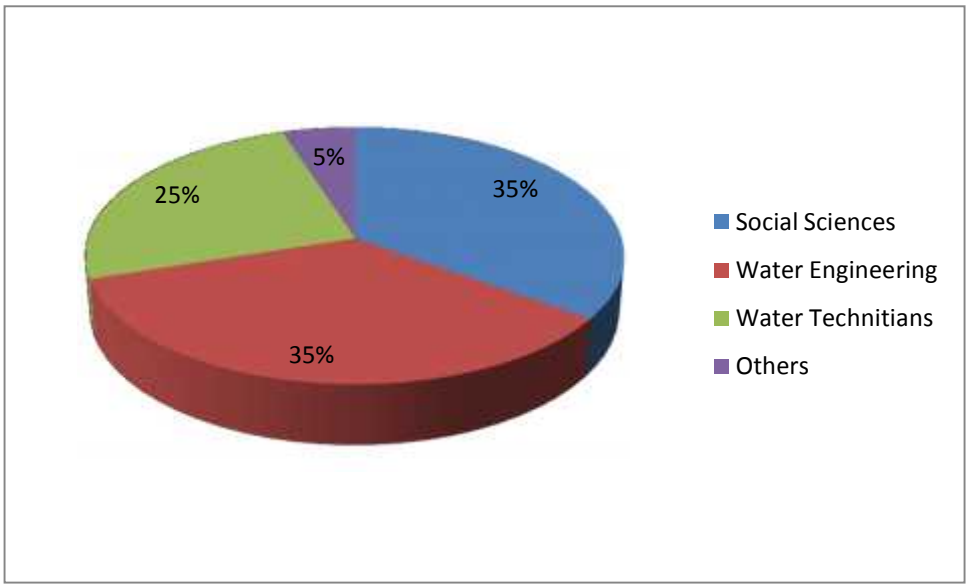


Figure 4.4 Areas of Specialization
Source: Author (2014)

The study indicates that majority of the staff had specialized in either social sciences or water engineering at 35% for each discipline; the water technicians were 25% whereas the other disciplines accounted for only 5%. From the researcher"s perspective, the staff had requisite technical and management skills to contribute towards achievement of the institution"s core mandate of supplying water and sanitation services to consumers. Considering that water supply systems require a blend of both technical and management skills to operate efficiently, the scenario depicted in figure 4.4 above is ideal for optimal performance.

4.2.2.4 Department in Which Respondents are Deployed

The question aimed at identifying the department in which the respondents were deployed, the graph below indicates the respective departments in which the respondents were deployed;

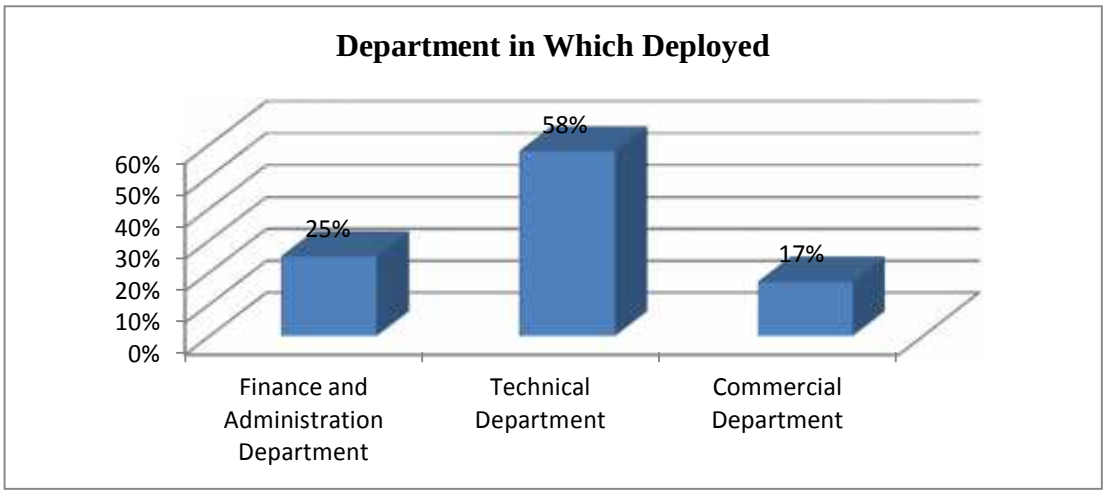


Figure 4.5 Department Deployed
Source: Author (2014)

The study established that the Technical Department had a staff deployment level of 58%, Finance and Administration Department had 25% of the staff whereas the Commercial Department had 17% of the staff. This suggests that majority of the staff were deployed in the Technical Department which is key in any water supply system. According to the researcher, the staff deployment structure at NZOWASSCO is ideal in facilitating adequate operations and management of the institution. The institution has a balanced team with requisite human resources necessary for management and operations of the water supply systems under its jurisdiction.

4.2.2.5 Relevance of Duties and Responsibilities

To further probe on the issue of deployment, the study sought to find out whether duties and responsibilities were in line with respondent"s job description. The following is a graph representing level of alignment of duties and responsibilities with the respective job descriptions for the respondents;

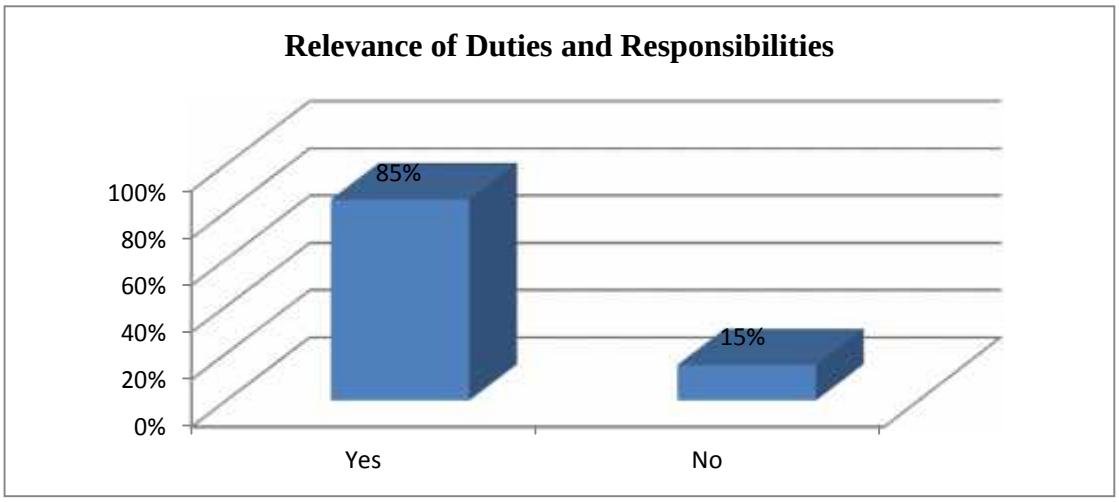


Figure 4.6 Duties and Responsibilities
Source: Author (2014)

The study findings indicated that the duties and responsibilities of the staff were aligned within their respective job description as attested by positive responses of 85%; however it is worth noting that the level of disagreement on the same aspect is at 15%. This suggests that a significant percentage of staff are given responsibilities that are not in line with their job descriptions. From the researcher"s perspective, this is a potential source of conflict amongst staff which can result to poor performance. When staff are given clearly defined duties and responsibilities as per their respective job descriptions, their engagement and motivation is assured and thus good performance is expected.

4.2.2.6 Respondents' Level of Experience

The research was also interested in determining the distribution of workers in the Nzoia Water and Sanitation Services Company by experience as measured by number of years in service. Working experience is an important factor with significant influence on understanding operations of the company and how its performance can be influenced. The results are tabulated in table 1 below.

Table 4.2: Number of Years in Service

Number of Years	Frequency	Percentage
Less than 1 Year	10	10.4
1 - 2 Years	31	32.3
3 - 5 Years	32	33.3
Over 5Years	23	24.0
Total	**96**	**100.0**

The Study found out that 10.4% of the respondents had a working experience of less than 1 years. About 32.3% of the respondent had a working experience of 1-2 years whereas 33.3% each had a working experience of 3-5 year and 24% had a work experience of over 5 years. These findings indicate that majority of respondents had worked for over one year and had the necessary understanding of water service provision.

It also implies that the staff has adequate understanding of the customers and thus capable of performing the duties and responsibilities bestowed on them.

4.3 Respondents' Understanding of Unaccounted-for-Water (UFW)

The researcher sought to establish the respondents" understanding of UFW; the following is a graph representing the respondent"s level of understanding of UFW;

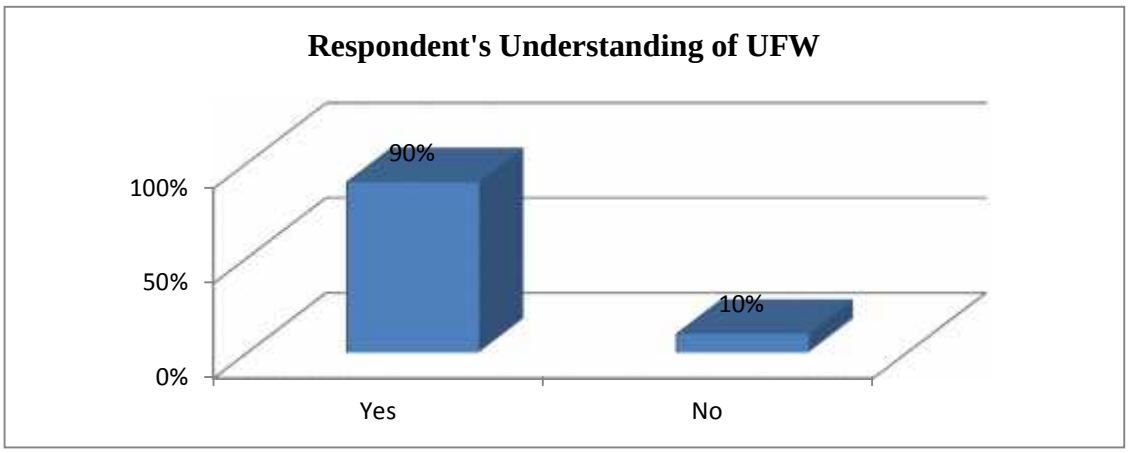


Figure 4.7 Understanding of UFW
Source: Author (2014)

The study findings indicated that the staff"s understanding of the term UFW is at 90%, however there is a significant number of staff who lack knowledge of UFW which is at 10%. This suggests that majority of the staff were aware of UFW and its implications on operations of the water supply system and thus efforts to reduce UFW would bear fruits. However, the 10% who do not understand UFW is a significant percentage that should not be ignored. The researcher is of the opinion that awareness creation and capacity building is necessary in an effort to bring understanding of UFW by all staff at the same level. UFW can only be significatly reduced if there exist a buy-in from all the employee of the WSPs because they are the entry points for the UFW reduction strategies.

4.4 Respondent's Knowledge on Level of Unaccounted-for-Water (UFW)

The question sought to establish the respondents" knowledge on level of UFW; below is a table representing the level of UFW according to the respondents;

Table 4.3 Level of Unaccounted-for-Water (UFW)

	N	Minimum	Maximum	Mean	Std. Deviation
What is the level of Unaccounted-for-water (UFW)?	40	20	56	45	0.063

The study implies that the minimum level of unaccounted-for-water was 20% and the maximum was 56%. This suggests that on average, the level of UFW in the study area was at 45%. The findings agreed with the WASREB impact report, 2010 which indicates that the prevailing level of UFW was 49% at the national level whereas the 2013 NZOWASSCO report indicates that the UFW was 43%. According to the findings, the respondents are informed of the real level of UFW in the company. This relates to no laxity in dealing with the recurring problem which is great influence to revenue collection in the firm.

4.5 Sustainable Resources Management

The question sought to assess areas of sustainable management of resources. The table below indicates the respondents" view on sustainable management of resources;

Table 4.4 Sustainable Resources Management

Sustainable Resources Management	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
	%	%	%	%	%
Sustainable water supply systems require responsible management.	10	12	13	40	25
Optimal utilization of the resources would yield significantly to reduction of UFW	12	13	12	35	28
Available resources should be optimally allocated to the planned activities.	12	15	20	38	15
A strong and proactive management team should motivate and supervise work force in order to reduce the large volume of water loss.	15	17	15	35	18

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.165[a]	12	.601
Likelihood Ratio	10.106	12	.607
Linear-by-Linear Association	4.753	1	.029
N of Valid Cases	400		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.25.

The study findings indicated that sustainable water supply systems require responsible management.The relationship between the variables is significant. In the researchers view, the findings are in tandem with Kumar (2010) who argued that in some Indian cities there was need

for a sustainable resource management. Therefore it can be inferred that in order to reduce the amounts of UFW; sustainable water supply systems require responsible management, optimal utilization of resources and a strong and proactive management is essential.

4.6 Causes of Unaccounted-for-Water (UFW)

This section deals with the causes of unaccounted-for-water; leakages in water systems, illegal connections, storage overflows, customer meter errors, billing errors and authorized unbilled uses.

4.6.1 Causes of Leakages in Water Supply Systems

The researcher sought to establish the causes of leakages in the water pipelines that results to UFW; the following is a table representing causes of leakages in water supply systems;

Table 4.5 Causes of Leakages in the Water Supply System

What are the causes of the leakages in the water supply system?	**Never**	**Sometimes**	**Often**	**Very often**
	%	%	%	%
Old and poorly constructed pipelines	5	40	30	25
Inadequate corrosion protection	20	50	22	8
Poorly maintained valves	10	57	28	5
Damage to main pipeline due to excessive pressure.	7	62	23	8
Poor quality of the pipeline	7	63	27	3
Flushing the mains	7	82	8	3
Mechanical damages	0	63	30	7
Vandalism	0	37	25	38

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.724E2[a]	21	.000
Likelihood Ratio	166.450	21	.000
Linear-by-Linear Association	5.616	1	.018
N of Valid Cases	800		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.00.

The relationship between the causes of water leakages in the Water Supply Systems and reduction of UFW is quite significant owing to the low recorded chi square value. This suggests that there was need to replace the current pipeline, employ adequate corrosion protection, and maintain the water valves to minimize the levels of excessive pressure.

4.6.2 Areas of Illegal Pipeline Connections

The question sought to find out where illegal connections occurred; the table below shows the respondents" view on areas where illegal connections (theft) occur in water supply systems;

Table 4.6 Areas of Illegal Connections

Where do illegal connections occur?	**Never**	**Sometimes**	**Often**	**Very often**
	%	%	%	%
Individual households or plots	0	17	40	43
Commercial entities (carwash, hotels)	0	30	43	27
Corporate institutions (Prisons, colleges)	10	75	15	0

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.205E2[a]	6	.000
Likelihood Ratio	142.821	6	.000
Linear-by-Linear Association	101.939	1	.000
N of Valid Cases	300		

a. 3 cells (25.0%) have expected count less than 5. The minimum expected count is 3.33.

Given the low recorded chi square value, it shows a less strong relationship between areas where illegal connections occur and reduction of UFW. This explains the variable under study being less significant to reduction of UFW. However, to minimize the levels of UFW there is need for continuous monitoring and auditing of household and commercial connections. Deterrent penalties should be imposed on offenders to discourage the vice from perpetuating.

4.6.3 Causes of Water Storage Leakages

The question sought to establish the causes of the water storage leakages; the following is a table representing the causes of the leakages;

Table 4.7 Causes of Storage Leakages

What are the causes of storage leakages	Never	Sometimes	Often	Very often
	%	%	%	%
Overflows at the storage tanks	5	45	30	20
Leaking of the storage tanks	25	15	45	15

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32.048[a]	3	.000
Likelihood Ratio	33.990	3	.000
Linear-by-Linear Association	1.252	1	.263
N of Valid Cases	200		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 15.00.

The great chi square number culminates that there is a strong relationship between the causes of storage leakages and reduction of UFW. This suggests that overflows at the storage tanks and storage tanks leakages need to be controlled.

4.6.4 Causes of Customer Meter Errors

The question sought to establish the causes of customer meter errors. The following is a table showing causes of customer meter errors;

Table 4.8 Causes of Customer Meter Errors

What are the causes of Customer meter errors?	**Never**	**Sometimes**	**Often**	**Very often**
	%	%	%	%
Inaccurate meter reading	7	50	40	3
Air valve problem	13	65	20	2
Installation problems	22	48	20	10
Wrong meter size	45	43	7	5

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	85.164[a]	9	.000
Likelihood Ratio	83.454	9	.000
Linear-by-Linear Association	43.209	1	.000
N of Valid Cases	395		

a. 4 cells (25.0%) have expected count less than 5. The minimum expected count is 3.61.

The high chi square value recorded shows that there is a very significant relationship between the causes of customer metre errors and reduction of UFW. From the researcher"s perspective, accurate reading of customer meters is a pre-requisite to reduction of customer meter errors. Quality air valves used in connections and professional installation of meters as well plays an important role in facilitating accuracy of customer meter readings and thus minimizing levels of UFW. Indeed, customer meter errors may encourage vices such as vandalism and illegal connections once frustration sets in.

4.6.5 Causes of Billing/Accounting Errors

The researcher probed further to find out the causes of billing/accounting errors. The following is a table indicating responses on the causes of billing/accounting errors;

Table 4.9 Causes of Billing/Accounting Errors

What are the causes of billing/accounting errors?	Never	Sometimes	Often	Very Often
	%	%	%	%
Delays in billing	30	55	15	0
Underestimation of flat rates	10	45	30	15
Non-reading of meters	2	58	35	5
Lack of access to customer meters	0	38	55	7

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.004E2[a]	9	.000
Likelihood Ratio	106.994	9	.000
Linear-by-Linear Association	51.845	1	.000
N of Valid Cases	400		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.75.

The low value of chi square recorded goes in tandem with the fact that the relationship between billing and accounting errors and reduction of UFW is not significant. The researcher suggests that in order to control billing errors, it is necessary to have an efficient billing system with adequate control on underestimation of flat rates. Customer meters should be installed in areas where they are easily accessible and appropriate staff deployment should be undertake to ensure consistent and accurate meter reading. Since accounting errors may result to frustration of customers, there are chances that they could consider exploring alternative opportunities to circumvent the systems if the errors are consistently recurring.

4.6.6 Causes of Authorized Unbilled Uses

The researcher sought to establish the causes of authorized unbilled uses; the following is a table representing responses from the respondents;

Table 4.10 Causes of Authorized Unbilled Uses

What are the causes of authorized unbilled uses?	Never	Sometimes	Often	Very often
	%	%	%	%
Fire Fighting	15	38	22	5

The study findings indicate that firefighting sometimes caused authorized unbilled uses of water at 38% and often at 22%. In the researchers view, there could be possibilities that water purported to have been used for firefighting is diverted for commercial use. As a result, the water benefits a few individuals at the expense of the larger population. Therefore, the firefighting department should have an independent metering to minimize the levels of UFW.

The researcher then sought to employ the test below to identify if the data can be subjected to factorization for comparison purposes. KMO was used to measure sampling adequacy that is whether the data can be analyzed using Factor analysis. In this case, the required value should be should be above >0.6. Bartlett"s test of sphericity which was employed in this test is used to measure or test for significant correlation within data. The researcher found the data suitable for factorization since 0.612 is greater than 0.6.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.612
Bartlett's Test of Sphericity	Approx. Chi-Square	553.536
	Df	210
	Sig.	.000

Table 4.11 Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	4.050	19.285	19.285	4.050	19.285	19.285	3.804
2	2.305	10.974	30.259	2.305	10.974	30.259	2.122
3	1.646	7.837	38.096	1.646	7.837	38.096	2.025
4	1.491	7.101	45.196	1.491	7.101	45.196	1.868
5	1.408	6.702	51.899				
6	1.199	5.708	57.607				
7	1.159	5.518	63.126				
8	1.075	5.118	68.244				
9	.981	4.670	72.913				
10	.857	4.083	76.996				
11	.807	3.842	80.838				
12	.699	3.327	84.165				
13	.616	2.934	87.099				
14	.541	2.576	89.676				
15	.514	2.446	92.122				
16	.490	2.334	94.456				
17	.411	1.958	96.414				
18	.259	1.233	97.647				
19	.222	1.058	98.705				
20	.175	.835	99.541				
21	.096	.459	100.000				

The researcher used Principle Content Analysis as the extraction method. In this method, when components are correlated; the sums of squared loadings cannot be added to obtain a total variance. The researcher extracted five factors which explain 52% of the total variance or observations.

Table 4.12 Components of resource Utilization

	Component			
	1	2	3	4
Old and poorly constructed pipelines				.540
Inadequate corrosion protection				.608
Poorly maintained valves				.604
Damage to main pipeline due to excessive pressure.		.376		
Flushing the main			-.537	
Mechanical damage				-.702
Vandalism		-.368		
Individual households or plots			-.733	
Commercial entities; (car wash, hotels)			.401	
Corporate institutions; (Prisons, colleges)			.573	
Overflows of storage tanks.		.547		
Leaking storage tanks		.440		
Inaccurate/incorrect meter reading	.773			
Air valve problem	.831			
Installation Problem	.374			
Wrong meter size	.766			
Delays in billing	-.668			
Underestimates of flat rates	.885			
Non-reading of meters	-.847			
lack of access to customer meters	.560			

Areas where resource utilization should be focused

The researcher found four components where resource utilization should be focused. The first component realized that Customer meter errors and billing problems explains 20% of the UFW problem in the WSP. The second component showed that losses due to leakages explain 11 percent of the problem. The third component on the other hand showed that areas where illegal connections and theft occurs, explains 8% of UFW while the forth component found that poor maintenance of infrastructure, explains 7% of UFW. It is expected then that resources in the WSP should be given preference based on the information provided. More resources should therefore be geared toward customer meter errors and billing problems and less on maintenance of infrastructure.

The total variance is 45%. The rest of the variance is explained by other phenomena which were not specified in this study.

4.7 Appropriate Monitoring Measures for Reduction of UFW

This researcher sought to identify appropriate monitoring measures for the reduction of UFW. The following is a table representing the respondents" view on monitoring measures for reduction of UFW;

Table 4.13 Appropriate Monitoring Measures for Reduction of UFW

Monitoring measures	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
	%	%	%	%	%
Monitoring helps to track progress in the achievement of water supply targets.	15	17	15	35	18
Reduction in water leakages in the supply systems contributes significantly to achievements of targets.	20	15	15	33	17
Monitoring of water flow in the supply systems is an important aspect of UFW reduction.	10	20	15	40	15
Monitoring of leakages in the water systems should be done on a continuous basis.	10	7	10	40	33

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.546[a]	12	.023
Likelihood Ratio	23.422	12	.024
Linear-by-Linear Association	9.457	1	.002
N of Valid Cases	400		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.75.

The great chi square value indicates that mornitoring measures are significant for reduction of UFW. This suggests that in order to minimize the levels of UFW there was need for monitoring of leakages in the water systems on a continuous basis. The findings were in tandem with Krone (2010) who argues that monitoring of leakages should be done on a continuous basis using bulk meters. Monitoring of water systems is crucial in identifying areas that require immediate remedial action to avert avoidable losses.

4.8 Appropriate Control Measures for the Reduction of UFW

This question sought to identify appropriate control measures for the reduction of UFW. The following is a table representing the respondents" view on control measures that facilitates reduction of UFW;

Table 4.14 Appropriate Control Measures for the Reduction of UFW

Control measures	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
	%	%	%	%	%
Inefficiencies in the water supply systems results to high UFW due to poor control systems.	5	2	22	48	23
Water utilities should provide accountability by auditing their operations.	0	5	20	63	12
Implementing controls keep water system losses to reasonable minimal levels.	10	5	20	45	20
Consumers should be acquainted with the cost of water wasted unnecessarily.	12	15	17	44	12

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	38.167[a]	12	.000
Likelihood Ratio	42.553	12	.000
Linear-by-Linear Association	14.754	1	.000
N of Valid Cases	400		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.75.

The research established that appropriate control measures are significant for reduction of UFW following the high value of chi square recorded. This suggests that in order to minimize the levels of UFW in the water supply systems, there is need to implement water loss control measures, ensure customers" acquaintance with the cost of water wastage and provide accountability of WSPs. The findings were in tandem with study by Deborah (2009) who argues

that water utilities should provide accountability by auditing their operations and then implement controls to keep the system losses to minimal levels. Indeed, implementation of appropriate and timely control measures in the water supply systems contribute significantly to reduction of UFW.

4.9 Assessment of Level of Agreement for Regulatory Mechanisms in minimizing UFW.

The researcher sought to establish the level of agreement on adequacy of the regulatory mechanisms in reduction of UFW, the following is a graph representing level of adequacy of the regulatory mechanisms;

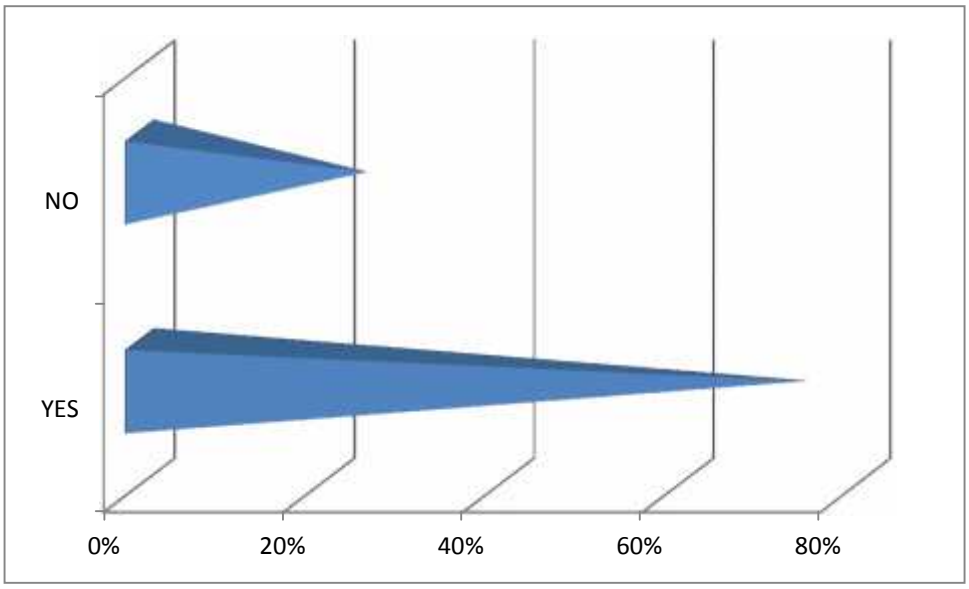


Figure 4.8 Adequacy of the Current Regulatory Mechanism
Source: Author (2014)

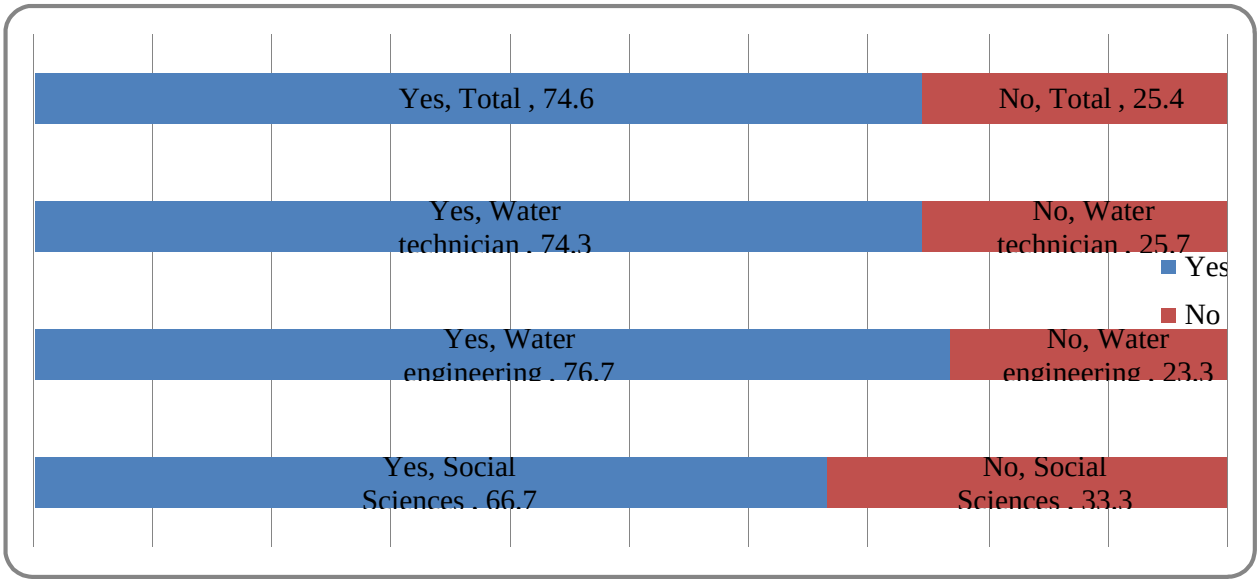
The study findings indicated that the prevailing regulatory mechanisms governing water supply are relatively adequate with a positive response of 74.6% and a negative of 25.4%. The number of staff in disagreement makes a significant percentage and thus it is necessary to address areas of inadequacies for smooth running of the water supply systems. Indeed, the interviews

established that review of the water by-laws and enforcement of punitive penalties for illegal connections would go a long way in improving the water supply systems.

To identify possibilities of improving the existing regulations to facilitate efficiency of water supply systems, the researcher related the respondents to their specific qualifications. 76.7% of those qualified in engineering concurred with the adequacy. Respondents qualified in Social Sciences on the other hand recorded 66.7% and 74.3% of those qualified as technicians responded positively. However a significant 33.3% for Social Sciences, 25.5% technicians and 23.3% engineering qualifiers were seen to have responded negatively.

Despite a cumulative 74.6% positive response, it is worth to note that 25.4% negative response is quite significant and that there is a problem that needs to be handled in this case.

Table 4.15 Adequacy of the Current Regulatory Mechanism as per qualification



Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.269[a]	2	.874
Likelihood Ratio	.258	2	.879
N of Valid Cases	71		

Upon conducting the chi-square tests, it was realized that 2 cells(33.3%) have expected count less than 5.The minimum expected count is 1.52

4.10 Assessment of Possibilities of Improving the Existing Regulation to Facilitate Efficiency of Water Supply Systems

In this question, the researcher probed on possibilities of improving existing regulations to facilitate efficiency of the water supply systems; the table below represents respondents" views on specific areas in the regulatory mechanisms that can be improved;

Table 4.16 Regulatory Framework

Regulatory Framework	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
	%	%	%	%	%
Bureaucracies in the water governance contribute to high levels of UFW.	15	12	18	45	10
Penalties for illegal connections are too lenient hence not a deterrent to the vice.	0	0	10	58	32
Inadequate enforcement of the stipulated regulations results to challenges in the management of water supply systems.	5	20	30	35	10
Water governance should incorporate cultural aspects/dimensions.	0	0	5	55	40

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.416E2[a]	12	.000
Likelihood Ratio	149.783	12	.000
Linear-by-Linear Association	31.460	1	.000
N of Valid Cases	395		

a. 4 cells (20.0%) have expected count less than 5. The minimum expected count is 3.61.

The low probability recorded assumed the fact possibilities of improving existing regulations to facilitate efficiency of the water supply systems as not being quite significant. According to the researcher, in order for UFW levels to decrease, bureaucracies in water governance should be reduced and emphasis put on enforcement of appropriate punitive penalties to deter illegal water connections. The cultural aspects were supported as being essential in water governance and thus should be given outstanding consideration while developing appropriate regulatory mechanisms on water supply systems.

4.11 Correlation Analysis

The researcher carried out correlation analysis to determine the strength of the relationship between the UFW and the independent variables i.e. sustainable resource utilization, monitoring measures, control measures and regulatory framework. The following is a table representing correlation analysis of the dependent and independent variables.

Table 4.17 Correlation Analysis

	UFW	Sustainable resource utilization	Monitoring Measures	Control measures	Regulatory Framework
UFW	1				
Sustainable resource utilization	-.041	1			
Monitoring Measures	-.457	0.135	1		
Control measures	0.038	0.084	0.048	1	
Regulatory Framework	-.332	0.031	.649	-0.183	1

The table above shows that there is a weak negative correlation (-0.041) between UFW and sustainable resource utilization, this suggests/ that an increase in sustainable resource utilization leads to decreased UFW. At the same time, there is a medium negative correlation (-.457) between UFW and monitoring measures, this suggests that an increase in monitoring measures decreases the amount of UFW.

The researcher further carried out a regression analysis on the independent variables (predictors) and the dependent variable. The following is a table representing the regression analysis of the variables;

Table 4.19 Regression Analysis

	B	Std. Error	t	Sig.
(Constant)	59.005	12.67	4.657	0.000
Sustainable resource utilization	0.412	0.452	1.912	0.008
Monitoring Measures	-0.595	0.461	-2.29	0.006
Control measures	0.113	0.529	3.213	0.000
Regulatory Framework	0.002	0.674	0.004	0.997
	.513a			
R Square	0.264			
Adjusted R Square	0.155			
F	21.434			.000

a. Predictors: (Constant), Regulatory Framework, Sustainable resource utilization, Control measures, Monitoring Measures
b. Dependent Variable: UFW

The coefficient of determination R^2 = 26.4%, this suggests that the independent variables sustainable resource utilization, monitoring measures, control measures and regulatory framework explains 26.4% variations of UFW. The f value of 21.434 indicates that the overall regression model is significant hence it has some explanatory value. This indicates that there is a significant relationship between the predictor variables sustainable resource utilization, monitoring measures, control measures and regulatory framework. At 95% confidence interval i.e. P−value ($p=0.00<0.05$) it implies that all the independent variables combined do influence the levels of UFW. Further, from the Table 4.16 control measures has the most statistically significant coefficient as indicated by a t-ratio of 3.213. This suggests that a unit change in control measures will change UFW by .113 units. Monitoring measures has a statistically significant coefficient as indicated by a t-ratio of -2.29. This implies a negative linear relationship with the level of UFW.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The main objectives of the study were; to assess areas of sustainable resource utilization, identify appropriate monitoring measures, identify appropriate controlling measures, and assess areas of improvement in regulatory mechanisms for enhancing efficiency of the water supply systems. This study identified the UFW reduction strategies used by NZOWASSCO, the factors influencing performance of the water supply systems and the challenges facing the water supply systems in regard to water loss. The researcher developed recommendations for reducing UFW which would contribute towards improving the water supply systems in NZOWASSCO. The data was analyzed using quantitative analysis and presented in form of tables and graphs.

The findings of the research are discussed in this section. Descriptive statistics such as frequency tabulations, percentages calculations for each item and selected staff as well as use of measures of central tendencies and inferential statistics was used in this research.

Summary of Findings

The study findings indicates that the respondents were 73% male and 27% female (figure 4.1). This suggests that there was a fair gender distribution. It was established that among the staff sampled, majority were involved in operations of the water management system, they interacted with consumers regularly and thus understood the various aspects of UFW (figure 4.3). Regarding sustainable resource utilization, the findings indicated that NZOWASSCO utilized resources sustainably to a great extent; however there is room for improvement since a significant number of respondents 5% to 10% expressed some level of dissatisfaction (table 4.3).

The findings further showed that 90% of the staff understood the term UFW, however 10% did not have an idea of what UFW mearnt (figure 4.9), which is a significant percentage that should not be ignored. Further, an assessment on causes of UFW revealed that majority of the staff were conversant with the various facets of water leakages. They expressed their views on areas susceptible to illegal connections, customer meter errors, billing errors and authorized unbilled

uses (tables 4.7, 4.8, 4.9 and 4.10) . It also emerged that monitoring and control measures that are essential in management of water supply systems were well understood by the staff, they objectively indicated their views in regard to the various aspects assessed (tables 4.11 and 4.12).

The study established that existing regulatory mechanisms governing water supply were quite adequate though not significant a factor to the reduction of UFW. Finally, the research indicated that management of the water supply systems should reduce bureaucracies, apply appropriate penalties to deter illegal connections and include cultural dimensions in the water governance (table 4.15).

The study also established that there was a very significant relationship between customer metre errors and the reduction of UFW. Mechanical damages and vandalism were some of the main causes of pipeline leakages in the water supply systems. Consequently, non-reading of meters and lack of access to customer meters were identified as key factors contributing to billing errors. Further, a probe on illegal connections established that individual households and commercial entities were the main culprits. Finally, inclusion of cultural dimensions in water governance emerged as a major factor that should be considered while developing regulatory mechanisms as expressed by majority of the staff.

5.1.1 Sustainable Resource Utilization

The study findings showed that sustainable water supply systems and subsequent UFW reduction require responsible resource management. A robust management system ensures optimality in resource utilization and consequent achievement of desired results.

5.1.2 Appropriate Monitoring Measures

Continuous monitoring of leakages in the water systems emerged as an essential aspect in UFW reduction (table 4.11). It was further noted that, monitoring reports is an input to the control level, therefore, it is crucial that accurate monitoring and timely reporting of leakages is done to facilitate on time repairs.

5.1.3 Appropriate Control Measures

The study findings indicate that water utilities should provide accountability by auditing their operations (table 4.12). Transparency and accountability of operations helps in creating confidence to the public, development partners and the employees of the institution. It is an indication that the basic beliefs of corporate governance are practiced.

5.1.4 Regulatory Framework

The study findings showed that lenient penalties for illegal water connections and lack of cultural dimensions in water governance contribute to high levels of UFW. This however was seen not to be quite significant a factor to reduction of UFW. It emerged that, in order to enhance water governance, it is vital to include cultural dimensions. This is in agreement with the theory of structuration which holds that all human action is performed within the context of a pre-existing social structure which is governed by a set of norms and/or laws which are distinct from those of other social structures. Therefore, the behavior of water consumers is partly predetermined based on the varying contextual rules under which it occurs.

5.2 Conclusion

The study indicated that there was a very significant relationship between customer metre errors and the reduction of UFW. Mechanical damages and vandalism are responsible for the high levels of UFW. The situation is increased by the fact that consumption and billing are not synchronized whereas bureaucracies in the regulatory mechanisms and lenient penalties for offenders encourage illegal practices. The essential factors identified as contributing in efficient performance and consequently reductions of UFW are monitoring and control of water leakages as well as inclusion of cultural dimensions in water governance.

Therefore, for UFW to be reduced in water supply systems, it is necessary to employ requisite resource management that controls water loss as well as respecting the cultural values for the people being served. Appropriate regulatory mechanisms are also important to see to it that the rights of all parties are respected and punitive measures are put in place to deter non-compliance.

5.3 Recommendations

In view of the findings of the study, the researcher recommends that; WSPs should put in place measures to reduce levels of illegal water connections, vandalism and customer billing errors as well as ensure inclusion of cultural dimensions in water governance. There is also need for optimal resource utilization complimented by sound management systems and consequently minimizing the levels UFW.

Further, the study recommends that in order for WSPs to improve on monitoring and location of sources of UFW they should ensure accurate measurement of water production and consumption and conduct pipeline mapping to identify legal, illegal, and potential connections. The WSPS should also undertake installation of macro metering of all major supply zones and territories to measure and micro metering for consumers to monitor flows in the distribution network.

Further recommendations from the study are that WSPs should increase consumer awareness on water wastage reduction and reporting of pipeline leakages to the appropriate authorities, this could reduce real/physical water loss significantly. In addition they should undertake detection and control of leaks as well as building up leak history patterns.

5.4 Recommendations for Further Study

This research project focused on assessment of strategies to reduce UFW based on a case study of NZOWASSCO. There is need to investigate further the strategies for reduction of the haphazard water connections and replace them with appropriately designed pipelines. These water connections are usually done unprofessionally, they are water connections characterized by shallow trenching and use of low quality pipes which are prone to physical damages and consequently frequent water leakages. Each consumer connects to the main line that could be 100 to 200 metres from the consumption point. Since the consumer is accountable for the water that is recorded by the meter, there is little or no attention given to water leakages between the connection point from the main line and the individual customer meter.

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APPENDIX I: INTRODUCTION LETTER

P.O. Box 18248 -00100
Nairobi.
E-mail: gnsulungai@gmail.com
Date:

The Chief Executive Officer
NZOIA WATER SANITATION SERVICES COMPANY
P.O. Box.....

Dear Sir/Madam,

REF: <u>REQUEST TO CONDUCT RESEARCH IN YOUR FIRM</u>

I am a student in Kabarak University pursuing a Masters degree in The School of Business Administration, Strategic Management. I am currently conducting a research on the strategies to be adopted for reduction of Unaccounted-for-Water in Kenya.

Having observed that your organization"s mandate as to ensure provision of water and sanitation services to residents within your scope, I therefore wish to request permission to conduct interviews and give questionnaires to your staff. This will be greatly instrumental in helping me acquire accurate and detailed information for my research. The research will be conducted professionally and without undue pressure nor hindrance of the staff schedules. I affirm that confidentiality will be ensured and that the research findings are purely for academic purposes.
All assistance will be highly appreciated.

Yours faithfully,
Gloria Sulungai.

APPENDIX II: QUESTIONNAIRE

Instructions

The questionnaire is designed to gather information on "Strategies to reduce Unaccounted-for-water (UFW) in Nzoia Water and Sanitation Services Company. The questionnaire is divided into two sections. Please complete each section as requested and respond to each question by either checking against the appropriate response or by giving your opinion with honesty. Your response will be completely anonymous and will be used by the researcher for the purpose of this study only. All the information in this questionnaire is CONFIDENTIAL. DO NOT WRITE YOUR NAME anywhere in this questionnaire.

PART A

Background information

1. Gender

   Male ☐ Female ☐

2. Background of the Organization

   a) What position do you hold in Nzoia Water and Sanitation Services Company ?

      Top management ☐

      Middle Management ☐

      Operations ☐

   b) What is the highest level of education attained?

      Postgraduate ☐

      Degree ☐

      Diploma ☐

      Certificate ☐

   c) In the qualifications selected in above what is your area of specialization?

      Social Sciences ☐

      Water Engineering ☐

      Water Technician (Plumbers, meter readers) ☐

d) Which department are you deployed in?

Finance and administration ☐

Technical ☐

Others (Please Specify)……..

e) Are your duties and responsibilities in line with your job description?

Yes ☐ No ☐

f) Years of experience

Less than 1 year ☐

1-2 Years ☐

3-5 Years ☐

Over 5 years ☐

PART B

3. Do you understand what Unaccounted-for-water (UFW) is?

Yes ☐ No ☐

4. What is the level of Unaccounted-for-Water (UFW) in your institution?

……

……

5. Please rate the level of agreement on the following statements on sustainable management of resources; each aspect on a scale of "1" to "5" with "1" Strongly Disagree and "5" Strongly agree.

	Sustainable resource Utilization	*Strongly Disagree*	*Disagree*	*Not sure*	*Agree*	*Strongly Agree*
i)	Sustainable water supply systems require responsible management.					
ii)	Optimal utilization of resources would yield significantly to reduction of UFW.					
iii)	Available resources should be optimally allocated to the planned activities.					
iv)	A strong and proactive management team should motivate and supervise work force in order to reduce the large volumes of water loss.					

6. Causes of Unaccounted-for-water

The table below presents some aspects of water supply systems that may be sources of unaccounted-for-water (UFW). Please rate each factor on scale of "1" to "4" with a "1" to those factors your think are **never** experienced by your water supply system and a "4" to those factors you think the water supply system experience **very often.**

		Never	**Sometimes**	**Often**	**Very Often**
a) What are the causes of leakages in the water supply system?					
i)	Old and poorly constructed pipelines				
ii)	Inadequate corrosion protection.				

iii)	Poorly maintained valves				
iv)	Damage to main pipeline due to excessive pressure.				
v)	Poor quality of the pipeline.				
vi)	Flushing the main				
vii)	Mechanical damage				
viii)	Vandalism				
b) Where do illegal connections (theft) occur?					
i)	Individual households or plots				
ii)	Commercial entities; (car wash, hotels)				
iii)	Corporate institutions; (Prisons, colleges)				
c) What are the causes of water loss in the storage Tanks?					
i)	Overflows of storage tanks.				
ii)	Leaking storage tanks				
d) What are the causes of the customer meter errors?					
i)	Inaccurate/incorrect meter reading.				
ii)	Air valve problem.				
iii)	Installation Problem				
iv)	Wrong meter size				
e) What are the causes of billing/accounting errors?					
i)	Delays in billing				
ii)	Underestimates of flat rates				
iii)	Non-reading of meters				
Iv)	lack of access to customer meters				
f) What are the causes of authorized unbilled uses?					
i)	Fire fighting				

7. Please rate the level of agreement on the following statement as monitoring measures to minimize UFW; each aspect on a scale of "1" to "5" with "1" Strongly Disagree and "5" Strongly agree.

	Monitoring Measures	*Strongly Disagree*	*Disagree*	*Not sure*	*Agree*	*Strongly Agree*
i)	Monitoring helps stakeholders to track the progress in the achievement of water supply targets.					
ii)	Reduction in water leakages in the supply systems contributes significantly to achievements of the targets.					
iii)	Monitoring of water flow in the supply systems is an important aspect of UFW reduction.					
iv)	Monitoring of leakages in the water systems should be done on a continuous basis.					

8. Please rate the level of agreement on the following statements as controlling measures to minimize UFW; each aspect on a scale of "1" to "5" with "1" Strongly Disagree and "5" Strongly agree.

	Control measures	*Strongly Disagree*	*Disagree*	*Not sure*	*Agree*	*Strongly Agree*
i)	Inefficiencies in the water supply systems results to high UFW due to poor control systems.					
ii)	Water utilities should provide accountability by auditing their operations.					
iii)	Implementing controls keep water system losses to reasonable minimal levels.					
iv)	Consumers should be acquainted with the cost of water wasted unnecessarily.					

9. In your opinion are the existing regulatory mechanisms governing water supply management in your organization adequate?

   Yes ☐ No ☐

   If no, which areas are not adequately covered?

   ……
   ……
   ……
   ……

10. Please rate the level of agreements on the following statement as regulatory measures to minimize UFW; each aspect on a scale of "1" to "5" with "1" Strongly Disagree and "5" Strongly agree.

	Regulatory Measures	*Strongly Disagree*	*Disagree*	*Not sure*	*Agree*	*Strongly Agree*
i)	Bureaucracies in the water governance contributes to high levels of UFW					
ii)	Penalties for illegal connections are too lenient hence not a deterrent to the vice					
iii)	Inadequate enforcement of the stipulated regulations results to challenges in management of water supply system					
iv)	Water governance should incorporate cultural aspects/dimensions.					

'Thank you for your response'

PROJECTED BUDGET

REQUIREMENTS	APPROXIMMTE VALUE
COST OF EQUIPMENT	7,000
COST OF COMPUTER TIME	4,500
COST OF STATIONERY	3,000
TRAVEL EXPENSES	8,000
SUBSISTENCE ALLOWANCES	2,500
OVERHEAD EXPENSES	2,000 **TOTAL:26,500/=**