THE EFFECT OF NON-REVENUE WATER ON REVENUE COLLECTION IN PUBLIC WATER COMPANIES

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International Academic Journal of Economics and Finance (IAJEF) | ISSN 2518-2366

Received: 29th March 2026

Published: 9th April 2026

Full Length Research

Available Online at: https://iajournals.org/articles/iajef_v5_i2_408_433.pdf

Citation: Nyongesa, E. N., Namusonge, G. S., Nambuswa, E. M. (2026). The effect of non-revenue water on revenue collection in public water companies. *International Academic Journal of Economics and Finance (IAJEF) | ISSN 2518-2366, 5*(2), 408-433.

ABSTRACT

The general objective of the study was to investigate the impact of Financial determinants on revenue collection in public water companies. The specific objective of the study was to assess the effect of non-revenue water on revenue collection in public Water Companies. The study applied public goods theory. Stratified sampling was employed, and a mixed research design was adopted, with a sample of 500 drawn from a target population of 1000. The results under descriptive statistics had an average mean of 4.38, and the standard deviation was 0. 78. Frequency on the level of agreement indicated that 88.7% of the respondents agreed that non-revenue water is a financial determinant of revenue collection. While 13.3 % of the respondents were not sure or disagreed. Inferential statistics findings indicated a coefficient of determination of (r =- 0.166**) with a significant level of (pv= 0.000), implying that there is a weak negative correlation between nonrevenue water and revenue collection in public water companies. Using pv=0.000, which is less than the hypothesis value, which is p-value≤ 0.005, indicating that non-revenue water has a significant impact and inverse relationship with revenue collection, hence a financial determinant of revenue collection in public water companies. The study recommended further investigations on unbilled metered consumptions, illegal connections on transmission line leakages, and unauthorized consumption, which are crucial financial determinant on enhancement of quality and sustainable clean and quality water service delivery in public water companies.

Key words: Unauthorized Consumptions, Unbilled Metered Consumption, Authorized Unmetered Consumptions, Illegal Connections, Cartels, Service Delivery Within 24 Hours, Leakage Records.

INTRODUCTION

Globally, access to safe drinking water and sanitation remains a critical challenge, with 2.2 billion people lacking safely managed drinking water and over 4.2 billion without adequate sanitation services (World Bank, 2023). Public water companies are mandated to provide reliable services to households, businesses, and institutions, yet their financial sustainability remains a persistent challenge. Revenue collection is critical to maintain operations, expand infrastructure, and meet growing demand. Non-Revenue Water losses are a major barrier to financial sustainability for water utilities.

Regionally, water utilities face constraints, with financial viability linked directly to effective revenue management (World Bank, 2020). Water service provision is aligned with national development goals and the Sustainable Development Goal 6 on clean water and sanitation (United Nations, 2015). Understanding the financial determinants of revenue collection is therefore essential for strengthening the sector and ensuring long-term sustainability. Studies estimate global physical water losses at 32 billion cubic meters annually, with half occurring in developing nations, which is enough to supply water to an estimated population of 90 million people (World Bank, 2023). Local utilities face high costs of treating and pumping water that ultimately leaks back into the ground, eroding revenue that could sustain operations and capital projects. As Klawitter and Qazzaz (2005) noted, financial crises directly affect service delivery, and projections indicated that billions will face water scarcity by 2025 (Ritchie & Ortiz-Ospina, 2019).

Locally, non-revenue water remains a major challenge for water service providers, with audits showing losses ranging from 31% to 85%, far above the global benchmark of 25%. While performance contracts and non-revenue water management programs have the potential to deliver rapid financial gains, political, financial, and technical hurdles often prevent these benefits from being realized. Reports highlight that small and medium utilities are particularly affected, facing high non-revenue water levels that undermine revenue collection and service delivery. Innovative financing beyond traditional transfers, taxes, and tariffs is needed to strengthen utilities. At the same time, privatization has been discussed as a possible way to reshape the government's role in promoting growth and efficiency.

Local governments often struggle with poor service delivery due to gaps between budgets and actual revenue collection. Water loss is recognized as a critical threat to resource management, with regions in Asia reporting non-revenue water averages near 30% and the World Bank estimating that $14 billion is lost annually by utilities. Countries like the United States have responded with strict legislation, such as California's Senate Bill 555 requiring annual water loss audits, while Japan has leaned on privatization to drive efficiency. Non-revenue water is about protecting scarce resources, ensuring fair billing, and strengthening financial sustainability so that utilities can deliver reliable services and communities can trust the systems meant to serve them.

Despite reforms, the urban water coverage stood at only 55% in 2014/2015, leaving a 45% shortfall, while global non-revenue water averages remain at 43%, still well above acceptable limits. The City Water and Sewerage Company, for example, reported non-revenue water levels of 36–38% between 2013 and 2019, with targets to reduce this to 33% by 2021, yet the gap compared to global standards remains significant. Persistent inefficiencies such as leakages, under-billing, and poor monitoring continue to erode financial sustainability. These gaps motivated this research, which examines non-revenue water as a key financial determinant of revenue collection in public water companies, aiming to identify practical solutions that can reduce losses, improve liquidity, and strengthen trust in the water sector.

Statement of the Problem

Insufficient revenue collection is a major challenge affecting the ability of public water companies to deliver quality and sustainable water and sanitation services. This issue threatens progress toward the United Nations Sustainable Development Goal of universal access to clean water and sanitation by 2030. Contributing factors include illegal water connections, inaccurate metering, billing inefficiencies, and high levels of Non-Revenue Water. United States Aid for International Development (2008) warns that over 2.8 billion people will live in water-stressed conditions by 2025, emphasizing the need for effective revenue collection to ensure sustainable service delivery.

Studies show that in both rural and urban areas, water service providers face structural and financial barriers. Foster et al. (2017) note that rural communities are often left to self-finance their water points using inconsistent methods, while urban utilities like the City Water and Sewerage Company face persistent gaps between budgets and actual collections, as reported by the Auditor General. Although research has been done on billing technologies, Geographic Information Systems, and non-revenue water reduction (e.g., David et al., 2017; Farouk et al., 2021), none directly address the financial determinants of revenue collection by Public Water Companies.

The study seemed to fill that gap by examining the financial and technological factors affecting revenue collection efficiency in public and private water companies. The findings will guide strategic reforms such as the adoption of e-payment systems, the reduction of accounts receivable, and the development of new revenue collection strategies. These improvements will enhance the financial sustainability of water providers, enabling them to better meet operational and capital costs and align with Vision 2030 and global water and sanitation goals**.**

Specific objectives

To investigate the impact of Non-Revenue Water on Revenue Collection in public water companies.

Hypotheses of the study

H_{04}: Non-Revenue Water has no significant effect on Revenue Collection in Public water companies.

H_{05}: Political environment as a Moderating variable has no significant effect on Revenue Collection in public water companies.

Significance of the Study

This study is critical in addressing the persistent financial challenges faced by public water companies. Despite the constitutional mandate under the Water Act No. 8 of 2016, which obligates the government to ensure access to clean water and sanitation for all citizens as a basic human right, budgetary constraints and inconsistent revenue allocations have hindered the realization of this goal (Government, 2016). Consequently, water companies are compelled to seek alternative internal financial mechanisms to sustain the operational and capital obligations. The research explores under-examined predictors, especially those influencing

non-revenue water and their impact on financial performance. While previous studies have touched on aspects of water management, few have directly investigated the role of multiplier predictors in the context of non-revenue water and its relationship to revenue generation. This study will address the gaps by offering insights into time and action.

LITERATURE REVIEW

Theoretical framework

Theories serve as structured frameworks that explain relationships between variables and guide inquiry across disciplines. According to Kamayu, Namusonge, and Bichanga (2015), a theory is defined as a system of ideas formulated to explain phenomena, particularly when grounded in general principles that can be tested and applied. Their work emphasizes the role of theory in shaping research design and interpreting complex organizational dynamics. Beckett (2006) supports this view by highlighting that theories not only offer explanatory power but also serve as tools for integrating knowledge across contexts. Revenue collection in public water companies draws upon numerous financial, economic and corporate management theories. The relevant theories explained the variables explored, indicating the existing studies and their conclusions.

Public Goods Theory

This theory states that although it is impossible to measure the utility derived from a good or service, it is usually possible to rank the alternatives in their order of preference to the consumer. Since the choice is constrained by the consumer, the rational consumer will not spend money on an additional unit of a good or service unless its marginal utility is at least equal to, or greater than that of a unit of another good, or service. Therefore, the price of a good or service is related to its marginal utility and the consumer will rank his or her preferences accordingly. (Alchian) American Economic Review (Samuelson, 1954) states that goods that are collectively consumed are non-rival and non-excludable.

This theory is also referred to as the Theory of Public Expenditure (Witta, 2010). The effectiveness of Revenue Collection Strategies at the Revenue Authority states that Revenue Collection is the amount of money that a company receives during a specific period through the sale of a product or service. Mutisya (2014) indicated that public revenue collection is an integrated component of fiscal policy and administration in any economy because of its influence on national operations and the grassroots. According to the City County (United Nations Human Settlement Programme, 2007), indicated that 40% of the water is lost through leakages and illegal connections.

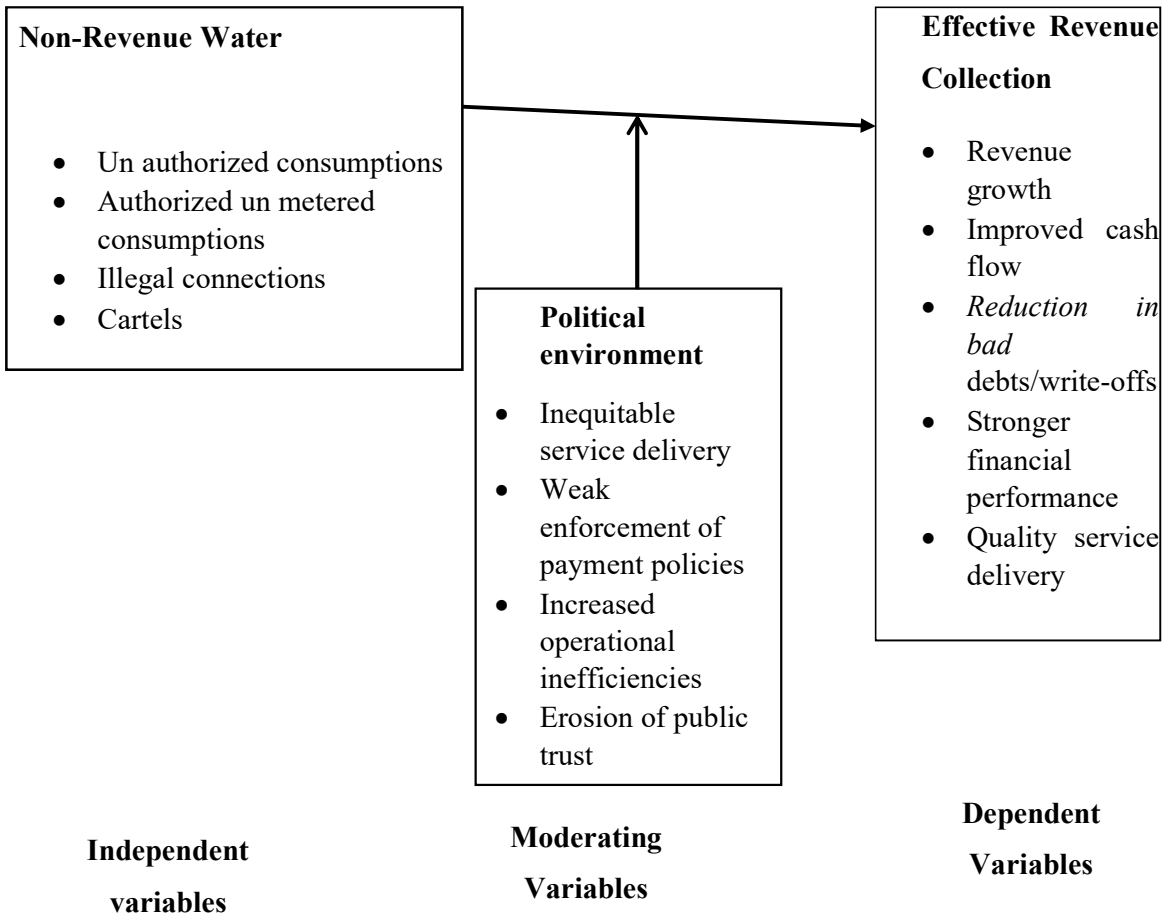
The (Constitution, 2010) indicates that water and sanitation are a basic right for every person. Article 43 of the Constitution states that: “Every person has the right to reasonable standards of sanitation [and] to clean and safe water in adequate quantities”. Article 21 further states that: “It is a fundamental duty of the State and every State organ to observe, respect, protect, promote and fulfill the rights and fundamental freedoms in the Bill of Rights. The State shall take legislative, policy and other measures, including the setting of standards, to achieve the progressive realization of the rights guaranteed”.

(Broome, 2011) Expected utility theory shows that each person's preferences may be represented by a utility function defined on the domain of alternatives. These utility functions are expectations. By this it means that if an alternative has uncertain results, its utility is the expectation of the utility of its possible result. According to Tayler (1985), Eugene (2004), Summer (1977), and Edgeworth (1881) on public good theory, asserted that principles of economics state that every agent is actuated only by self-interest.

Conceptual Framework.

Guattari (1991) defines the conceptual framework as a network or a plane of interlinked concepts that together provide a comprehensive understanding of a phenomenon, or the concepts that support a conceptual framework support one another, articulate their respective phenomena, and establish or framework specific philosophy. A conceptual framework gives a diagrammatic representation of linkages or relationships between study variables (Robson, 2011). The independent variables and the dependent variable. The dependent variable is revenue collection while the independent variable is non-revenue water.

fig 2.1 Conceptual frame work.



Empirical literature review

According to Kothari (2004), an empirical literature review contains the review of the research studies made earlier which are similar to the proposed, in order to acquire knowledge as to

which data and other materials are available for the operational purpose thus enabling the researcher to specify her own problem in a meaningful context. This section reviews the discussions of the previous scholars regarding the financial determinants of revenue collection in public water companies.

Empirical studies

While the study by Darko, Adarkwah-Donkor, and Kyei (2016) provided valuable insights into the role of smart metering in enhancing billing accuracy and revenue collection within Ghana's Electricity Company, several limitations were evident. First, the study primarily focused on operational benefits without critically examining the socio-economic and behavioral factors influencing customer compliance and satisfaction. Secondly, the research was largely descriptive and lacked a robust empirical framework to measure long-term financial impacts or scalability across different utility contexts. Additionally, the study did not explore the challenges of implementing smart metering in rural or underserved regions, where infrastructural limitations and digital literacy may hinder adoption.

Without real-time monitoring, utilities struggle to detect leaks, illegal connections, and excessive consumption, leading to non-revenue water losses exceeding 40% (Otuke, 2024). The lack of automated billing systems further exacerbates inefficiencies in revenue collection, making it difficult for utilities to recover costs effectively.

Impact of Non-Revenue Water on Revenue Collection in Public Water Companies

Reducing Non-Revenue Water remains a critical challenge for the water sector despite being declared a national priority. The Ministry of Water and Sanitation aimed to reduce the national Non-Revenue Water average from 60% to 30% in its 2007–2015 strategy, yet many Water Service Providers still face issues like illegal connections, unmetered or faulty meters, and poor infrastructure. Kayaka (2007) highlights difficulties in collecting reliable Non-Revenue Water data due to inadequate metering systems and outdated infrastructure. Additionally, the Water Company reported Non-Revenue Water levels as high as 70%, largely due to poor management information systems and widespread illegal connections.

Various reports and institutions, including the Water Service Regulatory Board and Water Regulatory Management Authority, underscore the need for increased investment and better financial management to improve water service delivery. With the water sector comprising over 90 public utilities and 80 private bottled water providers, effective revenue collection and Non-Revenue Water reduction are essential for financial sustainability. The national budget and county-level allocations have set aside significant funding for water and sanitation, but issues such as political interference, infrastructure breakdowns, and inaccurate billing continue to undermine progress. According to Itron (2012) and the World Bank (2006), Non-Revenue Water includes both real losses (leaks) and apparent losses (theft, meter inaccuracies), both of which significantly impact utility revenue and resource sustainability.

The empirical research done by Onyango et al. (2022) showed a strong correlation between physical water losses and water quality degradation. Non-Revenue Water also causes broader

environmental harm, such as soil erosion and pollution. Farouk et al. (2021) identified 14 effective strategies to reduce Non-Revenue Water, including pressure management, leak detection, and water distribution network rehabilitation. These methods not only help recover lost revenue but also enhance water system reliability and sustainability. The integration of decision-support technologies was noted as the most comprehensive approach, capable of addressing multiple categories of Non-Revenue Water simultaneously. Addressing Non-Revenue Water requires a combination of technical solutions, strong governance, and increased investment in infrastructure and technology**.**

Revenue Collection as Dependent Variables

According to Witta (2010), Revenue Collection is the amount of money that a company receives during a specific period through the sale of a product or service. Mwachiro (2013) defines revenue collection as the income that a company receives from its normal business activities.

In the Water Company, the services sold are water and sewerage services, and revenue is collected after sale on credit (Mutisya, 2014). It is indicated that public revenue collection is an integrated component of fiscal policy and administration in any economy because of its influence on national operations and the grassroots. It is the fuel. According to Fachrudin *et al* (2019), a local government's financial health is crucial because it enables it to carry out its duties, including supplying the community with goods and services. Tax receipts from lodging, dining, entertainment, and parking are the main funding sources. With the self-assessment method, there are considerable challenges because taxpayers are reluctant to submit their true income.

Contribution to Knowledge Gap

This study contributes to the academic and practical understanding of Non-Revenue Water by addressing overlooked financial determinants and revenue collection dynamics within the public water utilities. Unlike prior research that predominantly emphasized engineering solutions, this work integrates financial and managerial perspectives, offering a more comprehensive framework for Non-Revenue Water reduction. Through empirical analysis, the study quantifies revenue losses linked to Non-Revenue Water and demonstrates how targeted interventions such as smart metering, automated billing, and debt management can enhance financial sustainability.

K Mwangi (2025) underscores the transformative potential of smart technologies in improving operational efficiency and revenue recovery. His findings support the notion that digital innovations are particularly impactful in developing contexts, where manual systems often impede financial performance. Otieno (2025) complements this view by advocating for a managerial and financial reorientation in Non-Revenue Water strategies. He emphasizes that bridging the gap between theoretical models and practical implementation can yield replicable solutions tailored to the socio-economic realities of emerging economies.

Despite existing literature on Non-Revenue Water, significant gaps remain. Farouk et al. (2021) conducted a systematic review of Non-Revenue Water reduction strategies, but did not explore the financial implications within public utilities. Similarly, Xuan et al. (2015) and Foster et al. (2017) examined revenue management broadly, yet failed to address the specific financial determinants affecting water companies. Imene et al. (2020) and David et al. (2017) also offer limited insights into the fiscal dimensions of Non-Revenue Water, leaving a void in context-specific financial analysis.

It introduces a nuanced understanding of how financial strategies can complement technical interventions, thereby offering a more holistic approach to water utility management. In doing so, the study not only advances scholarly discourse but also equips practitioners and policymakers with actionable insights for sustainable water governance.

RESEARCH METHODOLOGY

Introduction

This chapter comprises the following: Research Design, Target Population, Sample Size, Sampling Frame, Data Collection, Pilot study, and finally data analysis methods and interpretations. The tool used for data testing validity, reliability and correlation between the dependent and independent variables was the Analysis of Variance regression model.

Research Design

The study applied a Mixed Research Design which enables the researcher to explain the relationship between variables. The design is useful for formulating investigation issues (Kothari, 2006). Research Design is the function of a design ensuring that the evidence obtained enables a researcher to effectively address the research problem logically and as unambiguously as possible (De, 2001). Research design provides a frame work of data collection and analysis. (chepcheng, 2018) Ngugi (2014), cited with Schward (2005), who indicated that a research design establishes procedures to obtain cases for study and to determine how scores will be obtained for those cases.

Ngugi (2014) agreed with Newing (2021), stating that research design was used in the overall process described in research methodology and research structure. Cooper (2001), indicated that the research design constitutes the blueprint for the collection, measurement and analysis of data. It aids the scientist in the allocation of their limited resources by posing crucial choices. Research Design is a structure of research that holds the entire element of the research project together.

Target population

A target population is described as an entire group of individuals, events or objects with common observable characteristics (Chumo, 2013). Lumley and Benjamin (1995) state that a population target is a group the research wants to use in the research study to form an opinion on the study's findings. Kithara (2004) defines population as all items in any field of inquiry and it is also known as the universe. A population is described as the set of sampling units or cases that the researcher is interested in (Newing, 2011).

The research study targeted the population of 1000 respondents which was drawn from the City Water and Sewerage Company staff and management, the Ministry of water and Sanitation, the Water Service Regulatory Board, and professionals from the County. The main focus was on seven regions. The reasons behind selection of the target population is that ministry of water is the overall government ministry responsible for water management, Water Service Regulatory Board is responsible for regulations and licensing the Water Service Providers. The water management and unionized staff being the implementers of water and sewerage services which currently stand at 101 licensed water companies by (8) eight water service board. The table below indicates the respondent groups in three categories: water regulators, policy makers, government financiers of water projects, employees who are part of the water and sewerage service users and providers of water services, and are also decision makers of all water and sewerage operations, refer to table 3.1.

Table 3.1: Target Population.

Cadres of groups	Target
Management, staff and union	850
Ministry of water and sanitation	50
Water Services Regulatory Board, Non-Governmental Organization, and professionals from City Water and Sewerage Company	100
Total	1000

Sampling Frame

According to Memba (2011), the research findings indicated that a sampling frame is a list of sampling units for the selection of a sample. Chumo (2013) stated that a sampling frame is a list of elements from which a sample is drawn. For the purpose of a research study, a sampling frame is a list of all items that have a representative sample (Nachmias, 2008). The sample frame consists of executive members from the Ministry of Water and Irrigation, water service board, County officials, City Water and Sewerage Company limited management and staff members. The reasons for the choice were due to limited resources and the accessibility of required data from the whole target group.

Sample Size and Technique

Gerstman (2003) states that a requirement for an appropriate sample size is to first declare an acceptable margin of error (€). The Cochran formula allows you to calculate an ideal sample size given a desired level of precision, desired confidence level, and the estimated proportion of the attribute present in the population. Cochran's formula is considered especially appropriate in situations with large populations. It was established by William G Cochran in 1977 as the following formula for a definite population target. The sample size n for a finite population for the study with a confidence of 95% at a maximum proportion of 50% Z= 1.96, while acceptable within an error margin of 0.0438 of the target population of 1000. As indicated in Table 3.2

Cochran's formula for sample calculation

Cochran W, G, (1977) $n = \frac{Z^2 * P * (1-p)}{e\hat{}2}$

Where:

n- The sample size

Z- Z-score associated with the desired confidence level

P- The expected proportion or prevalence of the outcome or characteristic of interest in the population.

e- The margin of error i.e., the maximum distance between the true population parameter and the sample size.

Table 3. 2: Sampling frame.

Cadres of staff	Target population	Sample size
Management, staff and union	850	425
Ministry of Water and Irrigation	50	25
Water Services Regulatory Board, Water Services Boards, and Professionals of City Water and Sewerage Company	100	50
Total	1000	500

Data Collection Instruments

The study utilized questionnaires for primary data collection. Structured questionnaires ensured coherence and reliability during the pilot phase. The main study allowed respondents to express opinions on the investigated in agreement with Samson (2017) and cited by Mohamed, A (2022). These questionnaires are best used with standardized questions interpreted by all respondents. Mugenda (2008) stated the advantages of the quantitative and qualitative methods used after analysis and making a conclusion.

Analyzing quantitative data is easier and one can determine statistical relations that can then be questioned. Questionnaires work best with standardized questions that are interpreted the same way. According to Kothari (2014), a questionnaire is a piece of writing that consists of several questions printed in a specific order on a form or collection of forms. The study adopted both primary and secondary data. The literature review was used for secondary data.

Data Collection Procedures

Data collection is a process that involves gathering, measuring, and analyzing information to answer research questions, test hypotheses, and evaluate outcomes. This is done through a researcher administering questionnaires to the respondents or assisted by the research assistants, questionnaires in the collection of data. The European Thyroid Association Researchers (2008) defined a questionnaire as a set of questions for gathering information from individuals.

According to Creswell, 2014, the data collection steps include setting the boundaries for the study, collecting information through unstructured or semi-structured observations and interviews, documents, and visual materials, and establishing the protocol for recording information. A questionnaire was thought to be the best tool for this study. Both primary and secondary data were used in the study. The benefits of the quantitative approach include the ease with which one can analyze quantitative data and the ability to identify statistical relationships that can then be used to derive general conclusions. Questionnaires were administered by being dropped off and picked up after two weeks. A drop and pick method was used but to increase the response rate, the research assistance to the respondents.

The questionnaires had seven sections whereby; Section one had items on general characteristics, section five had items on Non-Revenue Water and section seven had items on Financial determinants of Revenue Collection.

RESEARCH, FINDINGS AND DISCUSSIONS

Introduction

The chapter commenced with analyzing the results from the pilot study to test the reliability and validity of the research instruments. The return rate of the research instruments and the analysis of respondents' demographic information. The main findings of the research questions were analyzed based on the specific main objectives of the study, which were to establish the effect of non-revenue water on revenue collection of Public water companies. The analysis was done using descriptive statistics, which include frequency, mean, mode and standard deviation and measures of dispersion such as correlation coefficient, and presentation was done through graphical presentation and tabular form. Both qualitative and quantitative analyses were used in coming up with the findings. The program applied was the Statistical Package for Social Statistics. Additionally, the chapter also covers the inferential analysis of the study model called the logistic linear regression model

Response Rate

The data was collected by the use of questionnaires which were sent to 500 respondents out of the total questionnaires dropped 487 respondents returned the questionnaires, having a response rate of 97.4 percent while 2.6 % did not return the questionnaire. The study was conducted in Nairobi County in the three cadres of staff in the Water and Sewerage/Sanitation management, staff and union, Ministry of Water and Irrigation and sanitation, Water Services Regulatory Board, Water Services Boards, World Bank and Professionals, having a population target of 1000 respondents. With a sample size of 500. According to Best & Khan (2007) a response rate of 50 percent is considered adequate, 60 percent good and above 70 percent very good. The respondent rate of 97.4 was considered very good as it exceeded the threshold postulated by Best and Khan (2007).

Descriptive Analysis

The section deals with descriptive analysis of study variables, which begins with the independent variable being Non-Revenue water, specific objectives and moderating variables being Political Environment by measures of central tendency and dispersion.

Respondents on Non-Revenue Water

The study sought to find the effect of Non-Revenue water on the revenue of public water companies. The respondents were asked to indicate their level of agreement/disagreement as presented in the questionnaires about Non-Revenue water. A Likert scale was used which indicated strongly Disagree =1, Disagree =2, Not sure =3, Agree = 4, and Strongly Agree=5.

Percent of respondents agreed that unbilled metered consumption authorized increases revenue loss .88.7 (%). The Percent of respondents agreed that authorized unmetered consumption affects revenue collection negatively .84.4 (%) percent of respondents agreed that the technical team service is within the company policy period to repair water leakage. 87.7 (%) percent of respondents agreed that there are records on reported cases of leakages on transmission lines and distribution from mains. 87.1 (%) percent of respondents agreed that there are records of reported leakages on service connections up to the point of customer use in terms of volume of water and reports of unbilled metered consumption by customers in the company. 89.0 (%) percent respondents agreed that illegal water connections lead to a high volume of non-revenue water .89.0 (%) percent respondents Cartels have increased the level of non-revenue .91.2 (%) percent respondents agreed that there are reports of unbilled metered consumption by customers in the company. Below is the outcome as indicated in Table 4.17

Table 4. 17: Respondents on Non-Revenue water.

Statement	Strongly disagree	disagree	Not sure	Agree	Strongly disagree
Unauthorized consumption could lead to increased loss of revenue (unaccounted for water loss.	1.8%	1.4%	3.9%	36.6%	53.2%
Unbilled metered consumption authorized increases revenue loss.	1.4%	1.4%	3.1%	40.5%	50.5%
Authorized unmetered consumption affects revenue collection negatively.	1.4%	1.8%	3.9%	38.0%	50.7%
The technical team's service is within the company policy period to repair water leakage.	1.6%	2.9%	6.8%	40.7%	43.7%
There are records of reported cases of leakages on transmission lines and distribution from mains.	1.2%	1.8%	6.8%	44.4%	43.3%

There are records of reported leakages on service connections up to the point of customer use in terms of volume of water and reports of unbilled metered consumption by customers.	1.4%	3.3%	5.1%	44.8%	42.3%
Illegal connections lead to a high volume of non-revenue water.	0.8%	1.6%	5.1%	41.7%	47.6%
Cartels have increased the level of non-revenue.	1.0%	1.4%	5.1%	36.3%	53.0%
There are reports of unbilled metered consumption by customers in the company.	1.2%	0.4%	3.7%	39.0%	52.2%

In Table 4.18 below, the respondents were asked to indicate the level of agreement as indicated in the research tool. The output on sampled respondents, on average, as agreed, (Mean=4.45; Standard Deviation =0.708) that there are reports of unbilled metered consumption by customers in the company. This means that the management of water companies needs to concentrate on unbilled metered consumption. In general, most of the respondents agreed that Non-Revenue water is a determinant of effective Revenue Collection of public water companies. Using the standard deviation, the lower the standard deviation, the better the performance in revenue collection.

Table 4. 18: Respondents on Non-Revenue water by the measure of dispersion.

Statement	n	M	SD
Unauthorized consumption could lead to increased loss of revenue (unaccounted for water loss.	487	4.42	.800
Unbilled metered consumption authorized increases revenue loss.	487	4.40	.782
Authorized unmetered consumption affects revenue collection negatively.	487	4.40	.793
The technical team's service is within the company policy period to repair water leakage.	487	4.29	.845

There are records of reported cases of leakages on transmission lines and distribution from mains.	487	4.31	.764
There have been reports of water leaks on service lines before reaching customers, as well as instances of metered use not being billed.	487	4.29	.821
Illegal connections lead to a high volume of Non-revenue water.	487	4.39	.734
Cartels have increased the level of non-revenue.	487	4.43	.756
There are reports of unbilled metered consumption by customers in the company.	487	4.45	.708
n	**487**	**4.38**	**0.78**

Inferential Statistics

One of the two major branches of statistics is inferential statistics which is defined by Norman (2003) as a process of random sampling of data from that population and predicting the generalized opinion for further research. It is a branch of statistics which is concerned with using probability concepts to deal with uncertainty in decision making, to draw inference a bout population from a sample, to help process decision making and to suggest explanations for a situation or phenomenon. It allows you to draw conclusions based on extrapolations, and is, in that way, fundamentally different from descriptive statistics that merely summarize the data that has actually been measured.

On Methodology, Pearson Correlation Coefficient was adopted and the researcher computed the Pearson correlation coefficient to measure the level of relation between linearly related variables and the confidence interval of the coefficient was calculated at a 95 percent confidence level with an error margin of 0.05. The coefficient of Correlation denoted as “r,” quantifies the strength and direction of the relationship between two variables. It ranges between -1.0 (perfect negative correlation) and 1.0 (perfect positive correlation).

Table 4.23 shows the relationship between the dependent Variable (Revenue Collection) and the independent variable (Non-Revenue Water) to be negatively correlated. However, a significant and strong relationship was found with the independent variable, Non-Revenue Water (-0.166**, $p<0.01$; 2-tailed). Hence, management needs to focus on the predictor (Non-Revenue Water) as a Financial Determinants of Revenue Collection in Public Water Companies.

Table 4.23: The correlation matrix between Non-Revenue Water and Revenue Collection.

Variables		Revenue Collection	Non-Revenue Water
Revenue Collection	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	487	
Non-Revenue Water	Pearson Correlation	-0.166**	1
	Sig. (2-tailed)	0.01	
	N	485	485

4.5

Multiple Linear Regression model ANOVA test of hypothesis

Multiple linear regressions were run at (95%) percent confidence interval of 5% (0.05 margin error) to show the multiple linear relationship between the independent and dependent variables of the study. The decision of rejecting or accepting the null hypothesis was based on the outcome of the study. If the p-value was less than 0.05, then the null hypothesis was rejected, and the alternative hypothesis was accepted; if the p-value was greater than 0.05, then the study failed to reject the null hypothesis.

Coefficient of Determination (R2)

The coefficient of determination is used to analyze how differences in one variable can be explained by differences in a second variable. The correlation coefficient formula will tell you how strong a linear relationship is between two variables, as indicated in Table 4.25 below.
The dependent variable is Revenue Collection and Predictors (Constant) Non-Revenue Water. Table 4.25 model fit has allowed multiple models in a single regression command which has indicated the number of models used while predictors (constant), Non-Revenue. It shows a coefficient of correlation (R) of 0.191, indicating a positive correlation between the observed predictors (Non-Revenue Water) and the predicted values of the dependent variable, Revenue Collection, in Public Water companies. 3.7% percent is the overall measure of the strength of the association. It does not reflect the extent to which any particular independent variable (Non-Revenue Water) is associated with the dependent variable (Revenue Collection). Adjusted R-square as predictors are added to the model, each predictor explaining some variance in the dependent variable's chance. The adjusted R-Square yielded a more accurate value to estimate the R-squared for the population which indicates a correlation of 3.5% between Revenue Collection and Non-revenue water.

Table 4.25: Regression of Independent Variables and Dependent Variable

Model	R	R Square	Adjusted Square	RStd. Error of the Estimate
1	.191[a]	.037	.035	.775

Table 4.28 indicates the regression degree of freedom is (4), thus, Non-Revenue Water revenue systems. The Chi-square test was performed on Moore Spull (1975). The output of the analysis of Variance revealed that F-statistics had a value of 23.787 with a p-value of 0.268, which is greater than the significant level of 0.05. which indicated that the model was fit and accepted the alternative hypothesis that the Financial Determinants were statistically significant in predicting the Revenue Collection in Public Water companies.

Table 4.28: (ANOVA); Regression between Independent and Dependent Variables.

Model		Sum Squares	ofDf	Mean Square	F	Sig.
1	Regression	11.871	4	1.214	23.787	.268[b]
	Residual	237.562	416	.499		
	Total	249.433	420			

a. Dependent Variable: Financial Determinants of Revenue collection of Public Water companies.

b. Predictors: (Constant), Non-Revenue Water.

Table 4.26 indicates that all the independent variables have a significant positive impact on the revenue collection of Public Water companies and the most influential variable is the Non-Revenue Water coefficient of 0.531 (p-value = 0.000). According to this model when the independent variable values are zero and 42.192 as a constant or y intercept in the linear equation.

Dependent Variable: Revenue Collection

Predictor: (Constant), Non-Revenue Water Revenue systems.

The study tested the conceptual model, where the output of the tests was as follows

(β_0-------- β_3) were the coefficients of variations as below, and e was the error term. In the regression model and (x_1, $x_{3,}$) independent variable, non-revenue water

$Y = \beta_0 + \beta_3 x_3 + e$

$Y = 42.192 + 0.531X3$

Table 4.26 Multiple Regression Coefficients of variation.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	42.192	3.882		59.420	.000
Non-revenue water	.531	.128	.337	3.143	.000

Hypothesis 3: Non-revenue Water

HO: Null Hypothesis

H_1: Alternative Hypothesis which is also called the Research Hypothesis which is to be investigated

Where the level of confidence is at 95% and the significance level is 5%, $t \leq 1.96$

$H_{O:}$ $\geq$ 0.05 Not reject

H_1 < 0.05 Reject

H_O: Non-Revenue Water has no significant effect on Revenue Collection in public water companies.

H_1: Non-Revenue Water has a significant effect on Revenue Collection in public water companies.

The objective of the hypothesis is to determine the relationship between Non-Revenue Water and Revenue Collection when the regression was obtained through a logistic linear regression model, as indicated below;

$Y3= \beta_0+\beta_1 x_{3+} \epsilon$

Table 4.37 indicates the direction of the relationship between Non –Revenue Water and Revenue Collection. The analysis further reveals that the determinant coefficient is 0.191, implying that Non-Revenue Water has a weak positive direction, indicating that Non-Revenue Water has a positive influence by 3.5 (%) percent (adjusted square) improvement on Financial Determinants and Revenue Collection in Public water companies.

Table 4.37: Regression Model Summary of the relationship between Non –Revenue Water and Revenue Collection Model Summary.

Model	R	R Square	Adjusted R-Square	Std. Error of the Estimate
1	.191[a]	.037	.035	.775

Table 4.39 below, Non-Revenue Water (β = 0.191) was found to be positively related to Revenue Collection in Public Water companies. From the t-test analysis, the t -value was found to be 4,216 and the ρ -value 0.000. Statistically, this null hypothesis $H_{0:}$ was rejected because $\rho<0.05$. Thus, the study accepted the alternative hypothesis and it concluded that Non-Revenue Water has effects on Revenue Collection in Public Water companies.

a. Dependent Variable: The company has impressed e-commerce in revenue collection
b. Predictors in the Model: (Constant), Cartels have increased the level of non-revenue water

Table 4.39: Coefficients of variation of non-revenue water on Revenue Collection.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	3.512	.211		16.682	.000
Cartels have increased the level of non-revenue	.198	.047	.191	4.216	.000

Table 4.40 indicated the output of logistic linear regression between Non -Revenue Water and Revenue Collection, five variables. The statement that stated that unauthorized consumption could lead to increased loss of revenue (unaccounted for water loss revealed a beta of β= 0.068, indicating a weak positive correlation with Revenue Collection. (β = 0.068 sig=œ = 0.145 Unauthorized consumption could lead to increased loss of revenue (unaccounted for water loss). Unauthorized consumption could lead to increased loss of Revenue implying t that for every one-unit increase in unauthorized and Un unmetered consumption of water, there is a 0.068 increase in revenue collection of Public water companies in Kenya. The direction of the relationship between Unauthorized and an unmetered consumption and Revenue Collection has a Partial Positive Correlation of 0.067, indicating a weak positive relationship between Unauthorized and an unmetered consumption and Financial Determinants of Revenue Collection in Public water companies.

Unbilled metered consumption authorized increases revenue loss and Revenue Collection. The output of Regression Analysis indicated a beta of β = 0.091which implies that there was a weak and positive correlation between the Unbilled metered consumption authorized increases revenue loss and Revenue Collection. (β = 0,091, œ = 0.050) Unbilled metered consumption authorized increases revenue loss and Revenue Collection. β = 0.091 implies that for every one-unit there is an increase in the number of public water companies. The direction of the relationship between unbilled metered consumption authorized increases revenue loss and Revenue Collection has a Partial Positive Correlation of 0.091, which means that there is a low positive correlation between unbilled metered consumption authorized increases revenue loss and Financial Determinants of Revenue Collection in Public Water companies.

The output of the logistic linear regression indicated that there is a relationship between Authorized unmetered consumption and revenue collection, negatively as a result of under- or overestimated bills. β= 0.48indicating a weak positive correlation with Revenue Collection. (β = 0.048 sig œ = 0.305) Authorized unmetered consumption affects revenue collection negatively as a result of under- or overestimated bills, implying that for every one-unit improvement 0.048 increase in revenue collection for public water companies. The direction of the relationship between Authorized unmetered consumption affects Revenue Negatively Collection has a Partial Positive Correlation of 0.47 which means that there is weak positive relationship between Authorized unmetered consumption affects revenue collection negatively

as a result of under or overestimated bills implies that for every one-unit increase of non-revenue water, there is a decrease of 4.7% of Revenue Collection in Public water companies. The technical team service is within the company policy period to repair water leakage, β = 0.044, which was found to have a weak positive correlation with Revenue Collection. (β = 0.044, œ = 0.333) indicating that technical team service is within the company policy period to repair water leakage. This implies that for every one-unit improvement in the technical team service, is within the repair of water leakage is 0.044 improvement in Revenue Collection. The direction of the relationship between. The technical team service is within the company policy period to repair water leakage, which has a Partial Positive Correlation of 0.045 and the Revenue Collection Water Company has accurate data on revenue collection in Public Water companies.

Table 4.40: logistic linear regression between Non- Revenue Water on Revenue Collection Excluded Variables a

Model	Beta In	T	Sig.	Partial Correlation	Collinearity Statistics Tolerance
Un authorized consumption could lead to increased loss of revenue (unaccounted for water loss	.068[b]	1.462	.145	.067	.944
Unbilled metered consumption authorized increases revenue loss	.091[b]	1.967	.050	.091	.952
Authorized unmetered consumption affects revenue collection negatively	.048[b]	1.027	.305	.047	.949
The technical team service is within the company policy period to repair water leakage	.044[b]	.971	.332	.045	.994
There are records on reported cases of leakages on transmission lines and distribution from mains	.080[b]	1.746	.082	.081	.984
There are records of reported leakages on service connection up the point of customer use in terms of volume of water and reports of unbilled metered consumption by customers in the company.	.045[b]	.989	.323	.046	.992

Illegal connections lead to high volume of non-revenue water	-.028[b]	-.566	.572	-.026	.865
There are reports of unbilled metered consumption by customers in the company	.058[b]	1.180	.239	.055	.841

a. Dependent Variable: The company has impressed e-commerce in revenue collection.
b. Predictors in the Model: (Constant), Cartels have increased the level of non-revenue.

Table 4:27 Summary of hypothesis testing of non-revenue water on Revenue Collection of public water companies.

Hypothesis on Variables	**β=unstandardized regression coefficient**	**Remarks**
m./h	42.192	
$H0_3$ Non-Revenue Water does not have a significant effect on the revenue collection of public water companies.	β=0.531, p-value=0.000	$H0_3$ was rejected $H1_3$was accepted

Research Discussion

Non-Revenue Water remains a critical challenge for water utilities and globally, undermining both financial sustainability and service delivery. Studies show that Non-Revenue Water is caused by leaks, illegal connections, and poor billing practices—ranges between 31% and 50% in major cities, far above the internationally acceptable benchmark of 25% (Water Services Regulatory Board, 2022). The World Bank estimates that utilities worldwide lose over $14 billion annually due to water losses, with developing countries bearing the greatest burden (World Bank, 2023). Research highlights that effective Non-Revenue Water management, including smart metering, real-time monitoring, and improved billing systems, can significantly reduce losses and enhance revenue collection, thereby enabling utilities to reinvest in infrastructure and expand access (Olwa, 2012; Alima, 2020). Addressing Non-Revenue Water is therefore not just a technical issue but a financial and governance priority, essential for achieving sustainable water service delivery and meeting long-term development goals.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

From the study findings, it was revealed that Non-revenue water as a financial determinant has a negative impact on Revenue Collection in Public water companies. Justify by the use of stratified data, descriptive, and inferential.

Impact of Non-Revenue Water on Revenue Collection

This study sought to examine the effect of Non-Revenue Water on Revenue Collection of Public Water companies. The research results indicated that non-revenue water has a negative impact on revenue collection in Public Water Companies. The findings also reveal that there is a negative relationship between non-revenue water and Revenue Collection in public Water Companies.

Similar study findings by Onyango *et al* (2022) concluded that severe water losses in their distribution networks as a result of leakages, unauthorized use, or bookkeeping mistakes have a negative impact on the collection. The study also discovered that water losses have an impact on land and soil, which can cause pollution and environmental damage. Farouk *et al* (2021) also had consistent results with the findings that indicated that the loss of energy and water caused by non-revenue water makes sustainability difficult, thus influencing revenue collection negatively.

The p-value for Non-Revenue Water was found to be 0.000 which is less than the significance level of 0.05 ($p<0.05$). The result indicated that the Pearson Correlation coefficient (R-value) of 0.166**represented a strong, positive relationship between non-revenue water and Revenue Collection of Public Water Companies. Using the rank correlation, it is concluded that a unit of Non-Revenue water causes 3.7% change in Revenue Collection, hence Non-Revenue water is a financial determinant of Revenue Collection in Public Water Companies.

Conclusion of the study

Non-Revenue Water Revenue System

The study concluded that non-revenue water is a Financial Determinant of revenue collection in public water companies. This implied that there was a negative relationship between the variables of non-revenue water and revenue collection. This poses a negative effect on revenue collection since there is a negative implication on the revenue collected, causing revenue challenges to the company.

Recommendations

Based on the findings of this study on Non-Revenue Water and its impact on revenue collection in public water companies, the following recommendations are proposed: Strengthening Non-Revenue Water Management and Reduction Strategies. Implement smart metering systems to ensure accurate water usage measurement and minimize losses from faulty meters. Enhance the facilitation of monitoring, leak detection, and repair leaks promptly. Among the staff members within the Non-Revenue Water Unit are those responsible for pressure monitoring and leak detection technologies.

Areas of further research

Future studies should explore the effectiveness of smart metering technology and Information Communication Technology driven solutions in reducing Non-Revenue Water and improving revenue collection. Comparative Analysis of Public Water Companies: Further research could compare the revenue collection efficiency and reduction strategies between public water

companies to determine best practices. Socioeconomic effects of Non-Revenue Water on Urban and Rural Populations: While this study focuses on financial determinants, future research should assess how Non-Revenue Water impacts water accessibility, pricing, and service quality in both urban and rural settings. Role of Government Policies and Legal Frameworks: A study on how regulatory frameworks, enforcement mechanisms, and legal reforms influence Non-Revenue Water management and revenue collection in water utilities. Sustainability of Non-Revenue Water Reduction Programs: Investigating the long-term sustainability of Non-Revenue Water reduction measures, including the challenges of funding, maintenance, and policy implementation. Integration of Renewable Energy in Water Utilities.

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