FACTORS INFLUENCING PERFORMANCE OF SEWER SYSTEM IN URBAN AREAS; A CASE OF ISIOLO WATER AND SEWERAGE COMPANY, ISIOLO TOWN

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ARTS DEGREE IN PROJECT PLANNING AND MANAGEMENT OF THE UNIVERSITY OF NAIROBI

2014

DECLARATION

I hereby declare that this project is my original work and has not been presented for the award of a degree in any other university.

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This Research project has been submitted for examination with my approval as the university supervisor

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DEDICATION

This work is dedicated to my dear Husband Patrick, my Sons Ezra and Elvis for their patience, support and encouragement during the very busy time I spent working on the research project.

ACKNOWLEDGEMENT

I would like to express my sincere appreciation to all those who assisted me in one way or another during my study period. Special thanks to my supervisor Prof. Christopher M. Gakuu for his support and guidance throughout my research period. I highly recognize the support of Eng. Joseph W. Guyo the Managing Director of the Isiolo Water and Sewerage Co. Ltd. for giving time off away from my busy schedule at work to work on the project and the entire staff of the company for their support. Last and not least, I wish to thank my family members particularly my Husband, my children, and my Sisters Ann and Vivian or their support during the entire period of my academic study.

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ABBREVIATIONS AND ACRONYMS

IWASCO	Isiolo Water and Sewerage Company
MDGS	Millennium Development Goals
MEWASS	Meru water and sewerage services
SPSS	Scientific Package of Social Sciences
TAM	Technology Acceptance Model
UN	United Nations
UNICEF	United Nations Children's Funds
UWSSI	Urban Water Supply and Sanitation Initiatives
WHO	World health organization
WSD	Water and Sewer Department
WSS	Water Supply and Sanitation

ABSTRACT

The study was to investigate the factors that influence the performance of sewer systems in urban areas with a focus on Isiolo water and Sewerage Company in Isiolo town. This study examined factors influencing sewer system in urban areas. Based on that, the researcher came up with some findings and recommendations on sewer performance. These findings is of great benefit to the Isiolo water and Sewerage Company since it finds out the causes of its poor sewer performance in service delivery and thus review their sewer policies in order to improve their service delivery and performance. Some respondents were unwilling to provide the required information on time, leading to delay in concluding the study. But in order to overcome the problem the researcher explained the importance of the study and promised confidentiality of individuals. The study adopted descriptive research design employing ex-post facto technique. According to Kothari (2009), this design will help the researcher to report what has already happened in the ground or what is happening since the problem has been well designed. The study population included all the 15 management employees of Isiolo water and Sewerage Company and the sewer consumers in Isiolo town. The sewer consumer population included the commercial and domestic consumers. There are 578 sewer consumers who comprise of both commercial and domestic. The study used stratified sampling method, where each institution was treated as a stratum. Since the population is not large for the IWASCO management and commercial consumers, and there are well organized structures where the respondents can be found easily, the researcher conducted a census. For the domestic consumers who are landlords, the researcher used a simple random method where 10% of all the respondents was selected. A list of all the domestic consumers was drawn from the sewer service provider. The researcher assigned numbers and every 10^{th} consumer was picked as a respondents hence a total of 50 respondents from domestic consumers was used. A total sample of 128 respondents was used for the study. Primary data was collected by use of structured questionnaires, designed to gather information regarding the issues addressed in the research. The SPSS tool was used by the researcher to analyze data. Descriptive statistic was used. Quantitative data was represented using tables while qualitative data was presented in narrative form. The study identified a number of key factors which were directly related to sewer performance. They included population, system infrastructure, physical environment and System technology. The discussion of the findings of the study is centred on the major research questions directing the study. The study therefore sought to establish the factors that influence performance of sewer system in urban areas; a case of Isiolo Water and Sewerage Company, Isiolo town and the following conclusions were drawn from the findings of the study. The management of IWASCO should endeavor to improve the sewer system by either building enough sewer manholes to accommodate the increasing population growth. The management should keep up the good spirit of embracing modern technology that will enhance sewer performance. The management of IWASCO should endeavor to maximize their staff capacity by training them and equipping them with technology skills for effective management of sewer performance.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

According to Akinola (2002), Western countries have the lowest total water supply coverage of any region in the world. Currently about 300 million people in western countries do not have access to safe water and about 313 million have no access to proper sewer and sanitation facilities. This situation exacts a heavy toll on the health and economic progress of western countries. The Africa water vision was presented at the second world water forum in Hague, 2000, as part of the world water vision and represents efforts at addressing the impending sewerage crises.

In Africa, millions of its population without water supply and access to sanitation is even worse than water supply. This situation is the cause of water related diseases, loss of valuable productive time and greatly contributes to perpetuate poverty on the continent. In line with its strategic plan for 2003 to 2007 and in response to the Africa Water Vision and the UN Millennium Development Goals on water supply and sanitation (WSS), the African Development Bank Group launched an Urban Water Supply and Sanitation Initiative (UWSSI) with the view to accelerating access to water supply and sanitation services in Urban Africa. Access to water supply and sanitation has been determined to contribute to poverty reduction and spur economic development (Akinola 2002).

The Rwanda Water & Sewerage Sanitation is part of the Bank Group's contribution towards meeting the international development goals on water supply and sanitation, while addressing a major developmental. The water supply and sanitation infrastructure is insufficient, especially in rural areas and concerning sanitation. There are substantial discrepancies between access data from various sources, partially because of different definitions being used by different institutions that are providing access data (Buller 2006).

The share of non-functional sewer supply systems in Ghana is estimated at almost one third, with many others operating substantially below designed capacity. However, according to the multi-donor Africa, assessment access to an improved water sources is much lower (56%) and access to improved sanitation is higher (35%). Moreover, domestic water supply competes with a rising demand for water by the expanding industry and agriculture sectors.

Ghana aims at achieving 85% coverage for water supply and sanitation by 2015, which would exceed the Millennium Development Goals' target of 78%. According to one estimate, only one quarter of the residents in Accra receive a continuous water supply, whereas approximately 30% are provided for 12 hours each day, five days a week. Another 35% are supplied for two days each week.

The remaining 10% who mainly live on the outskirts of the capital are completely without access to piped water and sewer services. The lack of clean drinking water and sanitation systems is a severe public health concern in Ghana, contributing to 70% of diseases in the country. Consequently, households without access to clean water are forced to use less reliable and hygienic sources, and often pay more(Buller, 2006).

It is estimated that in 2000 the urban areas of Ghana generated about 763,698 m^3 of wastewater each day, resulting in approximately 280 million m^3 over the entire year. Regional capitals count for another 180 million m^3. Only a small share of the generated urban wastewater is collected, and an even smaller share is being treated. In Accra, the share of wastewater collected is approximately 10%. Moreover, less than 25% of the 46 industrial and municipal treatment plants in Ghana were functional according to an inventory undertaken by the Ghana Environmental Protection Agency in 2001. Treatment plants for municipal wastewater are operated by local governments, and most of them are stabilization ponds. A biological treatment plant has been built in the late 1990s at Accra's Korle Lagoon. However, it only handles about 8% of Accra's wastewater. This has been a challenge to the entire nation as at when will the country be able to handle sewer problems(Kinoti, 2010).

In Kenya, a sewer system was built in the late colonial period and the first wastewater treatment plant was completed at Kariobangi just east of the city in 1961, shortly before independence. A second wastewater treatment plant was commissioned in 1980 in Dandora further east and further downstream on the Nairobi River. In parallel, an effort was made to expand the sewerage system. With the new infrastructure the discharge of liquid waste in open drains declined considerably and for a period between 1987 and 1995 the water quality of the Nairobi River improved. However, the discharge of untreated wastewater in non-sewered areas continued. Because of inadequate garbage collection and poor maintenance sewers became clogged and overflowed, so that the benefits of the sewerage were less than expected. Furthermore, the Kariobangi plant was poorly maintained and stopped functioning

so that the wastewater bypassed it and was discharged without treatment to the Nairobi River (Kinoti 2010).

According to Davis, (2005), Sewer system in Kenya has been cropped by many challenges which include of an institutional nature: The Water and Sewer Department (WSD) had difficulties retaining qualified staff because of its salary structure that made it uncompetitive compared to the private sector and other parastatals. For example, out of 57 staff sent for training in 2008–2009, one third had left by 1998. The morale of those who remained was said to be low. Furthermore, cost recovery was low and declining. For political reasons tariffs were increased less than the inflation rate, so that real tariff levels declined between 2009 and 2010. Furthermore, the devaluation of the Kenyan Shilling in the early 2010s led to high losses because the utility was indebted in foreign currency. The sustainable operation and maintenance of the water and sanitation infrastructure was thus in jeopardy because of lack of financial resources. The Environmental Sanitation Programme supported by WHO-UNICEF was carried out in Kenya with the aims of developing water supplies for small rural communities, improving waste disposal methods and providing sanitary education for the rural population. The rural water supply schemes set up as part of the programme were operated by County Councils (under the Ministry of Local Government).

In Isiolo county, local communities have started developing their own water supplies and set up water committees. This has been necessitated by poor performance of the sewer company in Isiolo where sewer blockage is the order of the day. The county has experienced spilling and flooding of human waste along the sewer line and sometimes in town centre due to blockage of the system. The county government is helping the sewer company to address the issues in order to improve the falling performance and efficiency and the sanitation of the county. The study focused on four variables influencing sewer performance which includes; population of people in Isiolo town, system infrastructure, system technology and physical environment. These are the variable that will guide the entire study in order to find out why sewer performance is below expectations

1.2 Statement of the problem

Improved access to water supply and appropriate sanitation is fundamental to the elimination of poverty and the achievement of millennium development Goals (MDGs).Yet, access to water for most urban and rural poor groups remain very poor in developing countries (UNDP, 2007). The provision of adequate water supplies is essential in order to meet basic human needs and to address poverty, and promote economic development, health and

hygiene. Water supply has a long history in this respect, and the rationale for its improvement has always been the need to protect public health, to reduce mortality and morbidity in the population, and to promote economic development, especially in the developing world.

Water supply and sanitation in Kenya is characterized by low levels of access, in particular in urban slums and in rural areas, as well as poor service quality in the form of intermittent water supply. Only 9 out of 55 water service providers in Kenya provide continuous water supply and proper sewer systems. Seasonal and regional water scarcity exacerbates the difficulty to improve sewer system.

The Kenyan water sector underwent far-reaching reforms through the Water Act No. 8 of 2002. The Ministry of Water and Irrigation is in charge of policies for water supply and the Ministry of Public Health and Sanitation is in charge of policies. Water and sanitation sector in Kenya is characterized by institutional fragmentation that led to numerous inefficiencies and by subsequent attempts at reform. 95% of the excreta disposal facilities in Kenya urban areas are major use of sewer systems hence providing varied degrees of safety, hygiene and privacy.

The government of Kenya has provided legal framework and entered into collaboration with donors such as JICA to ensure that the sewer systems in Kenya urban areas are functioning properly and sanitation is improved. Despite all the government efforts to modernize urban sewer system, there has seen complains that the urban sewer systems are not up to standards. This has been characterized by poor drainage of sewer system, blockage of pipe, spilling and flooding of wastes in towns. This can be exemplified by low delivery of services, lethargy, cronyism, slow implementation of government policies and programs leading to hue and cry from the stakeholders both internal and external.It is in this strength that the researchers have identified that there exists a problem which requires a study to establish the factors influencing sewer systems in urban areas.

1.3 Purpose of the study

The study investigated the factors that influence the performance of sewer systems in urban areas with a focus on Isiolo water and Sewerage Company in Isiolo Town.

1.4 Objectives of the Study

The study sought to achieve the following objectives

i. To determine the extent to which population is a factor influencing performance of sewer system in urban areas.
ii. To establish how system infrastructure influences performance of sewer system in urban areas.
iii. To determine the extent to which physical environment influences performance of sewer system in urban areas.
iv. To establish how System technology influences performance of sewer system in urban areas.

1.5 Research questions.

The study was guided by the following research question

i. To what extent does population influence performance of sewer system in urban areas?
ii. How does a system infrastructure influences performance of sewer system in urban areas?
iii. To what extent does physical environment influence performance of sewer system in urban areas?
iv. How does system technology influences performance of sewer system in urban areas?

1.6 Significance of the study.

This study examined factors influencing sewer system in urban areas. Based on that, the researcher came up with some findings and recommendations on sewer performance. These findings is of great benefit to the Isiolo water and Sewerage Company since it will find out the causes of its poor sewer performance in service delivery and thus review their sewer policies in order to improve their service delivery and performance. The senior managers in the County government shall be able to know how to they can help the Isiolo water and sewerage company to streamline the sewer system and help them improve the sewer performance in the County.

Other researchers may use this study finding to relate to their own research and come up with other findings, recommendations and conclusions.

1.7 Delimitation of the study.

The study population included all sewer consumers of Isiolo water and Sewerage Company which includes commercial and domestic consumers. There is a total of 578 sewer consumers in Isiolo town. This is because for the researcher to come up with precise findings, recommendations and conclusion, all clients must be involved. The researcher used the data gathered from the sewer consumers to generalize the finding.

1.8 Limitations of the Study.

Some respondents were unwilling to provide the required information on time, leading to delay in concluding the study. But in order to overcome the problem the respondents were explained the importance of the study and promised confidentiality of individuals.

There was lack of effective communication and interaction due to the fact that Isiolo is a marginalized area. To overcome this, the researcher used a language that all the respondents understood and interpreters were also used. They were explained the significance of carrying out the study to the respondents in order to ensure the study objective was achieved.

1.9 Assumptions of the study

The study assumed that respondents answered the questions correctly and truthfully. It also assumed that the data collection instruments had validity and they measured what was intended to be measured.

1.10 Definition of Significant Terms

Commercial consumer: A consumer is the final user of a product or service therefore a commercial consumer is the user that provides a wide market.

Infrastructure: Structures needed for operation of a system

Performance of Sewer: It is the accomplishment of a given task measured against preset known standards of accuracy, completeness, cost and speed. It is a fulfillment of all obligations of a sewer system.

Physical environment: The physical environment includes land, air, water, plants and animals, buildings and other infrastructure, and all of the natural resources that provide our basic needs and opportunities for social and economic development. The term can also be defined as the material surroundings of a process, system or organism.

Population: All the inhabitants of a particular town, area, or country:

Sewage: Water that is discharged after home or industrial use, and cleared away via a system of pipes leading to a waste water treatment plant.

Sewer System: The sewer system is responsible for the transportation of the wastewater from the households to the wastewater treatment plant

Urban Areas: An urban area is characterized by high population density and vast human features in comparison to the areas surrounding it. Urban areas may town or cities.

System: a set of interrelated and integrated components making a whole.

Technology: Knowledge and tools used to improve a pre existing problem.

1.11 Organization of the Study

This study is organized into five chapters which capture various components of the research. Chapter one captures the spirit of the research in the introduction; it also attempts to respond to the questions as to why the research is necessary and what it aims at achieving. It also explores into the expected challenges and opportunities for good research results as well as defining key concepts in the research. Chapter two forms the Literature review of the study and equally focus on what other scholars have observed in as far as issues and variables in this research are concerned. It also comes up with the conceptual framework, which forms the spine of the research.

Chapter three deals with the specific methodology of research as well the procedure in data analysis. It includes the research design, target population, sampling procedure, data collection methods, methods of data analysis, the validity and reliability, operational definition of variables and ethical issues.

Chapter four has provided provide an analysis and interpretations of the data from the field. Finally chapter five presents the summary of the findings from chapter four and also gives conclusions and recommendations of the study based on the objectives of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter covers other related works by different scholars, assessed so as to give a theoretical and empirical foundation to the study.

2.2 Empirical Review

According to Renzetti & Dupont (2004), the diversity of the service sector makes it difficult to make useful generalization concerning the management of service organization. Water and sewerage services have certain special features not necessarily typical of other infrastructure services. They are exceptionally capital-intensive compared with other public services. The capital costs (including interest and depreciation) are often 65-75 percent of annual operating costs. The greatest share of capital costs by far is related to pipe and sewer networks. Contrary to common belief, adequate and modern wastewater treatment accounts for only 10-15 percent of annual operating costs (Megginson & Netter, 2001).Yet, the treatment processes are of utmost importance for health and environmental reasons.

The capital intensiveness is partly due to the low ratio of annual turnover to cost of assets. A second special feature of sewerage services operations is that fixed costs i.e. those that do not vary with the volume of production, except within very wide limits are about 80 percent of operating expenses. Yet, the revenue of many utilities depends mainly on the volume of water sold(Pickford, 2001). This has a profound effect on the structure of rates and charges. Consumers have to pay for the services, commonly through consumption related charges, sometimes by other means like taxation (Panda,2007). Lack of proper cost recovery policy has been one of the key problems in many countries. The third, and maybe the most important, feature from the viewpoint of this study is that the Water and sewerage services infrastructure is a natural monopoly a concept first introduced by John Stuart Mill in 1848 (Perkins, 2008). In the case of services like water and sanitation it is feasible to construct only one system for one service area. General services and efficiency standards are commonly benchmarked, and finance efficiency is also tracked extensively (Pickford, 2001).

2.3 Population and performance of sewer system

According to a study conducted by UNDP (2007), on the rapid urban population increases found that during the nineteenth century, there was considerable urban population growth in the United States. In 1820, less than 5 percent of all Americans lived in urban areas (cities with a population larger than 8,000), but by 1860 the percentage increased to 16 percent and by 1880 had risen to 22.5 percent. From 1820 to 1880, most major cities in the United States experienced considerable growth. For example, during this time Boston's population increased eightfold, New York City's tenfold, Philadelphia's thirteen fold, and Washington, D.C.'s fivefold. As a result of this increased population density in urban areas, the decentralized privy vault-cesspool wastewater management systems became overtaxed. Mitigation measures included increasing the cleaning frequency and constructing additional privy vaults and cesspools. The improvements, however, only slightly reduced the periodic overflows and development of nuisance conditions.

The privy vault-cesspool system, as it existed then, was inadequate to handle the increased amount of wastewater. The centralized water-carriage sewer system, on the other hand, was being promoted as the management alternative for urban areas with increasing populations.

The rapid population increases of certain small towns convey the advantages and disadvantages associated with urbanization. Income redistribution, enlarged tax revenues, and increased property values can best benefit a community when that society's newly accumulated traffic, power, water, and waste demands are kept to a minimum. The acquisition of metropolitan lifestyles usually means abandonment of the resourcefulness associated with rural agricultural communities. Wastes of all types tend to increase especially in cases where water is readily available. Water is easily converted from its natural state by the addition of various dissolved and suspended, organic and inorganic pollutants. Virtually all industrial production uses water to some extent somewhere along the raw-to-finished-product line (UNDP 2007).

Panda (2007), argues that domestic water, regarded as an always present and constant commodity, is used as a produce and laundry cleaner, a carrier for garbage disposal grist, and a necessity for human metabolic functions. Each process excretes the utilized water with its own type of pollutant yet all converge at the same location, the local sewage treatment plant. Too often the municipal treatment plant designed for a particular capacity and type of sewage cannot keep up with demand and allows the outflow of non-treated or only partially treated

wastewaters. The eutrophic problem of receiving waters caused by the release of municipal wastewater effluents was one of the prime reasons for implementation of Public Law 92-500. The law seeks to sequentially outline the standards and scheduling of water pollution abatement procedures. The law applies to "point source" discharges and the applicable guidelines issued by the Environmental Protection Agency. By 1977, "secondary treatment", based on aerobic bacterial decomposition, must be used by all municipal sewage treatment facilities. By 1983, these plants must furnish the "best practicable waste treatment technology" which will produce "reasonable progress" toward zero discharge of pollutants, the 1985 goal.

As rural populations around metropolitan areas grow, they often outgrow their vital services' capacities. Not only is the sewage treatment facility itself not able to handle the influx due to new homes and businesses but the sewage pipelines which transport the wastes also reach capacity limits. Enlargement of or supplements to the whole system are sometimes needed. This requires the acquisition of additional easements and extension properties to meet current and future needs and regulations. Residential wastewater management in seventeenth-century colonial America consisted primarily of a privy with the outlet constructed at ground level, usually discharging into the yard, street, gutter, or an open channel serving as a sewer. Because population densities were low, privies constructed in this way did not create sanitation problems or unbearable nuisances in colonial cities (e.g., New York City in the eighteenth century), but as populations increased, so did the sanitation problems and nuisances (Panda, 2007).

In his study on performance of private water services providers, Kinoti, (2010), argued that the majority of residents accepted the sanitation problems and nuisance conditions as a necessary part of urban life, except during epidemics or following a disease outbreak when sanitation was given considerable attention. To alleviate the nuisance conditions caused by the discharge of privies into streets and gutters, residents would construct a vault or tub beneath the privy, or would discharge wastewater into a nearby cesspool. Privy vaults and cesspools were meant to store the wastewater until it either soaked into the ground or could be manually removed and disposed of away from the residence. One alternative to the privy vaults and cesspools used in the United States was the dry sewage system. Dry sewage systems in the nineteenth century (e.g., pail systems) entailed placing containers beneath the seats of privies to collect human excrement. Once the containers were full, the homeowner or other responsible party would transport the excrement to a convenient disposal location near

the residence. Compared to the privy vault, dry collection of human waste required a diligent effort on the part of the homeowner to maintain the system in a sanitary state. The prime advantages of the dry sewage system were the quick removal of wastes from the residence and the potential use of the waste as fertilizer on nearby farmland.

Sewer service providers often contracted workers to remove the wastes from residences and deposit them in suitable disposal locations outside the city limits. But the crews hired to perform these duties did not perform adequately, leading to accumulated wastes, nuisances, and public health problems. Decentralized dry sewage systems were more common in Europe and Asia than in the United States because Europeans and Asians had more experience using human excrement as fertilizer and doing so cost effectively. In addition to the reluctance to effectively use human excrement in the United States, residents were not enthusiastic about maintaining or cleaning dry sewage systems. Despite the implicit of the dry sewage systems, the prevailing opinion during the mid-nineteenth century in Europe and the United States was against their use in urban areas, as suggested by the following excerpt from an 1876 report by a committee appointed by the Local Government Board of England (Kinoti, 2010).

2.4 System Infrastructure and performance of sewer system

The role of infrastructure such as safe drinking water in societal welfare and development has long been recognized. Infrastructure is regarded as the systemic framework which underpins community's ability to fulfill its mission of providing a base for its citizens to be productive and to nurture social equit (Davis, 2005). It is a kind of public trust of commonwealth upon which every citizen relies and draws for prospect and day to day socio-economic opportunities. When it functions efficiently the whole society benefits and the resultant effect is manifested on the growth and development of the community, when it functions below expectation, everybody pays in kind and cash (Akinola, 2002).

Sewer supply like energy, capital and communications is a very important infrastructural prerequisite for sustainable development. Apart from its primary role in enhancing human health and wellbeing, it is equally important for industrialization and commercial developments (Pickford,2001). Adequate water is absolutely necessary to support the population and economic life of a city. Critical shortages of water not only inhibit or stop economic development but also directly damage the health of the city's people.(Pickford 2001) contends that without water, there is no life; he cautioned that bad water could be

almost as harmful as no water at all. The recognition of the significant role of water resources to support life in a city and its use for urban development has instigated interest on it at the global level and its inclusion on the subject of sustainable development and environmental sustainability.

According to UNEP (2008), the environmental resource systems which are important for sustainable urban development include water resources, among others. Various commentators suggest that more dispersed and localized wastewater systems are required even in the major developed cities (Tjandraatmadja & Burn, 2005) along with nutrient recovery and better control of substances introduced into wastewater systems. Although there are arguments over the relative merits of localised (or "on-site") systems for wastewater management, serving individual or small groups of properties – compared with the "end-of-pipe" systems traditionally used – there is a growing usage of on-site sanitation in countries such as the United States. Such systems can recover nutrients and energy and also be linked to local water supply and reuse technologies. This potentially changes the approach to service provision in the future, with systems being smaller and requiring much less up front capitalization for their implementation.

Buller (2006) argues that decentralized systems are also better at coping with the need to expand services. In the area of storm water drainage, there is also a growing use of "source control" technologies that handle storm water near the point of generation, i.e. locally, also providing opportunities for direct use for, e.g., toilet flushing.

2.5 Physical environment and performance of sewer system

According to Pickford, (2001), there are two basic physical environment reasons why the implementation of centralized water-carriage sewer systems was favored over decentralized privy vault-cesspool systems. Water-carriage sewer systems were believed to be more cost effective over the long term. Experience in England showed that physical environment of a water supply and water-carriage sewer system cost with interest, divided over a period of thirty years would be less than the cost of keeping privy vaults and cesspools clean. Similarly in the United States, proper physical environment a of centralized sewer system advocates pointed out that the capital and maintenance costs of sewer systems would represent a saving over the annual cost of collection and cleaning with the privy vault-cesspool system. Based on this economic reasoning, city councils, sanitary engineers, and health groups almost unanimously agreed that water-carriage sewer systems provided the most benefits and the

lowest long-term costs compared to other disposal options, as was the case for New York City.

The other physical environment reason according to (Pickford 2001), was the public opinion in favor of sewer system implementation because of the potential advantages it offered, most notably, convenience. Water carriage sewer systems eliminated most maintenance work by the homeowner and permitted wastes to be collected and disposed of in the least obtrusive and offensive manner. Public opinion could not directly secure funds for the construction of a centralized water carriage sewer system, but its influence over elected officials could indirectly secure funds.

A study by WHO & UNICEF (2007), argued that sewage collection and disposal systems transport sewage through cities and other inhabited areas to sewage treatment plants to protect public health and prevent disease. Sewage is treated to control water pollution before discharge to surface waters. The focus of sewage treatment was on the conveyance of raw sewage to a natural body of water, e.g. a river or ocean, where it would be satisfactorily diluted and dissipated. Early human habitations were often built next to water sources. Rivers would often double as a crude form of natural sewage disposal. Sewage system may convey the wastewater by gravity to a sewage treatment plant. Where pipeline excavation is difficult because of rock or there is limited topographic relief (i.e., due to flat terrain), gravity collection systems may not be practical and the sewage must be pumped through a pipeline to the treatment plant. In low-lying communities, wastewater may be conveyed by vacuum. Pipelines range in size from pipes of six inches (150 mm) in diameter to concrete-lined tunnels of up to thirty feet (10 m) in diameter. Community sewage can also be collected by an effluent sewer system, also known as a STEP system (Septic Tank Effluent Pumping). At each home, a buried collection tank is used to separate solids from the liquid effluent portion. Only the liquid portion is then pumped through small diameter pipe (typically 1.5" to 4") to downstream treatment. Because the waste stream is pressurized, the pipes can be laid just below the ground surface along the land's contour. Sewage can also be collected by low pressure pumps and vacuum systems. A low pressure system uses a small grinder pump located at each point of connection, typically a house or business. Vacuum sewer systems use differential atmospheric pressure to move the liquid to a central vacuum station.

2.6 System technology (ICT) and performance of sewer

Automation and ICT were adopted in sewer supply facilities and networks since the early fifties. Most of modern sewer supply plants in the developed countries are nowadays fully automated, utilizing ICT for synchronization of water supply with demand, regulation of pumps operation for energy savings, coordination of withdrawal from different sources and reservoirs and control of purification processes in sewerage reclamation facilities (Davis, Bagozzi & Warshaw, 2001). The introduction of variable speed pumps, incorporating frequency adjustment drives, facilitates high-level regulation of discharge and pressure regime for savings of energy and water. The use of this advanced technology was boosted by the increase in oil price during the last decade. The anticipated oil price hike in the future increases the incentive for more extensive adoption of ICT in water supply facilities. Energy savings by installed appliances, amount to 20% - 30% by increasing the efficiency of pumping units, balancing withdrawals and eliminating pressure surges and fluctuations (Tjandraatmadja & Burn, 2005).

The public sector, particularly government facilities, sewer supply is lagging behind the in controlling the supply and consumption. According to Karanja and Nyambura (2014), system technology will always lead to improved performance especially if its adoption is fully supported by management and the end users. Most government facilities consumers in the world do not pay for sewer according to consumption. Many of them do not pay at all for the sewer consumed (Renzetti & Dupont. 2004). Only in limited number of countries, like Israel, each consumer's sewer outlet is equipped with a sewer meter. But, due to increasing worldwide sewer facilities shortages, interest is growing in measuring government and household sewer consumption and invoicing the users according to the actual amount of sewer consumed.

The planning and design of wastewater management systems in European and American cities was usually based on the experience of the design engineers because the transfer of technology was slow, and standardized wastewater management procedures were not yet widely published. During the nineteenth century, junior engineers from most disciplines would learn engineering skills on the job from senior engineers. The newness of wastewater management meant that there were few experienced engineers available in the United States.

Consequently, the first coordinated U.S. wastewater management efforts followed practices established in Europe. European cities were constructing large-scale centralized water-

carriage sewer systems and proving them successful for removing wastewater from urban areas. U.S. engineers often consulted with the designers of the successful European systems when designing their own systems. Thus, through person-to-person technology transfer, European engineers promoted the use of centralized sewerage technology in the United States.

2.7 Theoretical Framework

This study shall be based on two theories: Technology acceptance Model and the Brett frischmanns economic theory of infrastructure. A theory as defined by (Mugenda and Mugenda 2003) is a set of concepts and interrelations that are presumed to exist among concepts. Theoretical framework is a collection of interrelated ideas based on theories –a reasoned set of prepositions which are derived from and supported by data or evidence (Kombo and Tromp, 2006).The two theories will complement each other for the purpose of this study.

2.7.1 Technology Acceptance Model

One of the well-known models related to technology acceptance and use is the technology acceptance model (TAM), originally proposed by Davis in 1986. TAM provides a basis with which one traces how external variables influence belief, attitude, and intention to use. Two cognitive beliefs are posited by TAM: perceived usefulness and perceived ease of use. According to TAM, one's actual use of a technology system is influenced directly or indirectly by the user's behavioral intentions, attitude, perceived usefulness of the system, and perceived ease of the system. The study adopted this model to explain the role of information in enhancing efficiency in the provision of sewer services.

2.7.2 Brett Frischmann's economic theory of infrastructure

Brett Frischmann's economic theory of infrastructure and commons management offer a comprehensive new proposal about managing certain types of resources by providing public access to them on an obligatory and nondiscriminatory basis. It critiques any systematic right to exclude as inappropriate—a right that would be an integral part of a typical resource management scheme based on private property. For many resources that are broadly shared and reusable, Frischmann argues, open access will be more conducive to maximizing the production of public and nonmarket goods on an ongoing basis. The beneficial processes of shared use and reuse, with their many positive spillover effects, would be impeded by

granting a property right to an owner who then could exclude potential downstream users, based on inadequate signals about demand. Frischmann concludes that fundamental infrastructure should instead be shared. His theory is important and helpful in addressing current issues of management, organization structure and information.

2.8 Conceptual framework

The conceptual framework below explains that the performance of sewer systems is dependent on population the system infrastructures and at other stages the system technology and the physical environment. Moderating variables that equally play a role in the performance of sewer is the government policies and political stability.

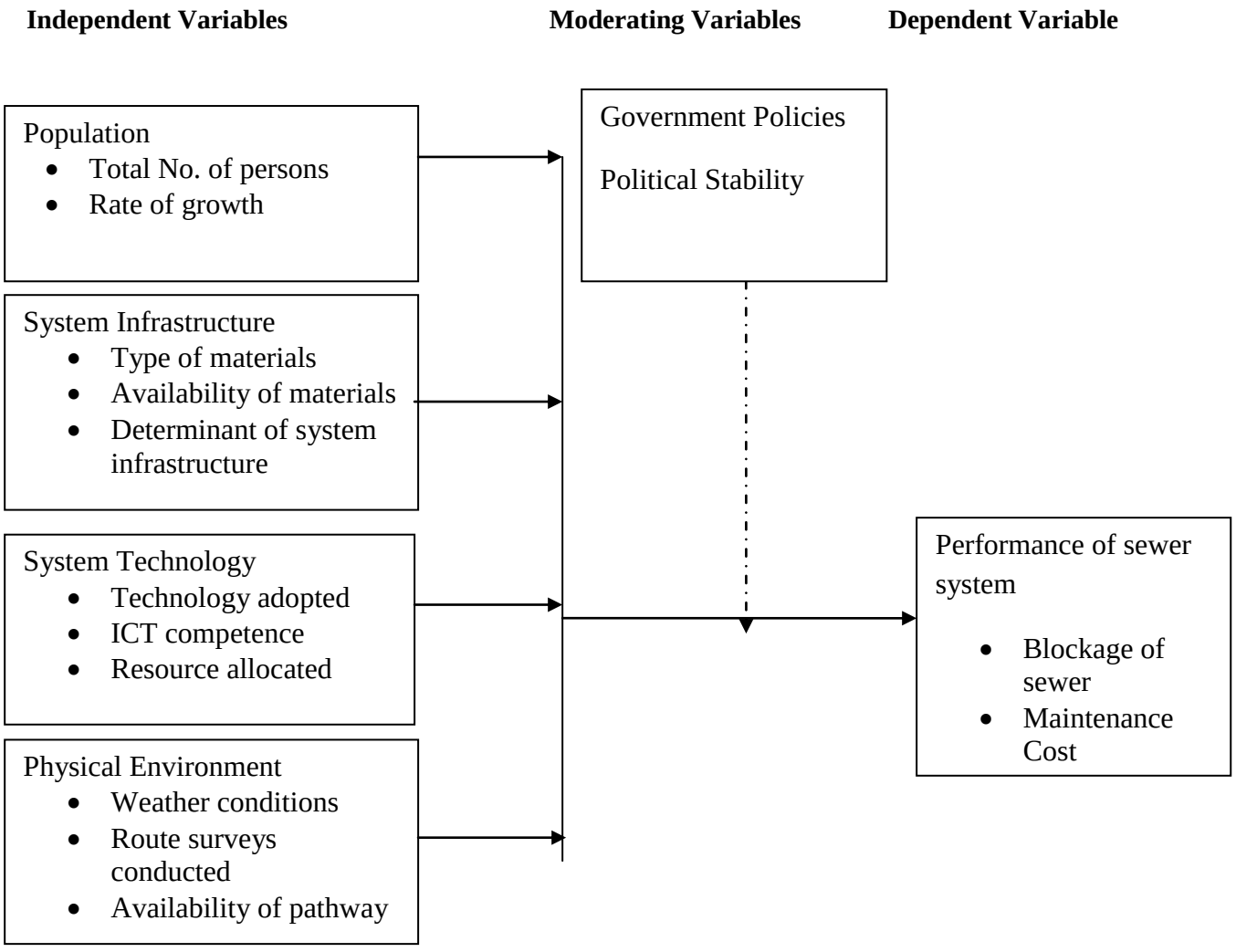

Figure 1. Conceptual framework

2.9 Summary of literature Review

This chapter will review the literature on the factors influencing the performance of sewer systems in the urban areas both globally and locally through history to contemporary times. Theories on Technology acceptance model and economic theory of infrastructure have been discussed. Other literatures on other factors which include population and physical environment have been reviewed. Conceptual framework has been included to explain the relationship between the independent variables and the performance of sewer systems in the urban areas.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter deals with the research design and methodology. It contains the research instruments which the researcher used in the study. In addition to that, the sampling design and the data collection procedures are also outlined. The section describes the target population, sampling method, the procedure of data collection, data analysis and presentation.

3.2 Research Design

A research design is a conceptual structure within which research is conducted. It constitutes the blue print for the collection, measurement and analysis of data. The study adopted descriptive research design employing ex- post facto technique. According to Kothari (2009), this design will help the researcher to report what has already happened in the ground or what is happening since the problem has been well designed .It involves fact finding and enquiries of different types. This is the research design that was used to establish factors influencing performance of sewer system in urban areas.

3.3 Target Population

The study population included all the 15 management employees of Isiolo water and Sewerage Company and the sewer consumers in Isiolo town. The sewer consumer population included the commercial and domestic consumers. There are 578 sewer consumers who comprise of both commercial and domestic. The researcher liased with Isiolo water and Sewerage Company to get contacts and physical address of the respondents who formed the target population. This is because for the researcher to come up with precise findings, recommendations and conclusion, all clients must be involved.

Table 3.1.1: Target Population

	Frequency	Percent
Management IWASCO	15	3
Commercial	63	11
Domestic	500	86
Total	**578**	**100.0**

3.4 Sampling Procedure

A sample is a set of entities drawn from a population with the aim of estimating characteristics of the population. It is a fraction or portion of a population selected such that the selected portion represents the population adequately. Cooper and Schindler (2003) explains that the whole idea of sampling is selecting some of the elements in a population ,so the same conclusions can be drawn about the entire population.10- 30% is a good representation of the target population.

Kothari (2009), highlights the formula of sample size as $nf = \frac{n}{(1+n)/N}$

nf= the desired sample size

N= the estimate of population size

The study used stratified sampling method, where each institution was treated as a stratum. Since the population is not large for the IWASCO management and commercial consumers, and there are well organized structures where the respondents can be found easily, the researcher conducted a census. According to Kothari (2009), a complete enumeration of all items in the population is known as a census inquiry. It can be presumed that in such an inquiry, when all items are covered, no element of chance is left and highest accuracy is obtained and especially when the population is small hence no need for further sampling.

For the domestic consumers who are landlords, a simple random method was used where 10% of all the respondents was selected. A list of all the domestic consumers was drawn from the sewer service provider. Numbers were assigned and every 10^{th} consumer was picked as a respondents hence a total of 50 respondents from domestic consumers was used. A total sample of 128 respondents was used for the study.

Table 3.4.1 Sample size

Institutions	No of Employees

Isiolo water & sewerage company	15
Isiolo Boys	9
Isiolo District Hospital	12
County Commissioner's Headquarters	10
County Government headquarters	15
Kenya Police Service	7
Kenya Prisons Service	10
Estate Owners (Landlords)	50
Total	128

3.5 Methods of Data collection

The questionnaire was used to collect the data from the sample. Primary data was collected by use of structured questionnaires, designed to gather information regarding the issues addressed in the research. The questions were simple and logical. The questionnaire contained simple but straight forward directions for the respondents so that they not feel any difficulty in answering the questions. The questionnaires were administered to the respondents and were given 2 days to complete, and then picked from them after the 2 days. The questionnaires were used because they enables the researcher to ask structured questions which are easier to analyze as well as to administer as each question is followed by alternative answers, similarly the questionnaire enables the researcher to use open-ended questions thus permitting a greater in-depth response from the respondents. These particular responses enable the researcher to get greater insight into the feelings, decisions and thinking of the respondents (Fraenkel & Wallen, 2000).

3.6 Validity and Reliability

Patoon (2002) states that validity and reliability are two factors which qualitative researchers should be concerned about while designing results and judging the quality of the study.

3.6.1 Reliability of the Questionnaire

According to Mugenda and Mugenda (2003), reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. The test-retest method was applied and correlation coefficient was calculated using spearman's formula .A 0.81 correlation coefficient of performance of sewer was attained. According to (Mugenda and Mugenda 2003), a reliability coefficient of 0.7 and above is acceptable to make

inferences that are accurate in social sciences research. Since the computed coefficient relationship was 0.81 which is above 0.7, hence the instrument was accepted as reliable.

3.6.2 Pilot Testing

The questionnaire was validated through a pilot with a sample of respondents from Meru water and sewerage services (MEWASS). This confirmed the reliability of the structure, question sequence and the meaning of questions. The population samples from the both sewer companies were used in the pilot to avoid irregular skewing of the results and ensure uniformity of meaning and clarity of instruments to all respondents.

3.6.3 Validity of the questionnaire

Validity refers to the extent to which instruments measures what it is supposed to measure, (straight et al 1993). The questionnaire was validated through a pilot with a sample of respondents from MEWASS. This confirmed the reliability of the structure, question sequence and the meaning of questions. The population samples from the two sewer companies were used in the pilot to avoid irregular skewing of the results and ensure uniformity of meaning and clarity of instruments to all respondents.

3.7 Methods of data Analysis

Data analysis process included data sorting, editing, coding, or variable generation, data entry, cleaning, processing and interpretation of results. The SPSS tool was used by the researcher to analyze data. Descriptive statistic was used.. Quantitative data was represented using tables while qualitative data was presented in narrative form.

3.8 Operational Definition of Variables

The operationalization of variables explains the relationship between the variables .That is how the independent variables work together towards the performance of sewer systems in urban areas.

Objective	**Variable**	**Indicator**	**Scale**	**Data collection Method**	**Level of analysis**
To determine whether population influences performance of	Independent Population	- Total No. of persons - Rate of growth	Ordinal	Questionnaire	Descriptive

sewer system					
To establish whether system infrastructure influences performance of sewer systems	Independent System infrastructure	- Type of materials Availability of materials Determination of system infrastructure	Ordinal	Questionnaire	Descriptive
To determine whether physical environment influences performance of sewer systems	Independent Physical environment	Weather conditions Route surveys conducted Availability of pathways	Ordinal	Questionnaire	Descriptive
To establish if system technology influences performance of sewer systems	Independent System technology	Technology adopted ICT competence Resource allocated	Nominal	Questionnaire	Descriptive
Performance of Sewer system	Sewer performance	Blockage of sewer Maintenance cost	Nominal	Questionnaire	Descriptive

3.9 Ethical Issues

In this study, the researcher sought permission from the head of departments in all the institutions involved. Before completing the questionnaire, the respondents explained the purpose of the research and request them to participate in the study. Only those who consented were included in the actual data collection. There was cover letter accompany the questionnaires requesting cooperation from the respondents, a statement of confidentiality and a copy of a letter from the University indicating the study is purely for academic purposes and all ethical practices are to be respected.

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CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter discusses the presentation, analysis and interpretation of the findings as per the data collected from the respondents. The questionnaires contained five sections in which section A required the demographic data, section B, C, D and E had structured questionnaires with both closed and open ended questions on physical environment, system infrastructures, system technology and population

Data was analysed in relation to the study objectives. The general objective of the study was to investigate the factors influencing performance of sewer systems in urban areas a case of Isiolo water and Sewerage Company in Isiolo town. A profile of data from each of the respondents was compiled and analysed. The data was presented and classified in form of frequency tables and numerical values and percentages generated through statistical package of social science version 17.

Only 108 questionnaires were returned which accounted for 84% return rate. The reasons for this response rate was attributed to the fact that some of the respondents who were issued with the instruments returned questionnaires whose most items were not filled, some the questionnaires contained data which was deemed not useful or irrelevant and some of the subjects did not return the questionnaires at all.

4.2 Demographic information

This section sought to gather information relating to or concerning demography among the respondents targeted in the study.

4.2.1 Gender distribution

Respondents were required to state their gender. Data collected indicated that out of 108 respondents, majority (92.4%) of them were men while (7.6%) of them were female. The table below represents the distribution of the gender of the respondents. This show that there is no gender equality in the management of sewer in Isiolo town.

Table 4.1 Gender Distribution

Respondents Gender Distribution

Gender	Frequency	Per cent
Male	100	92.4
Female	8	7.6
Total	**108**	**100.0**

4.3.2 Age distribution

The respondents for the study were asked to state their age category. Data collected indicated that majority (26.1%) of the respondents were of age category 41-45 years, 20.4% of the respondents were between 36-40 years, 17.2% were between 25-30 years,11.5% were between 31-35 years,9.6% were over 51 years of age,8.9% were between 46-50 years while the remaining 6.4% were those below 25 years of age. The table below represents the distribution of the ages of the respondents. It can be concluded that majority of the respondents were between 41-45 years.

Table 4.2 Respondents by Age

Age	Frequency	Per cent
Below 25 years	7	6.4
25-30 years	19	17.2
31-35 years	12	11.5
36-40 years	22	20.4
41-45 years	29	26.1
46-50 years	9	8.9
Over 51 years	10	9.6
Total	**108**	**100.0**

4.3.3 Level of education

The respondents level of education was considered to significant for the study as it would help to generally establish the literacy levels of the respondents. They were therefore asked to indicate their highest level of education.

Data collected indicated that majority (68.8%) of the respondents had a Diploma education, 24.2% had a degree education, 1.9% had a Masters education and above 5.1% were of Secondary education. The table below shows the response of the respondents. This shows that majority of the consumers and management of IWASCO are diploma graduates.

Table 4.3 Respondents Level of Education

	Frequency	**Per cent**
Primary education	0	0
Secondary education	6	5.1
Diploma	74	68.8
Degree	26	24.2
Masters and above	2	1.9
Total	**108**	**100.0**

1.3.4 Years worked in Isiolo town

Respondents' length of service was considered significant for the study as it would help establish the level of experience and understanding of the sewer performance in Isiolo town among the respondents. They were therefore asked to indicate the period they had worked in Isiolo town. Data collected indicated that majority (39.5%) of the respondents had worked in Isiolo town for a period of over 15 years, 21.7% had served for a period between 5-10 years, and 20.4% had served for a period between 11-15 years while 18.5% had served for a period below 5 years. This shows that majority of the respondents are conversant with the sewer performance in Isiolo town. This can be concluded that majority of the respondnets have stayed in Isiolo town for more than 15 years hence they are conversant with sewer system in Isiolo town.

Table 4.4 : Respondents years worked in Isiolo town

	Frequency	Percent
Below 5 years	12	18.5
5-10 years	15	21.7
10-15 years	13	20.4
Above 15 years	26	39.5
Total	**108**	**100.0**

4.4 Influence of Population on performance of sewer

This section sought to gather the feelings of the respondents in regard to the population in Isiolo town. They were asked to express their opinion by placing a tick in an appropriate column that expresses what you feel.

4.4.1. (a): High growth rate of population in Isiolo town

Respondents were asked to express their opinion on high growth rate of population in Isiolo town. The table 4.5 presents respondents responses to the item.

Table 4.5: High growth rate of population in Isiolo town

	Frequency	Per cent
Strongly Agree	13	12
Agree	79	73
Neutral	0	0
Disagree	11	10
Strongly Disagree	5	5
Total	**108**	**100.0**

Majority (73%) of the respondents agreed that there is high growth rate of population in Isiolo town, 12% strongly agreed that there is high growth rate of population in Isiolo town while 10% disagreed that there is high growth rate of population in Isiolo town and only 5% strongly disagreed that there is high growth rate of population in Isiolo town. This can be concluded that there high population in Isiolo town which have contributed to poor performance of sewer in Isiolo town.

4.4.1. (b): High population connected to the sewer system

Respondents were asked to express their opinion on whether there is high population connected to the sewer system. The table 4.6 presents respondents responses to the item.

Table 4.6: High population connected to the sewer system

	Frequency	Per cent
Strongly Agree	72	67.5
Agree	28	24.8
Neutral	2	2.1
Disagree	2	2.2
Strongly Disagree	4	3.4
Total	**108**	**100.0**

Majority of the respondents (67.5%) strongly agreed that there is high population connected to the sewer system, 24.8% agreed that there is high population connected to the sewer system while 3.4% of the respondents strongly disagreed that there is high population connected to the sewer system and 2.2% disagreed that there is high population connected to the sewer system. Only 2.1% of the respondents could not make a decision as to whether or not there is high population connected to the sewer system. This can be concluded that the high population in Isiolo town which is connected to sewer might have contributed to poor performance of sewer in Isiolo town

4.4.1(.c) Inefficiency system to cater for huge population

Respondents were asked to express their level of agreement whether there is inefficiency of system to cater for huge population. The table 4.7 presents respondents responses to the item.

Table 4.7 Inefficiency system to cater for huge population

	Frequency	Per cent
Strongly Agree	77	72.7
Agree	17	15.3
Neutral	3	2.6
Disagree	6	5.1
Strongly Disagree	5	4.3

	Frequency	Per cent
Strongly Agree	77	72.7
Agree	17	15.3
Neutral	3	2.6
Disagree	6	5.1
Strongly Disagree	5	4.3
Total	**108**	**100.0**

Majority of the respondents (72.7%) strongly agreed that whether there is inefficiency of system to cater for huge population. 15.3% agreed that whether there is inefficiency of system to cater for huge population while 5.1% of the respondents disagreed with the proposition that whether there is inefficiency of system to cater for huge population and 4.3% strongly disagreed with the proposition that whether there is inefficiency of system to cater for huge population. Only 2.6% of the respondents who could not make a decision as to whether or not there is inefficiency of system to cater for huge population. This can be concluded that there is inefficiency of system to cater for huge population in Isiolo town.

4.4.1. (d) Poor usage of system by the population

Respondents were asked to express their opinion on whether there is poor usage of system by the population. The table 4.8 presents respondents responses to the item.

Table 4.8 Poor usage of system by the population

	Frequency	Percent
Strongly Agree	64	59.2
Agree	29	27
Neutral	0	0
Disagree	6	5.5
Strongly Disagree	9	8.3
Total	**108**	**100.0**

Majority of the respondents (59.2%) strongly agreed that there is poor usage of sewer system by the population. 8.3% of the respondents strongly disagreed while 5.5% disagreed that there is poor usage of sewer system by the population. There were no respondents who could not make a decision as to whether or not there is poor usage of sewer system by the population. This can be concluded that there is poor usage of sewer system by the population in Isiolo town.

4.4.1. (e) Occupation of areas kept a side for sewer expansion by individuals

Respondents were asked to express their opinion on whether there has been occupation of areas kept a side for sewer expansion by individuals. The table 4.9 presents respondents responses to the item.

Table 4.9 Occupation of areas kept a side for sewer expansion by individuals

	Frequency	Percent
Strongly Agree	16	15
Agree	12	11
Neutral	1	1
Disagree	31	29
Strongly Disagree	48	44
Total	**108**	**100.0**

Majority of the respondents (44%) strongly disagreed that there has been occupation of areas kept a side for sewer expansion by individuals. 29% of the respondents disagreed that there has occupation of areas kept aside for sewer expansion while only 11% of the respondents who agreed that there is occupation of areas kept a side for sewer expansion by individuals. This can be concluded that there is no occupation of areas kept a side for sewer expansion by individuals.

4.4.2 Facets Related to system technology

The respondents were provided with a number of facets related to system technology. They were required to express their level of agreement on items related to sewer system technology and the responses were as follows.

4.4.2. (a) Lack of modern sewer system equipment's

The respondents were required to state their level of agreement on whether there is lack of modern sewer system equipment's. Data collected from the respondents indicated that majority (50.3%) of the respondents agreed that there is lack of modern sewer equipment's, 15.3% strongly agreed while 7.6% disagreed and another 7.6% of the total targeted population strongly disagreed that there is lack of modern sewer system equipment's. However, 19.1% neither agreed nor disagreed at all. The table 4.10 presents respondents responses to the item. It can be concluded that there is lack of modern sewer system equipment's in IWASCO.

Table 4.10 Lack of modern sewer system equipment's

	Frequency	Per cent
Strongly Agree	17	15.3
Agree	54	50.3
Neutral	21	19.2
Disagree	8	7.6
Strongly Disagree	8	7.6
Total	**108**	**100.0**

4.4.2. (b) Training staff on how to operate the sewer systems

The respondents were required to state their opinion on whether there is trained staffs on how to operate the sewer systems. The table 4.11 presents respondents responses to the item.

Table 4.11 Training staff on how to operate the sewer systems

	Frequency	Per cent
Strongly Agree	2	2
Agree	4	4
Neutral	12	10
Disagree	24	23
Strongly Disagree	66	61
Total	**108**	**100.0**

Data collected indicated that majority of the respondents (61%) strongly disagreed that there is untrained staff on how to operate the sewer systems while 23% of the respondents disagreed that there is untrained staff on how to operate the sewer systems while 10% did not agree or disagreed that there is untrained staff on how to operate the sewer systems. However, 4% agreed and 4% strongly agreed that that there is untrained staff on how to operate the sewer systems. It is concluded that there is trained staff on how to operate the sewer systems.

4.4.2.(c) Poor investment on sewer system technology

The respondents were required to state their opinion on poor investment on sewer system technology. The table below presents respondents responses to the item.

Table 4.12 Poor investment on sewer system technology

	Frequency	Per cent
Strongly Agree	7	6.4
Agree	21	20.4
Neutral	14	12.7
Disagree	32	29.3
Strongly Disagree	34	31.2
Total	**108**	**100.0**

Majority of the respondents 31.2% strongly disagreed that there is poor investment on sewer system technology, 29.3% of the respondents disagreed that poor investment on sewer system technology while 20.4% agreed and 6.4% strongly agreed that poor investment on sewer system technology. However 12.7% neither agreed nor disagreed that poor investment on sewer system technology. From the data obtained, it can be concluded that there is poor investment on sewer system technology.

4.4.2. (d) Staff Competence

The respondents were required to state their opinion on whether there is sufficient competent staff they were provided with. The table 4.13 presents respondents responses to the item.

Table 4.13 Staff competence

	Frequency	Per cent
Strongly Agree	13	12.1
Agree	28	25.5
Neutral	6	5.1
Disagree	11	10.2
Strongly Disagree	50	47.1
Total	**108**	**100.0**

Majority of the respondents 47.1% strongly disagreed that there is sufficient competent staff, 25.5% of the respondents agreed that there is sufficient competent staff while 12.1% of the respondents strongly agreed that there is sufficient competent staff and 10.2% disagreed. However 5.1% did not agree nor disagree sufficient competent staff. It can be concluded that there is no sufficient competent staff to enhance effective sewer performance.

4.4.2. (e) ICT systems to monitor sewer operations

The respondents were required to state their opinion on the construct that there is no ICT system to monitor sewer operations. The table 4.14 presents respondents responses to the item.

Table 4.14 ICT systems to monitor sewer operations

	Frequency	Per cent
Strongly Agree	7	6.4
Agree	23	21.7
Neutral	14	12.7
Disagree	20	18.5
Strongly Disagree	44	40.8
Total	**108**	**100.0**

Majority of the respondents 40.8% strongly disagreed that there is ICT systems to monitor sewer operations, 21.7% of the respondents agreed that There is ICT systems to monitor sewer operations while 18.5% disagreed that There is ICT systems to monitor sewer operations and 6.4% agreed. However 12.7% were neither agreed nor disagreed that there is ICT systems to monitor sewer operations. It can be concluded that there is no ICT systems to monitor sewer operations.

4.4.2. (f): Response on whether members of staff in IWASCO have appropriate technology to manage the system.

The respondents were asked to state whether members of staff in IWASCO have appropriate technology to manage the system. The table below presents respondents responses to the item.

	Frequency	Per cent
Yes	27	25
No	81	75
Total	**108**	**100.0**

Majority of the respondents 75% indicated that the members of staff in IWASCO does not have appropriate technology to manage the system while 25% of the respondents argued that the staff of IWASCO have appropriate technology to manage the system. This has led to poor management of the sewer system in Isiolo town. It can concluded that members of staff in IWASCO does not have appropriate technology to manage the sewer system.

4.4.2 (g) System Infrastructure

The respondents were required to state their opinion on the adequacy of the infrastructure funding. The table 4.15 presents respondents responses to the item.

Table 4.15: adequate Infrastructure funding

	Frequency	Percent
Strongly Agree	8	7.6
Agree	26	24.2
Neutral	23	21.0
Disagree	20	18.5
Strongly Disagree	31	28.7
Total	**108**	**100.0**

Majority of the respondents 28.7% strongly disagreed that there is adequate infrastructure funding, 24.2 % agreed that there is adequate infrastructure funding, 18.5% disagreed and 7.6% strongly agreed that there is adequate infrastructure funding. However 21% of the respondent neither agreed nor disagreed with the adequate Infrastructure funding. It can be concluded from the data that there is in adequate infrastructure funding in sewer systems in Isiolo town.

4.4.2. (h) Availability of sewer treatment facilities

The respondents were asked to state their level of satisfaction with the internal complaint mechanism. The table 4.16 presents respondents responses to the item.

Table 4.16 Availability of sewer treatment facilities

	Frequency	Percent
Strongly Agree	48	45.0
Agree	25	22.7
Neutral	3	3.0
Disagree	24	22.3
Strongly Disagree	8	7.0
Total	**108**	**100.0**

Majority of the respondents 45% strongly agreed that there is availability of sewer treatment facilities, 22.7% of the respondents agreed that there is available sewer treatment facilities while 22.3% disagreed with the proposition that there is availability of sewer treatment facilities. However only 3% who neither agreed nor disagreed with the construct that there is an available sewer treatment facility. It can be concluded that there is availability of sewer treatment facilities.

4.3.6 Poor constructed sewer systems

The study sought to establish the level of agreement on the construct that there is a poor constructed sewer system. The table 4.5 presents respondents responses to the item.

Table 4.17 Poor constructed sewer systems

	Frequency	Percent
Strongly Agree	8	7.6
Agree	14	12.7
Neutral	31	28.7
Disagree	21	19.1
Strongly Disagree	34	31.8
Total	**108**	**100.0**

From the table above, it was established that majority(31.8%) of the respondents generally strongly disagreed and 7.6% strongly agreed that there is a poor constructed sewer system. However,12.7% of the respondents agreed and 19.1% disagreed while 28.7% of the respondents did not agree neither disagreed that there is poor constructed sewer system. This can be concluded that sewere systems are not poorly constructed in Isiolo town.

4.3.6 Poor constructed sewer systems

The study sought to establish the level of agreement on the construct that there is a poor constructed sewer system. The table 4.18 presents respondents responses to the item.

Table 4.18 Availability of electricity

	Frequency	Percent
Strongly Agree	17	15.3
Agree	31	28.7

Neutral	14	13.4
Disagree	28	25.5
Strongly Disagree	18	17.2
Total	**108**	**100.0**

Data obtained revealed that majority (28.7%) of the respondents agreed that there is availability of electricity in Isiolo town and 15.3% strongly agreed that there is there is availability of electricity. However, 25.5% of the respondents disagreed with the construct that there is there is availability of electricity and 17.2% strongly disagreed there is availability of electricity e and 13.4% were neutral about it. This can be conclude that there is availability of electricity in Isiolo town and this should enhance good performance of sewer system.

4.3.6 Response on how important is infrastructural facilities in managing the performance of sewer systems

The respondents were asked to rate the importance of infrastructural facilities in managing the performance of sewer systems. The table below presents respondents responses to the item.

	Frequency	**Percent**
Very important	46	42.7
Important	26	24.2
Do not know	22	20.4
Less important	6	5.1
Not important	8	7.6
Total	**108**	**100.0**

Data obtained revealed that majority (42.7%) of the respondents argued that infrastructural facilities in managing the performance of sewer systems is very important. However, 7.6 % of the respondents argued that infrastructural facilities in managing the performance of sewer systems are not important and 5.1% argued that they are less important and 20.4% were neutral about it. This can be concluded that infrastructural facilities are very important in managing the performance of sewer systems.

4.3.7: Response on the sewer physical environment in Isiolo town.

The respondents were asked to describe the sewer physical environment and describe the environment. The following table 4.19 presents the respondents responses to the item.

Table 4.19: Weather conditions are reliable to enhance sewer performance

	Frequency	Percent
it describes	6	5.1
it does not describe	93	86.0
cannot decide	9	8.9
Total	**108**	**100.0**

From the above data, majority (86%) of the respondents indicated that they could not describe the weather conditions as being reliable to enhance sewer performance 5.1% of the respondents described the weather conditions as being reliable to enhance sewer performance while 8.9% could not describe the weather conditions as being reliable or not. This can be concluded that the weather condition in Isiolo town is not reliable to enhance sewer performance in Isiolo town.

4.3. 8: Route surveys are well conducted when laying down sewer line

The respondents were asked to state whether route surveys are well conducted when laying down sewer line. The following table 4.20 presents the respondents responses to the item.

Table 4.20: Route surveys are well conducted when laying down sewer line

	Frequency	Per cent
it describes	71	66.9
it does not describe	21	19.1
cannot decide	16	14.0
Total	**108**	**100.0**

Majority (66.9%) of the respondents described that route surveys are well conducted when laying down sewer line while 19.1% of the respondents described that route surveys are not well conducted when laying down sewer line. However, 14% could not describe as to whether the route surveys are well conducted when laying down sewer line. This can be concluded that route surveys are well conducted when laying down sewer line.

4.3. 9: Available pathways for the sewer lines

The respondents were asked to state whether there is available pathways for the sewer lines. The following table 4.21 presents the respondents responses to the item.

Table 4.21: There are available pathways for the sewer lines

	Frequency	Percent
it describes	8	7.6
it does not describe	77	71.3
cannot decide	23	21.0
Total	**108**	**100.0**

Majority (71.3%) of the respondents did not describe that there is available pathways for the sewer lines while 7.6% of the respondents described it as there is available pathways for the sewer lines. However, 21% could not describe whether there are available pathways for the sewer lines or not. This can be concluded that there are no available pathways for the sewer lines.

4.22: Response on satisfaction with the sewer physical environment in Isiolo town in influencing effective sewer performance

The respondents were asked to state their level of satisfaction with the sewer physical environment in Isiolo town in influencing effective sewer performance. The following table 4.23 presents the respondents responses to the item.

Table 4.23: Satisfaction with the sewer physical environment in Isiolo town

	Frequency	Percent
Highly satisfied	3	2.5
Slightly satisfied	17	15.3
Neutral	1	1.3
Slightly dissatisfied	11	10.2
Highly dissatisfied	76	70.7
Total	**108**	**100.0**

Data obtained revealed that majority (70.7%) of the respondents were highly dissatisfied with the sewer physical environment in Isiolo and 10.2% were slightly dissatisfied. However, 15.3% of the respondents were slightly satisfied and 2.5% were highly satisfied with the

sewer physical environment in Isiolo town and 1.3% was neutral about it. This can be concluded that the respondents were highly dissatisfied with the sewer physical environment in Isiolo.

4.3.10 Content analysis on improving sewer physical environment in Isiolo town.

The respondents were asked to give suggestions on what management should do to improve the suggestions on what sewer company should do to improve the sewer physical environment in Isiolo town. Majority of the respondents highlighted that management should endeavor to:-

i. There should be adequate survey of sewer lines Majority of the respondents indicated that this would result to having leaders who are more efficient and effective.

ii. Seminars should be organized more frequently to train the Isiolo residents on methods maintaining sewer physical environment.

iii. Majority of the respondents argued that IWASCO Company should come up with ways of getting alternative route paths for sewer flow in Isiolo town.

CHAPTER FIVE

SUMMARY OF FINDINGS DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the study findings conclusions and recommendations for further research based on the investigation carried out to investigate the factors that influence the performance of sewer systems in urban areas with a focus on Isiolo water and Sewerage Company in Isiolo town.

5.2 Summary of Findings

This section represents the key findings of the study.

5.2.1 Population influence on the performance of sewer system in urban areas

The study established with 73% of the respondents that there is high growth rate of population in Isiolo town, 12% strongly agreed that there is high growth rate of population in Isiolo town. However, this was followed by an agreement of 67.5% and 24.8%, of the respondents strongly agreeing that there is high population connected to the sewer system, agreed that there is high population connected to the sewer system. Most of the respondents (72.7%) indicated that there is inefficiency of system to cater for huge population. Majority of the respondents (59.2%) strongly agreed that there is poor usage of sewer system by the population. it was always noted from (44% and 29%) of the respondents that there is no occupation of areas kept a side for sewer expansion by individuals.

5.2.2 System technology influence on performance of sewer system in urban areas

The study established that (50.3% and 15.3%) of the respondents indicated that there is lack of modern sewer equipment's. it was also established from the study with 61% of the respondents that the staff are trained to handle and how to operate the sewer systems. However, it was found with 31.2% of the respondents that there is there is poor investment on sewer system technology,

It was also noted from the study with 47.1% of the respondents indicating that that there no sufficient competent staff who can handle sewer performance in Isiolo. The study also established with 40.8% of the respondents indicating that there is no ICT systems to monitor sewer operations,

It was also established from the study with 75% of the respondents indicating that the members of staff in IWASCO do not have appropriate technology to manage the system while. This was attributed to have caused the sewer problems in the in Isiolo town.

5.2.3 System Infrastructure influence on performance of sewer system in urban areas

The study established with 28.7% and 18.5% that there is no adequate infrastructure funding to enhance the sewer performance in Isiolo town. It was also established with 45% and 22.7% of the respondents that there is availability of sewer treatment facilities. However, the study also established that the swere systems are not poor consturucted and they are in good condition which was indicated by (31.8% and 7.6%). It was also found that there is is availability of electricity in Isiolo town with 28% and 15.3% which should have enhanced the performance of sewer systems.

The study established that infrastructural facilities in managing the performance of sewer systems is very important element which was indicated by (42.7%) of the respondents

5.2.4 Physical environment influence on performance of sewer system in urban areas

The study established that from (86%) of the respondents that the weather condition is not reliable to enhance sewer performance. It was also found (66.9%) of the respondents indicating that route surveys are well conducted when laying down sewer line and this should enhance the performance of sewer in Isiolo town. It was also indicated by (71.3%) of the respondents that there are no available pathways for the new sewer lines and this is a challenge especially when expanding the existing sewer lines. The respondents suggested that management should endeavor to ensure that should be adequate survey of sewer lines conduct seminars more frequently to train the Isiolo residents on methods maintaining sewer physical environment and that IWASCO Company should come up with ways of getting alternative route paths for sewer flow in Isiolo town.

5.3 Discussion of Findings

5.3.1 Influence of population on the performance of sewer system in urban areas.

During the study, the respondents were asked to think of population and to express their level of agreement by placing a tick in an appropriate column that expresses what you feel. Majority of the respondents agreed that there is high growth rate of population in Isiolo town which is connected to the sewer system and the system are not able to cater for the huge population. This agrees with the (UNDP 2007) study, on the rapid urban population increases

which found that during the nineteenth century, there was considerable urban population growth in the United States which as a result of this increased population density in urban areas; the decentralized privy vault-cesspool wastewater management systems became overtaxed. Mitigation measures included increasing the cleaning frequency and constructing additional privy vaults and cesspools. The improvements, however, only slightly reduced the periodic overflows and development of nuisance conditions.

5.3.2 Influence system infrastructure performance of sewer system in urban areas.

Data collected from the respondents indicated that majority of the respondents agreed that there is lack of modern sewer equipment's. This is agreeing with the study conducted by (Pickford, 2001), that sewer supply like energy, capital and communications is a very important infrastructural prerequisite for sustainable development. Apart from its primary role in enhancing human health and wellbeing, it is equally important for industrialization and commercial developments and if the infrastructures are not improved there will be critical shortages of water not only inhibit or stop economic development but also directly damage the health of the urban people. These findings also agrees with a study by (Davis, 2005) where he argued that infrastructure is s the systemic framework which underpins community's ability to fulfill its mission of providing a base for its citizens to be productive and to nurture social equity especially in sewer performance.

5.3.3 Influence of physical environment performance of sewer system in urban areas.

The respondents were asked to describe the influence of sewer physical environment on the performance of sewer in Isiolo town. The respondents indicated that they could not describe the weather conditions are not reliable to enhance sewer performance. However, respondents argued that there are no available pathways for the sewer lines. Majority of the respondents were highly dissatisfied with the sewer physical environment in Isiolo town. This agrees with findings of a study by (WHO & UNICEF 2007), where pipeline excavation is difficult because of rock or there is limited topographic relief (i.e., due to flat terrain), gravity collection systems may not be practical and the sewage must be pumped through a pipeline to the treatment plant. This also corresponds with the study by (Pickford, 2001), that there are two basic physical environment reasons why the implementation of centralized water-carriage sewer systems was favored over decentralized privy vault-cesspool systems. Water-carriage sewer systems were believed to be more cost effective over the long term. In low-lying communities, wastewater may be conveyed by vacuum.

5.3.4 Influence of system technology on performance of sewer system in urban areas.

The study noted that there are no ICT systems to monitor sewer operations. Majority of the respondents indicated that the member of staff in IWASCO does not have appropriate technology to manage the system. This was highlighted as to what has led poor management of the sewer system in Isiolo town. this study agrees with the findings of (Karanja & Nyambura 2014), that the public sector, particularly government facilities, sewer supply is lagging behind the in technology adoption controlling the supply and consumption which would lead to improved performance especially if its adoption is fully supported by management and the end users. These findings corresponds with those of (Bagozzi & Warshaw, 2001), where they argues that automation and ICT were adopted in sewer supply facilities and networks since the early fifties.

5.4 Conclusions

From the literature review it was established that the performance of sewer systems in the urban areas both globally and locally throughout the history has experienced challenges. With the poor sewer performance by IWASCO in Isiolo town it has been noted that very high population that have settled in Isiolo town has contributed to poor performance of sewer systems. There have been notable reforms in the sewer management but the use of technology has not been adopted well in the sewer management. Sewer infrastructures which have been introduced by IWASCO have not been able to bring improvement in the sewer management. However, despite the much envisaged reforms in the sewer company, it was noted that consumers are still highly dissatisfied with the level of physical environment and this has affected the sewer performance in Isiolo town.

5.5 Recommendations

i. The management of IWASCO should endeavor to improve the sewer system by either building enough sewer manholes to accommodate the increasing population growth.
ii. The management should keep up the good spirit of embracing modern technology that will enhance sewer performance.
iii. The management of IWASCO should endeavor to maximize their staff capacity by training them and equipping them with technology skills for effective management of sewer performance.

5.6 Suggestions for further research

i. Similar study can be carried out in other major towns to ascertain whether same findings apply.

ii. Similar study can be done to establish the determinants of sewer performance in major towns.

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APPENDIX I

INTRODUCTION LETTER

Cathrine Mwendwa Mugambi
University Of Nairobi
Meru Extra Mural Centre

Dear Sir/Madam,

RE: DATA COLLECTION

This is to kindly inform you that I am carrying out an academic research for the purpose of examination leading to th award of a degree of Masters of Arts in project planning and management of University of Nairobi. The study focuses on factors influencing the performance of sewer systems in urban areas.

The purpose of this letter is to request you to provide the required information as per the questionnaire provided. Kindly be has honest and thorough as possible. The information you will provide will be considered as confidential and will only be used for the purpose of my examination only. Confidentiality of the collected data and anonymity of the respondents is assured, and time taken to fill the questionnaire will be highly appreciated.
Thanking you in advance for your cooperation.

Yours Faithfully

Cathrine Mwendwa Mugambi
L50/60934/2013

APPENDIX II

QUESTIONNAIRE

GENERAL INSTRUCTIONS

The purpose of this questionnaire is to collect data on the factors influencing performance of sewer systems in urban areas a case of Isiolo water and Sewerage Company in Isiolo town. It is divided into two sections: Section A containing Background information and section B structured to establish the objectives of the study. Please tick ( ) appropriately or provide the answers in the provided spaces.

SECTION A: BACKGROUND INFORMATION

By means of a tick **(** √) kindly indicate an option that best describes:

1. Your gender
    a. Male ( )
    b. Female ( )
2. Your age:-
    a. Below 25 years ( )
    b. 25-30 years ( )
    c. 31-35 years ( )
    d. 36-40 years ( )
    e. 41-45 years ( )
    f. 46-50 years ( )
    g. Over 51 ( )
3. Your level of education:-
    a. Primary education ( )
    b. Secondary education (O level) ( )
    c. Diploma ( )
    d. Degree ( )
    e. Masters &Above ( )
4. Years you have worked in Isiolo town:-
    a. Below 5 years ( )
    b. 5-10 years ( )
    c. 11-15 years ( )
    d. Above 15 years ( )

SECTION B: POPULATION

5. The following table deals with Population as a factor influencing performance of sewer system in urban areas. Express your level of agreement by placing a tick in an appropriate column that expresses what you feel.

KEY: 1 = Strongly Agree; 2 = Agree; 3 = Neutral; 4 = Disagree; 5 = Strongly Disagree

Population	1	2	3	4	5
a) High growth rate of population in Isiolo town					
b) High population connected to the sewer system					
c) Inefficiency system to cater for huge population					
d) Poor usage of system by the population					
e) Occupation of areas kept a side for sewer expansion by individuals					

SECTION C: SYSTEM TECHNOLOGY

6. On a scale of 1 to 5 to what extent do you agree or disagree with the following factors as influencing performance of sewer system in urban areas

KEY: 1 = Strongly Agree; 2 = Agree; 3 = Neutral; 4 = Disagree; 5 = Strongly Disagree

Statements	1	2	3	4	5
a) Lack of modern sewer system equipment's					
b) Untrained staff on how to operate the sewer systems					
c) Poor investment on sewer system technology					
d) There is sufficient competent staff					
e) There is no ICT systems to monitor sewer operations					

7. Do members of staff in IWASECO have appropriate technology to manage the system?
   YES ☐ NO ☐

8. If they do, what are the benefits? _____

   _____

9. If they do not, what happens? _____

   _____

SECTION D: SYSTEM INFRASTRUCTURE

10. The following table deals with system infrastructures factors that influence performance of sewer system in urban areas. Express your level of agreement by placing a tick in an appropriate column that expresses what you feel.

KEY: 1 = Strongly Agree; 2 = Agree; 3 = Neutral; 4 = Disagree; 5 = Strongly Disagree

Statements	1	2	3	4	5
System Infrastructure					
a) inadequate Infrastructure funding					
b) Lack of sewer treatment facilities					
c) Poor constructed sewer systems					
d) Lack of electricity					

11. How important is infrastructural facilities in managing the performance of sewer systems?

a) Very important ☐
b) Important ☐
c) Do not know ☐
d) Less important ☐
e) Not important ☐

SECTION E: PHYSICAL ENVIRONMENT

12. Think of the sewer physical environment in Isiolo town. In each word/phrase given below circle the number that best describes your response.

Circle: 1 if it describes the physical environment.

2 if it does not describe the physical environment

3 if you cannot decide

a. Weather conditions is reliable to enhance sewer performance	1	2	3
b. Route surveys are well conducted when laying down sewer line	1	2	3
c. There is available pathways for the sewer lines	1	2	3

12. How are you satisfied with the sewer physical environment in Isiolo town in influencing effective sewer performance?

a) Highly satisfied ( )
b) Satisfied ( )
c) Neutral ( )
d) Dissatisfied ( )
e) Highly dissatisfied ( )

13. Give two suggestions on what sewer company should do to improve the sewer physical environment in Isiolo town.

i. ……

ii ……

Thank you very much for your cooperation