INFLUENCE OF SOCIAL, CULTURAL AND ENVIRONMENTAL FACTORS ON PUBLIC PERCEPTION TOWARDS SEWERAGE TREATMENT PLANTS IN MERU COUNTY, KENYA

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DECLARATION

This thesis is my original work and has not been presented for a degree award in any other institution.

EG407/201046/20

Signature…… Date……..….

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DECLARATION BY UNIVERSITY SUPERVISORS

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DEDICATION

I dedicate this thesis to my wife, Evelyne Gakii and my children, Christine Kendi, Victoria Mwendwa, and Liam Kinoti.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

DEFINITION OF OPERATIONAL TERMS

Acceptance	Acceptance is the willingness to approve, embrace, or support an idea, person, or situation.
Attitude	Attitude is a mental or emotional position toward a person, object, or idea, shaped by beliefs and experiences. A positive attitude reflects support or approval, while a negative attitude shows disapproval, resistance, or unfavorable judgment.
Community participation	Engagement of the community in the implementation of projects
Cultural factors	Issues related to the way of life of community members that affect sanitation behavior
Environmental factors	Physical conditions and surroundings that could have an influence on sanitation behaviors and hygiene practices
Public perception	Collective views or opinions by societal members regarding events or projects
Rejection	Rejection is the refusal to acknowledge, approve, or engage with something considered undesirable or unfit.
Seepage	The slow movement of liquid, in this case, sewage, through soil often causing gradual leakage or infiltration into surrounding areas.
Sewerage treatment plants	Sanitation facilities made for the processing and treatment of waste water that emanate from various residential, institutional or commercial sources using biological, chemical and physical processes
Sewage/Waste	Water that has been used and contains human excreta, used water from

water	households, industries or businesses
Social factors	Aspects within a community that influence people's lifestyle

LIST OF ABBREVIATIONS

CI	Confidence Interval
FGD	Focus Group Discussion
KNBS	Kenya National Bureau of Statistics
ESIA	Environmental and Social Impact Assessment
FSM	Fecal Sludge Management
NEMA	National Environment Management Authority
OR	Odds Ratio
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization
WWTP	Waste Water Treatment Plants

ABSTRACT

Effective wastewater management is essential for nature conservation and promotion of health. Although Government efforts in supporting establishment of waste water treatment plants have been shown, the projects are at times rejected by the community leading to wastage of resources, unsolved sewage disposal problems, and the spread of diseases emanating from poor sewage management. The study examined the influence of social, cultural and environmental factors on public perception toward sewerage treatment plants in Meru County, Kenya, whose solutions have often been facing rejection from the communities. The study targeted residents around Rwanyange, Gakoromone and Maua sewerage treatment plants in the County. Mixed methods approach was used with a convergent study design. A sample of 394 household heads was targeted. Cluster and simple random sampling techniques were used in selection of the areas and household heads respectively. Quantitative data was collected from households using structured questionnaires and analysed in descriptive statistics and inferential statistics using Statistical Package for Social Sciences (SPSS) version 26. Qualitative data was obtained from focus group discussions, analysed in NVIVO software and presented in narratives. Increased literacy level among communities increased the likelihood of positive perception by 1.09 as residents would understand thus appreciate the roles played by the treatment plants (adjusted OR=1.09, 95% CI: 0.52-3.45, P=0.008). Perception varied with age with people aged > 50 years being 2.78 times more likely to exhibit positive perception towards the treatment plants compared to those aged 18-28 years (P<0.05). Community participation was key and its presence or absence determined residents' perception (adjusted OR=5.95, 95% CI: 1.29-5.24, P=0.002) as it predicted acceptability and ownership of the solutions provided. Results also suggested that existence of taboos surrounding mixing of human faecal matter which affected communities' openness to new ideas reduced the likelihood of positive perception towards the treatment plants by 34% (adjusted OR=0.66, 95% CI: 1.13-9.78, P=0.001). Women's perception was likely to be more positive than for men, attributable to the fact that they bore the basic responsibility of sanitation and hygiene and care giving roles and availability of sanitation solutions would mitigate health risks for them and their children. Participants especially those who resided very near the treatment plants were also concerned of the odour that resulted from the plants and the impacts of the plants on soil contamination (adjusted OR=0.75, 95% CI: 0.86-3.06, P<0.001). Public notion on the possibility of the treatment plants to result in underground seepage and concerns on the quality of air due to pollution significantly lowered perception by 52% and 60% respectively (P<0.05). The study concluded that public perception towards the treatment plants was affected by the interconnection of social, cultural and environmental factors. The study recommends a two-sided bottom-up approach of community involvement in all implementation stages of sanitation projects for increased acceptance, ownership and trust of solutions by beneficiaries. There is also need for reconnaissance studies that focus on understanding cultural issues for provision of context-specific sustainable solutions. Besides, policies that substantiate environmental awareness are critical for sustainable solutions.

CHAPTER ONE: INTRODUCTION

1.1 Background of Waste Water Treatment Plants and Public Perception

Effective wastewater management is one of the targets envisioned in the Sustainable Development Goals by 2030 (United Nations, 2015) for safe disposal of human waste, nature conservation, and promotion of health. However, in a global scale, almost 50% of the waste water generated is released unsafely treated to the environment (WHO/UNICEF, 2022) hence a critical public health and environmental issue. Unsafe management of fecal contaminated waste water could attract significant health risks such as diarrheal infections which are among the leading causes of children deaths (Demissie et al., 2021). Safe faecal management remain a substantial concern particularly in developing countries due to limited infrastructure and resources for establishment of viable solutions (Oberg et al., 2020) which has been associated with inadequate sanitation facilities, the practice of open defecation and consequently contamination of water sources perpetuating spread of water borne diseases.

While some developed countries like America and Europe demonstrate a commendable progress of up to over 90% safe sanitation coverage, others like Sub-Saharan African countries, Kenya included, lag behind with less than half having access to safe faecal management options (WHO/UNICEF, 2022). Achieving universal safe management of faeces in waste water is a challenge which require efforts of ensuring equitable access to proper sanitation services through support and enhancement of viable sanitation infrastructure.

To ensure attainment of the Sustainable Development target, a range of sanitation options including on-site treatment systems (where waste water is handled at the point of collection) and conventional systems (sewerage systems conveying waste far from the point of

collection) have been thought as viable solutions (WHO 2020; Estévez et al., 2022). Although onsite sanitation solutions are economically viable (Oberg et al., 2020), constraints in space and operation mechanism especially in overpopulated areas could be a hindrance in effective management of waste water (Chunga et al., 2016). As people migrate to urban areas and as towns grow, the need for sanitation options that can ensure universal coverage cannot be ignored. Although Governments have shown efforts in supporting establishment of sustainable waste water treatment plants, their implementation and utilization success is not always guaranteed (Fu et al., 2022). The projects could at times be negatively perceived and rejected by the community leading to wastage of resources, unsolved sewage disposal problems, and the spread of diseases emanating from poor sewage management.

The manner in which communities perceive waste water treatment plants could be deeply rooted to their social context, cultural issues or environmental concerns. Comprehending the issues could be essential for sustainable developments in the waste water management space. Issues surrounding perception of the community on sewerage sanitation projects have received increased concern in the literature. In China, a study by Fu et al. (2022) found out that establishment and performance of wastewater treatment plants was constantly hindered by residents' negative stereotypes. Residents rejected waste water treatment plants due to the perception that they could discard disgusting, dangerous, and harmful water into their backyards. Although support for the establishment of waste water treatment plants may be offered, they may exhibit varying degrees of success and reactions if the perceived threats for the project by the community outweigh the ideal benefits.

Understanding the benefits of a community sanitation project requires that awareness is created before establishment of the projects else such projects be unacceptable. A report by

WHO/UNICEF (2022) indicated that stagnation in sanitation access could be linked to possession of limited information on how to cope and benefit from sewer and water purification and reuse systems. As such, possession of the right information concerning sanitation projects could encourage local communities to maintain a positive perception towards the projects thus supporting their establishment or operation.

In Muscat, a study by Baawain et al. (2020) established that the success of establishing waste water treatment plants was attributed to the positive opinion and feeling on the importance of reusable wastewater for industrial activities, groundwater recharge, and irrigation hence reducing environmental pollution. A similar study in Saudi Arabia by Mu'azu et al. (2020) established that people's perception on waste water not only varied with level of education but also depended on age or gender. Ecosite (2019) in Sub-Saharan Africa associated perception with sociocultural beliefs and taboos. Unless community's needs and concerns are well comprehended, government support for establishment of sanitation solutions may not be a completely viable solution as ownership and use could be compromised.

The need for ownership and acceptance of sewerage projects underscore the criticality of community participation at every stage of the project implementation (Munene, 2020). As per Munene (2020) community involvement builds a sense of full control over projects by the community. In Ethiopia, Manyazewal and Walelgn (2019) established that satisfaction with sanitation services by residents increased up to 80% due to high institutional engagement of the community in waste management. However, in China, limited community involvement saw establishment of waste water treatment plants in undesirable areas like near rivers and residential areas which was a potential source of environmental

and water contamination (Hu et al., 2015). Failure to engage the community during the implementation of sanitation projects could spearhead their rejection resulting in overwhelmed sanitation infrastructure.

Overwhelmed sanitation infrastructure requires maintenance or expansion for continued operation and service to residents. Although faecal sludge management options are limited in Meru County (Munene, 2016), and solutions to enhance safe human faecal management such as expansion of overwhelmed sewerage plants have been put in place, urban populations thrive in faecally contaminated areas, even in the presence of novel sanitation solutions due to continued community rejection and objection over the projects (Munene, 2016; Takouleu, 2020). An exploration into the factors that influence these negative perceptions was necessary for success in waste water management in the area. This study particularly focused on specific factors like social, cultural and environmental aspects and their influence on community perception on the waste water treatment plants.

1.2 **Problem Statement**

The Sustainable Development Goal 6.2 target advocate for achievement of universal access to equitable and adequate hygiene safe sanitation for all by 2030 (WHO/UNICEF, 2017). In Kenya, the Constitution of 2010 under Article 42 guarantees that all people must equally benefit from a healthy and clean environment (GOK, 2019). However, as countries are making milestones to achieve the goals, access to safe sanitation solutions remain a challenge particularly in low-income areas, Kenya included, which place them at risk of contracting diarrheal diseases. In such settings, government or non-governmental organizations' response has been to support citizens in establishment of safe options. However, response to the availed solutions has not always be as positive as expected (Fu et

al., 2022) due to constant rejection from beneficiaries, their inability to meet community needs as expected as well as cultural issues which encourage reluctance to change.

While the National Environment Management Authority (NEMA) is legally mandated to coordinate and supervise the Environmental and Social Impact Assessment (ESIA) for development projects (EMCA 2015), their approach is majorly expert-centered and at times overlook active community engagement in their processes. Although an Environmental and Social Impact Assessment (ESIA) was carried out for the Rwanyange, Maua and Gakoromone sewer projects the projects seemed unacceptable. A report by Takouleu (2020) indicated that Rwanyange residents disputed the proposal to reinstall the Meru wastewater treatment plant in their area as some of the residents held roadside demonstrations against the project, indicating subjective and varying information on the project.

Limited studies have hinted that community socio-cultural and environmental factors could impact sewer plants and the success of other sanitation projects (Hossain, 2016; Delanka-Pedige et al., 2020 & Kuberan et al., 2021). However, most studies show limited information on a local scale, on perceived risks and benefits in the expansion of wastewater treatment plants, varying regional perceptions on the use of wastewater as a resource, and discrepancies in the level of satisfaction with WWTP. Few studies focus on the social contexts, cultural issues and environmental factors that influence perception of sanitation projects and no similar published study for Meru yet it faces issues of limited access to safe waste water management options. Limited understanding on the influence of social, cultural and environmental factors on perception of the community on waste water treatment plants could result in over-expenditure and government investment in resources on projects which end up unaccepted and unused. Failure to accept the establishment of sanitation solutions

could attract unsafe ways of faecally contaminated waste water management which could expose the population to unending sanitation-related morbidities and mortalities.

1.3 Significance of the Study

The Sustainable Development framework has a special emphasis on the need for improved access to safe sanitation for improvement of health. When communities have safe facilities for management of human waste, incidences of diarrheal diseases could reduce and children mortalities associated with poor sanitation could be minimal. The findings of this study could inform strategies by planners to understand context-specific community sanitation needs in order to provide suitable and acceptable sanitation solutions for the communities. The insights generated in this study could enlighten the County Government of Meru and the Development Investors on the strategies to consider in the quest to offer solutions to communities so that their efforts are meaningful. They would therefore avoid investment in solutions which do not yield the expected outcomes. The study also acts as an advocacy tool for community engagement to ensure provision of acceptable solutions The findings generated in this study are also important for reference by future researchers who would wish to examine issues in line with this study.

1.4 Objectives

The general and specific objectives for the study were as outlined in the following sub-topics:

1.4.1 General objective

To examine the influence of social, cultural and environmental factors on public perception towards sewerage treatment plants in Meru County.

1.4.2 Specific objectives

i. To establish the influence of social factors on public perception towards sewerage treatment plants in Meru County.

ii. To examine the influence of cultural factors on public perception towards sewerage treatment plants in Meru County.

iii. To investigate the influence of environmental factors on public perception towards sewerage projects in Meru County.

1.5 Research Questions

i. What is the influence of social factors on public perception towards sewerage treatment plants in Meru County?

ii. How do the Cultural factors influence public perception towards sewerage treatment plants in Meru County?

iii. What is the influence of environmental factors on public perception towards sewerage treatment plants in Meru County?

1.6 Justification

The need for improved sanitation solutions in both urban and rural areas cannot be ignored due to its contribution in sanitation-related diseases prevention. Social, cultural and environmental-related issues are known to arise from the establishment of wastewater treatment plants and could affect the way communities deem sanitation options.

Community resistance is common in WWTP establishments. Such resistance has been witnessed in Meru County, in the ongoing establishment of sewerage treatment plants such as in Rwanyange despite investment of huge amount of money of up to 1 billion shillings. Successful development of the sewerage projects could be beneficial to residents in terms of

reusable wastewater and ability to minimize the discharge of untreated wastewater to the water bodies. Understanding public perception on the treatment plants and its associated factors is vital in ensuring acceptability and sustainability of sewerage projects. The study provides information on the influence of social, cultural and Environmental factors on the communities' perception, of sewerage systems and which could be beneficial in planning purposes and policy reforms.

1.7 Limitations of the Study

Some respondents engaged in the study were not in a position to understand questions in research instruments which were formulated in English. The researcher engaged research assistants who were in a position to understand the local language for interpretation of questions during data collection. Honesty was highly expected from the study, but the researcher was not in a position to completely control honesty of the responses given by participants. Some participants were uncooperative during the process of data collection and others were found busy in their households and farms. The researcher and research assistants ensured creation a good rapport before the process of data collection making most of the participants clearly understand the focus of the study.

1.8 Delimitations of the Study

This study focused on the influence of social, cultural, and environmental factors on public perception towards sewerage treatment plants in Meru County, Kenya. It was delimited to selected areas surrounding waste water plants within Meru County, thereby excluding other regions and counties. The study only focused on public perceptions, and did not include technical or engineering aspects of sewerage treatment. The study concentrated on social, cultural and environmental concerns, and did not account for any other factors. Data was

collected within a specific timeframe, and seasonal variations in perception were not considered.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This section presents literature from existing studies on public perception on sewerage treatment plants, influence of social, cultural and environmental factors on public perception on sewerage treatment plants.

2.2 Public Perception Towards Sewerage Treatment Plants

According to the sustainable development goals, the access and use of basic sanitation facilities is a global human need (United Nations, 2015). According to Tarawneh et al. (2024), there has been diversity in the knowledge, attitudes, and perceptions of various communities towards sanitation projects. When it comes to perceptions of various communities towards sanitation projects, it can vary greatly depending on different factors like cultural beliefs, socioeconomic conditions, and access to resources (Fu et al., 2022).

Some communities may embrace and appreciate sanitation projects, recognizing the benefits they bring in terms of health, hygiene, and overall well-being (Fu et al., 2022). On the other hand, some communities might have reservations or concerns about sanitation projects due to cultural or traditional practices. It is important to approach these communities with sensitivity and respect, understanding their perspectives and working collaboratively to address their specific needs and challenges (Hanif et al., 2022). To gain a better understanding of these perceptions, it would be valuable to conduct thorough research and engage in open dialogue with community members. By actively involving the community in the planning and implementation of sanitation projects, their concerns can be addressed, and their support can be gained. In summary, perceptions of communities towards sanitation projects can be diverse, and it's crucial to approach each community with an open mind,

understanding their unique perspectives, and working together towards finding sustainable and inclusive solutions (Hanif et al., 2022).

2.3 Social Factors and Public Perception Towards Sewerage Treatment Plants

The planners of sanitation projects rarely conceptualize the social factor on community knowledge of the local community when providing the plans for the sanitation infrastructures. The resulting impacts from a sewer treatment infrastructure are rarely considered to the utmost. However, the projects may result in the anticipated improvements in wastewater treatment. This is because the community knowledge directly relates to their influence on how they will utilize the improved infrastructure on wastewater treatment being set up within their locality.

This is according to Mela et al. (2022) whereby they found out that critical components have to be utilized in the initial planning of infrastructure to change the public health situations of the urban and peri-urban populations from the low-income areas across the African continent. The participation of the communities in any development project is a very essential factor to be considered. It is mandatory according to most funding agencies and it is used as a measurement to gauge the project effectiveness. Community participation fosters much-needed acceptance which shows the capacity building and empowerment of the community (Saad et al., 2017).

The literacy level of a community can have an influence on the establishment of sewerage plants (Tarawneh et al., 2024). A study by Tarawneh et al. (2024) in Jordan established that the perception of community members towards waste water management was high when more people were educated and had access to information about health and hygiene practices. The study showed that awareness campaigns created a greater insight of the

importance of proper sanitation and the need for sewerage infrastructure. With a literate community, people are more likely to understand the health hazards associated with inadequate sanitation and the benefits of having a sewerage system in place (Tarawneh et al., 2024). They can advocate for the establishment of sewerage plants through various channels, such as engaging with local government officials, participating in community meetings, or supporting awareness campaigns.

Furthermore, a literate community can actively participate in education programs about the proper use and maintenance of sewerage systems Mu'azu et al., 2020). This ensures that the infrastructure is used effectively and maintained properly, which leads to better overall sanitation and public health outcomes. However, it is important to note that even in communities with lower literacy levels, it is still possible to establish sewerage plants. In these cases, it may be necessary to employ different communication strategies, such as visual aids, hands-on demonstrations, community involvement or working with trusted community leaders to spread awareness about the benefits of sewerage systems (Devanadera et al., 2024). Ultimately, the establishment of sewerage plants relies on a combination of education, community engagement, and support from local authorities (Mela et al., 2022). By considering the literacy level of a community and implementing targeted communication strategies, sanitation improvement for the well-being of everyone could be realized.

Interventions to provide communities with sustainable sanitation have always been brought forward across the world, especially in developing nations. The barriers to the interventions have been either technical or non-technical. A study in Bolivia by Kvarnström et al. (2022) that explored the aspects of suitability of sanitation systems ranging from flush latrines to centralized wastewater treatment sewers for six communities established that condominium

systems were easily approachable according to the characteristics of technology that were measured, given their respective definitions by how they were accessible, the resources they required, the technology needed, the committee needed to manage, and the community level of knowledge and training (Mu'azu et al., 2020) . Another study in Ecuador defined the historical explanation of the origin of community participation in the establishment of water and sanitation projects. The study shows that there are levels of participation and each of them has its merits and demerits. To understand the process better there is a need to consider the emerging issues in the designing and planning of the project to accurately draw the recommendation for the future impact of the project Tarawneh et al., 2024)

In studies conducted in Africa, Asia, and Latin America the social factors on community knowledge of urban sanitation have always been brought to hard tests due to its ever-growing population with insatiable demand for inclusive sanitation services. This has been attributed to the need to alleviate the poverty levels of the urban poor as a collective effort for sustainable urban community development. The past decade has demanded a policy shift to upset the supply-led community-based approaches in providing sanitation services for the urban and rural populations(Lüthi et al., 2009). A related study conducted in Tanzania by Msaki et al. (2022) on the social knowledge, attitudes, and perceptions of wastewater treatment indicated that the general knowledge of the treatment processes and the technologies used are low. The study recommended that more focus should be on the civil education of the communities about the available technologies to allow for community adoption and positive environmental impact on the same.

2.4 Cultural Factors and Public Perception Towards Sewerage Treatment Plants

Beliefs, taboos, religion, and gender can indeed have an influence on the establishment of a community sewer system (Khalid, 2018). Cultural and religious beliefs can shape how communities approach matters related to sanitation and waste disposal. For example, some belief systems may prioritize cleanliness and hygiene, making communities more likely to invest in a well-organized sewer system and others may have specific rituals or practices surrounding waste management, which can influence the design or functioning of the sewer system (Khalid et al., 2016). Cultural taboos around waste disposal could impact the way sewer systems are designed and implemented. Some communities may have restrictions or rules about where and how waste can be disposed of, and these taboos can shape the infrastructure and practices around the sewer system.

Religious practices and doctrines can also play a role in the establishment of a community sewer system. Some religious teachings emphasize the importance of cleanliness and sanitation, which can lead to a greater emphasis on the development of a comprehensive sewer system within the community (Khalid et al., 2016). Gender dynamics can also influence the establishment of a sewer system. In some societies, gender roles may dictate who is responsible for waste management and maintenance of the sewer system (Saad et al., 2017). Understanding these dynamics is crucial to ensure that all members of the community, regardless of gender, have equal access to sanitation facilities and are involved in decision-making processes. It is important to recognize and respect the influence of beliefs, taboos, religion, and gender when planning and implementing community sewer systems. By taking these factors into account, we can better cater to the specific needs and values of different communities, promoting inclusivity and effective waste management.

The construction of a sewerage plant in society is essential in curbing water scarcity both directly and indirectly (Nyaga, 2018). A properly functioning sewerage project protects the community from related water-borne diseases that result from the use of fecal-contaminated water. In a cross-sectional study that involved adults in Thandalam village, Chennai, India, Kuberan et al. (2015) found that the majority of residents had poor practices towards sewer management for instance of disposal of sewage to water bodies. When sewage is disposed in water bodies, drinking water may be contaminated which could facilitate water-borne diseases among consumers.

A consultative study conducted by Ecosite Development Consultants (2019) focused on the perception of Meru Town and Makutano residents considering the construction of the Rwanyange Sewerage project. In their response, the majority of respondents acknowledged the construction of the new sewerage plant as it would benefit them through increasing space for the Gakoromone market, and many people would establish businesses and improve their livelihoods. The cost incurred in sewage handling and disposal by private handlers especially in areas not covered by the existing sewage network such as Makutano would be reduced (Ecosite Development Consultants, 2019). In addition, there would be no need for constructing septic tanks in upcoming developments. The respondents also reported that the development of the sewerage plant would create job opportunities during its construction and operational phases. The Rwanyange, Maua and Gakoromone Sewerage projects were expected to enhance hygienic and sanitation standards in the town thereby raising the quality of life of the people (Ecosite Development Consultants, 2019).

From this review, it is evident that many communities and a significant proportion of Kenyan towns are served by the old sewerage systems that only cover Central Business

Districts (CBDs). For instance, in Meru Kenya, MEWASS is the only licensed sewerage and water treatment plant tasked with the duty of handling sewerage and water in Meru Town and its environs. However, the sewerage system (MEWASS) only serves the CBD, GK prisons, and Hospitals. This leaves the rest of the residents facing sewerage handling problems and hence, opting for expensive sewerage handling techniques including the establishment of latrines. This study will be essential in unmasking the community's perception regarding the Rwanyange Sewerage Project that is currently under construction. Infrastructural developments are a priority in both established and third world countries as it directly affects all measures of sustainable development. As it is important for any society and its economy, sewerage construction projects are key in all countries (Delanka-Pedige et al., 2021).

Today, the principles of sustainability are generally highlighted in policies, laws, and strategies in both developed and developing countries (Mensah, 2019). The maximization of sustainability development goals, sustainability assessment, and reporting tools is a mandatory requirement to inform stakeholders about the progress achieved toward sustainable development goals. In addition, the evaluation of sewerage construction projects supports decision-making and policy creation in the general environmental, economic, and social contexts, hence, transcending purely scientific or technical assessments (Alnoaimi & Rahman, 2019). According to Hossain & Gencturk (2016), a comprehensive evaluation of any civil infrastructural project need three main components; economic, environmental, and social impact. However, many sustainability evaluation studies focus majorly on the environmental aspects compared to the economic and social aspects. Nevertheless, limited

studies have focused on the long-term sustainability of sewerage construction projects throughout their life cycle.

2.5 Environmental Factors and Public Perception Towards Sewerage Treatment Plants

A study in Europe showed that among other impacts, sewerage projects affect all categories of the life cycle environmental assessment of the wastewater treatment system except eutrophication (Preisner et al., 2021). Moreover, several studies cite that sewerage projects are more detrimental to the environment compared to water treatment plants in cases of a fault regarding natural land transformation, freshwater ecotoxicity, particulate matter formation, climate change, marine Ecotoxicity, and water depletion (Fuente et al., 2016; Neshaei et al., 2017).

Negative Environmental issues associated with the establishment of a sewer treatment plant could be the loss of biodiversity, the fouls smell from the sewer treatment sites, and the displacement of the local population. Hence, the establishment of large sanitation projects such as sewer projects has been faced with diverse views from the local populations situated around the areas. A study Fu et al. (2022) in China established that most of the people who lived near waste water treatment plants were likely to oppose the establishment of the project because it usually benefited the larger population residing away from the sewer plant rather than them. Some communities may be accepting the construction of the sewer plant because of the benefits which may come due to higher costs of compensation on land and the overall proper treatment of wastewater from the municipality hence the reduction in the unscrupulous disposal of untreated sewage to the nearby water bodies(Kuberan et al., 2015b). The study focused on establishing the knowledge of the local community on the

establishment, impacts and benefits of the sewer plants and their perception towards the project.

Sewerage networks are part of the main underground infrastructure and therefore exert a significant influence on all modern societies across the three sustainability dimensions including social, environmental, and economic aspects (Thacker et al., 2019). Furthermore, when a society has a sustainable sewerage system, it means that its sewerage performs all its intended purposes throughout its life span, hence, protecting users' quality of life at the lowest possible cost. In the current literature, studies investigated the sustainability of wastewater treatment with more emphasis on the sewage that sewers carry intending to develop more sustainable wastewater treatment technologies and systems (Delanka-Pedige et al., 2021). In many societies, the impact of sewerage systems on the surrounding and its population normally attracts little attention. For instance, in Norway, the authorities neglected sewerage and drainage system issues such as water leaks, flooding, infiltration, and pollution, hence resulting in the current challenge of addressing pollution of wastewater treatment plants in the past decade (Neshaei et al., 2017).

Nevertheless, the social impacts of constructing a sewerage plant are also significant. For instance, the benefits offered by the Rwanyange, Maua and Gakoromone Sewerage Project like any improvement, also contain associated negative (social) ramifications.

In the report published by Ecosite Development Consultants (2019), the social benefits that will accrue within the operational phase of the project include but are not limited to; minimal pollution risks to the groundwater (sheet water) in Meru Town and its environs when it is provided with a sewer service and improvement in the Meru Municipal water quality (primarily bacteriological and nutrient quality) due to the lowered level of untreated

sewerage discharges. However, the negative impacts of constructing a sewerage project also have negative impacts, especially during its construction phase. These include local decreases in air quality because of construction specks of dust and carbon monoxide emissions from construction vehicles, higher levels of noise pollution, some terrestrial disturbances, and disruptions in Meru Town traffic flow specifically along the affected roads and highways, hence, likely to affect businesses that are dependent on the traffic flow (Aciita & Wanjohi, 2019; Ecosite Development Consultants, 2019; Kiugu, 2017; Mangone, 2016).

The World Health Organization (WHO, 2020) shows that generally, there is a lack of the right information concerning the benefits of sewerage systems and the right sources from where clean, portable, and safe water can be obtained. The key facts from WHO, United Nations International Children's Emergency Fund (UNICEF), and Joint Monitoring Programme report (2015) indicated that local communities across the African continent had limited knowledge as the responsible players do not educate locals on how to cope, support and benefit from sewer and water purification and re-use systems. In many areas, natural water sources have not been adequately protected due to the ignorance of the community members on the potential pollutants and contaminants that result from poor sanitation and hygiene management systems at the domestic and industrial levels (Birungi, 2016).

In Meru Town, only 15% of the town is served by MEWASS while other areas of the town have no sewer system. The other towns of Meru County completely lack functional sewerage systems (Ecosite Development Consultants, 2019). The main sanitation facilities

include pit latrines that are used by approximately 70% of the population in Meru County. Other households applying flush toilets and VIP latrines account for about 7.9% and 9% respectively (Ecosite Development Consultants, 2019).

Government policies on water and sanitation provision in any particular community play a very integral part in the sewer plants. A study by (Acker et al., 2016) in Maputo, Mozambique municipal sanitation systems and the associated health risks. The study incorporates the contribution of the existing government policies on the health and sanitation standards to be implemented while providing sanitation services to the urban population. Another study conducted in Ogun state in Nigeria on assessing the public perceptions of treated wastewater reuse by urban communities showed that people were accepting to reuse water mainly endorsed by government officials such as medical doctors, university professors, and experts because they believed it would not have any negative implications to their health (Akpan et al., 2020).

2.6 Influence of Advocacy on Public Perception of Projects

Advocacy plays a critical role in shaping public perception regarding sewerage treatment plants, particularly in areas. In many developing regions, sewerage systems are often viewed with skepticism due to historical neglect, lack of awareness, or cultural beliefs associating waste with impurity (Fu et al., 2022). The United Nations (UN) (2015) suggests that advocacy, through education, public campaigns, and stakeholder engagement, can mediate negative perceptions arising from deep-rooted cultural taboos or misinformation about sanitation infrastructure. Effective advocacy could help to demystify sewerage treatment technologies and highlights their environmental and public health benefits. For instance,

community-led sensitization programs have been shown to increase acceptance and, most importantly, local participation in wastewater projects (Simiyu & Busienei, 2025).

Targeted advocacy could bridge the gap between scientific knowledge and public understanding in areas where traditional norms and environmental concerns shape opinions. Advocacy interventions could also help counter environmental fears by providing evidence-based reassurances about the solution's safety and ecological impact (Amin & Nath, 2023). Advocacy fosters transparency and trust in government and implementing agencies, improving the overall reception of such projects (Dickin et al., 2022). The intervening influence of advocacy could therefore not only be transformative but also essential in mitigating resistance and fostering informed support for sanitation projects.

2.7 Theoretical Framework

The study was guided by the theory of community participation. The theory was proposed by Arnstein Sherryis and is based on community development principles (Arnstein, 2015). The proposer emphasized on community empowerment as it fosters education, collective action and sense of agency. Arnstein (2015) proposed a ladder which provides a framework to illustrate several levels of involvement ranging from non-participation to citizen control.

The bottom part of the ladder shows degrees of manipulation and therapy where citizens have limited or no power at all. The ladder then illustrates tokenism which offer the illusion of participation without real influence. The next step is informing and consulting where limited input to citizens is provided. Moving up is true participation wherein citizens can have some influence but lack ultimate control. The topmost step of the ladder represents delegated power and full citizen control denoting genuine involvement where the community can actively lead implementation processes and decision-making. A

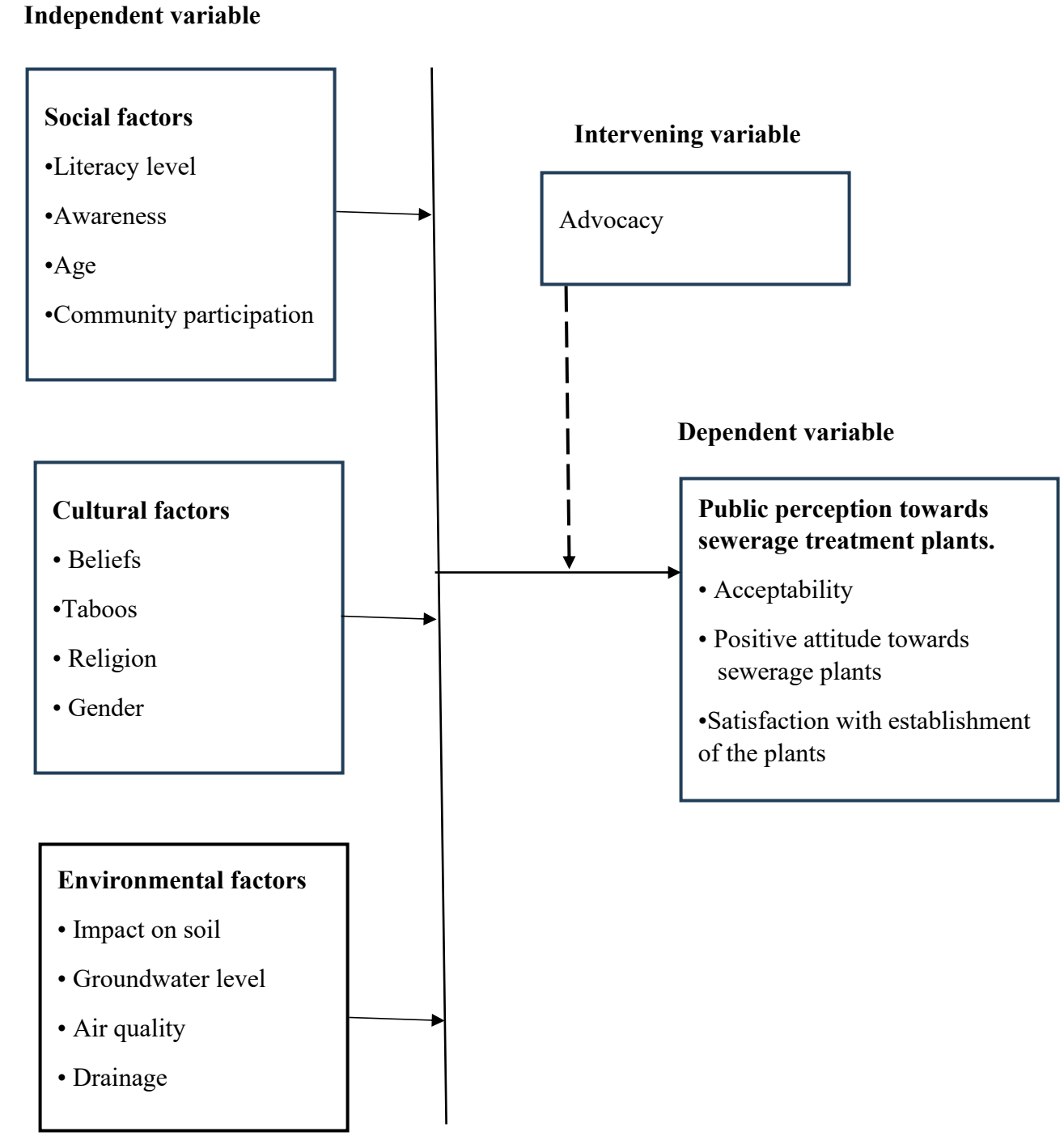
community's perception of sanitation projects could be shaped by its position in the participation ladder. Applied to sanitation projects, the theory of community participation emphasizes the link between genuine involvement and community's perception of initiatives. Social, environmental and cultural factors further shape the dynamics of community engagement making it imperative to consider the elements for effective sanitation interventions.

2.8 Conceptual Framework

The conceptual framework in Figure 2.1 shows how public perception of sewerage treatment plants (dependent variable) can be influenced by social, cultural and environmental factors (independent variables). The variables explored under social factors included: literacy level, awareness, age, and community participation; for cultural factors: beliefs, taboos, religion and gender while for environmental factors, variables explored were: perception on impact on soil, groundwater level, air quality and drainage. The intervening variable was advocacy. Presence of the dotted line for the relationship between the factors, perception and intervening variable shows that the variable was not part of the study but could affect the relationship.

Figure 2. 1:

Conceptual framework



Source: researcher 2024

CHAPTER THREE: METHODOLOGY

3.1. Introduction

This chapter outlines the methods that were used for the study. It describes the study area, research design, study population, sample size calculation and sampling techniques, data collection and analysis and ethical considerations.

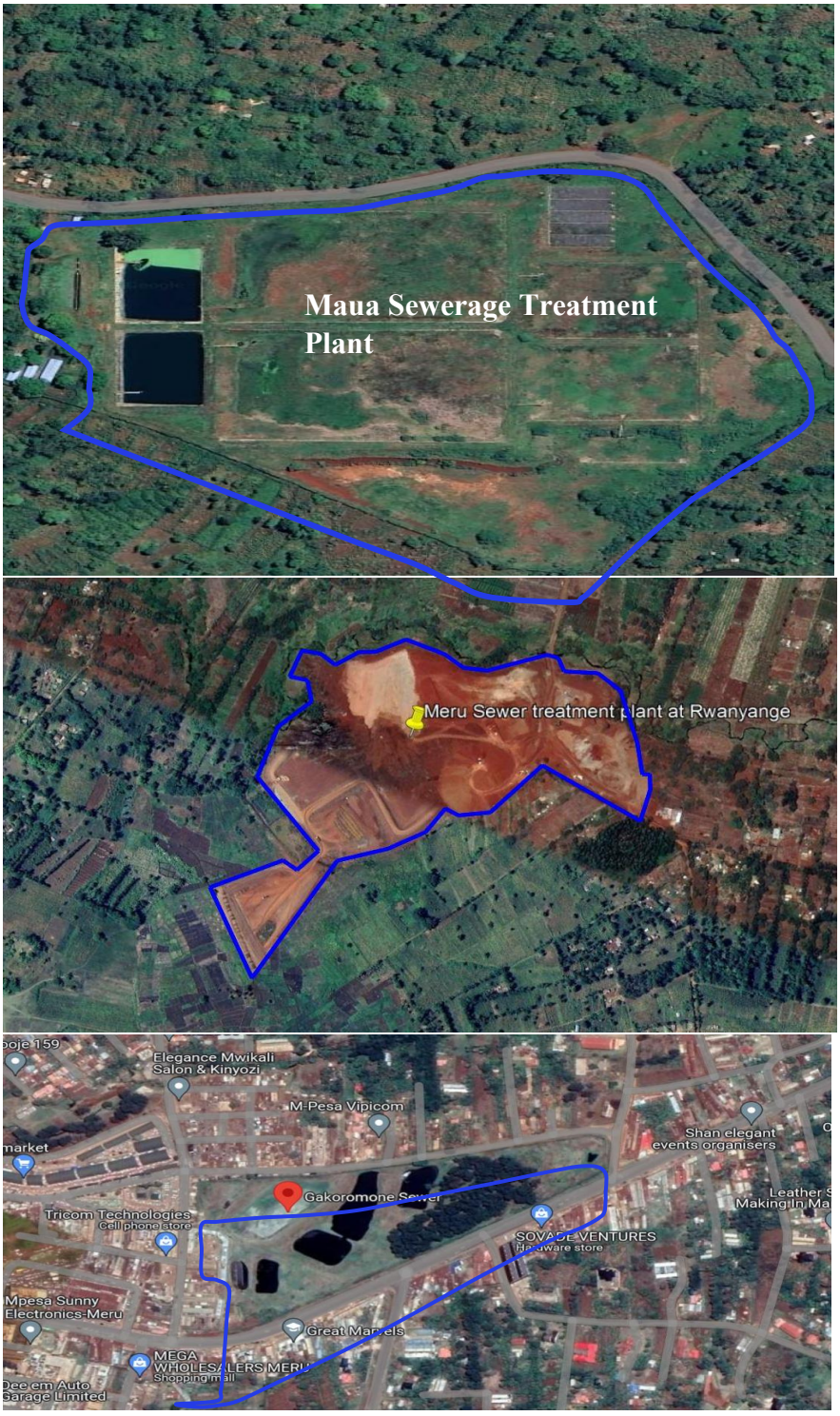
3.2. Study Area

The study was carried out in Meru County, Kenya. The County borders Isiolo County to the North, to the South West Nyeri County, Tharaka Nithi County to the East, and Laikipia County to the West. Meru County has a total area of 6,936.2 Km^2 out of which 972.3 km^2 is gazetted forest. The climate experienced in Meru is the tropical climate with dual-range rainfall between the months of March-May and October-December (KNBS, 2021). It is predominantly inhabited by the Meru tribe. The area is served by the conventional wastewater treatment plants and mostly are at the moment overwhelmed.

The need to ensure efficient wastewater treatment and to increase connections has triggered the establishment of the Rwanyange Sewerage project at Kinandi area, Ndiine Sub-location in Rwanyange Location which is expected to serve the entire Meru County. There are other sewer plants in Maua for Maua town and Gakoromone Sewage treatment plant which is existing in Meru Central Business District (CBD). However, despite government efforts to expand the wastewater treatment plants for the county, treatment plants especially in Rwanyange have been facing rejection with residents holding protests on their establishment. It was therefore necessary to explore the less understood and underexplored aspects regarding the influence of social, cultural, and environmental factors on public perception towards the sewerage treatment plants.

Figure 3. 1

Map of study areas



Source: Google maps., 2022

3.3. Research Design

The study used convergent research design and a mixed-methods approach to data collection. The design enabled the researcher to simultaneously gather and analyze both quantitative and qualitative data and compare the two for interpretation (Creswell & David, 2018). Through the use of a mixed methods approach, the researcher was able to investigate the influence of social, cultural, and environmental factors on public perception of sewerage water treatment plants. Mixed methods approach enabled the researcher to collect a wide range of data which boosted reliability of the study findings (Creswell & David, 2018).

3.4. Study Population

The study targeted the communities around Rwanyange area in Meru town, Maua and Gakoromone where waste water treatment plants were located. According to KNBS (2019) the total number of households in the study areas is 10, 752 with 1260 for Rwanyange, 6459 for Maua and 3033 for Gakoromone as shown in Table 3.1. Household heads from the study areas were targeted for participation in household surveys for quantitative data. The study also engaged community local leaders such as chiefs and sub-chiefs as they were the watchdogs of the areas and could be in a position to give permission for community entry for the research. Further, Public Health and Community Health Officers were engaged as they were the sanitation custodians at the community level and were likely to have a comprehensive information concerning the communities in the study areas. Other people engaged in the study included sanitation implementers for the project because they had a first-hand information concerning the treatment plants and had directly encountered the reactions of the community since the projects' inception.

Table 3. 1:

Population and households

Study area	Population	Number of Households
Gakoromone	8379	3033
Rwanyange	4471	1260
Maua	19760	6459
Total	**32610**	**10752**

Source: KNBS (2019); MEWASS (2023)

3.4.1 Inclusion and exclusion criteria

Since the study was based on voluntary participation, people who consented to participate in the study were engaged. The study therefore excluded all people who did not give informed consent of participation. Household heads aged 18 years and above were considered for participation and those aged below 18 were not considered for participation. Residents of Rwanyange, Gakoromone and Maua who were believed to be directly affected by the sewerage plants were be included for participation whereas non-residents were excluded from participation.

3.5. Sample Size Determination and Sampling Techniques

It was essential to obtain a representative population for generalizability of findings. This section shows how sample size was calculated and how samples were selected from the study areas.

3.5.1 Sample size determination

The sample size for this study was determined using Yamane's (1967) sample size determination formula. A margin of error of ±5% was used in calculation of the number of participants as illustrated:

$$n = \frac{N}{1+N(e^2)} \quad (1)$$

Where; n= sample size desired for the study

N = population size, and

e = Margin of error= 0.05

$$= \frac{10,752}{1+10,752(0.05^2)}$$

≈ 386 participants

3.5.2 Sampling techniques

Cluster sampling technique was used to classify the area into three clusters representing the areas covered by the waste water treatment plants namely: Rwanyange, Gakoromone and Maua. Participants for the quantitative study at the household level, who were household heads were sampled using simple random sampling techniques from each cluster. Since the population was unevenly distributed, the number of household heads to participate in the study from every cluster was determined using proportionate-to-size formula where the product of sample size and the ratio of total households in a cluster to total households in the entire area was obtained as demonstrated in the following word equation:

Participants per cluster= Desired sample size× (households in a cluster/total household for all clusters)

Table 3.2 shows the number of household heads who were selected from each area for participation in the study.

Table 3. 2:

Sample distribution per cluster

Study area	Population	Number of Households	Sample per cluster
Gakoromone	8379	3033	109
Rwanyange	4471	1260	45
Maua	19760	6459	232
Total	32610	10752	386

Source: KNBS (2019)

Participants engaged for the Focus Group Discussions were selected using purposive sampling technique because they were likely to have the desired knowledge on the sewerage treatment matters.

3.6 Data Collection Procedure

The study involved collection of both qualitative and quantitative data. Quantitative data was obtained from the households in the study area. The researcher used structured questionnaires to collect data from participants at households, who were household heads. On the other hand, qualitative data was gathered using Focus Group discussion guides. A total of 7 FGD participants, selected based on the principle of data saturation for qualitative studies were engaged for a Focus Group Discussion in every cluster. The participants considered for the Focus Group included a chief, Sub-chief, Public Health Officer, Community Health Volunteers, a volunteer community member and two implementers of the sanitation projects for each cluster. A total of three Focus Group Discussions were held, one for each cluster to ensure that ideas of the public in each study area were captured.

3.6.1 Pilot study

The pre-test process was carried out on 10% of the sample (39 participants) (Mugenda and Mugenda, 2003) from communities around Isiolo Waste Water Treatment Plant. Isiolo was considered because it shared the same characteristics with Meru County including tribes and the presence of an expanding Waste Water Treatment Plant. Pilot study was essential in testing the instruments for reliability.

3.6.2 Validity and reliability of research instruments

The researcher subjected the research instruments to 4 experts in Sanitation and Engineering specialization to confirm whether the instruments would be in a position to measure what they were expected to measure. The experts considered were from sanitation, research and engineering fields who understood the subject matter. Adjustments to the test questionnaires was done based on comments from the experts. The instruments were therefore confirmed valid by the experts after doing editing based on their suggestions. Reliability of research instruments was established from a test-retest technique where findings from the pilot study were analysed through Cronbach's alpha test. The Cronbach's alpha score was 0.88 which was greater than 0.7 as shown in Table 3.3 which implied that the data collection instruments were reliable.

Table 3. 3

Cronbach's alpha test of reliability

Number of items	Cronbach's Alpha
3	0.88
3	0.90
3	0.87
Total	**0.88**

Source: Researcher 2024

3.7 Data Analysis

The quantitative data obtained from the households was analysed using the Statistical Package for Social Sciences (SPSS) version 26 to generate descriptive and inferential statistics. Descriptive statistics like mean, percentages and standard deviations were obtained and presented in tables and graphs. A mean score of 1-2.9 was considered as low score (general disagreement) and a mean of 3-5 was considered as high score (general agreement) (Sullivan & Artino et al., 2013). Inferential analysis was conducted using binary logistic regression to ascertain the relationship between social, economic and environmental factors and public perception on sewerage treatment plants.

The logistic regression analysis involved both univariable and multivariable analyses. For univariable analysis, the association between public perception on sewerage treatment plants and each covariate was done in turn and the findings presented in adjusted odds at a confidence interval of 95%. Further, multivariable analysis on the covariates which turned significant in the univariable model was done. The analysis involved a step-by-step elimination of the covariates until all the remaining covariates in the multivariable analysis

were statistically significant. The results were presented as unadjusted odds at 95% confidence interval.

The following models were used to describe the relationship between independent and dependent variables:

$$y_i = \beta_{0+}\beta_i x_i + \beta_{ii} x_{ii} \ldots + e \quad (2)$$

In the first equation, $x_{i,\ ii\ \ldots}$=indicators of social factors

$$y_i = \beta_{0+}\beta_i x_i + \beta_{ii} x_{ii} \ldots + e \quad (3)$$

In the second equation, $x_{i,\ ii\ldots=}$indicators of cultural factors

$$y_i = \beta_{0+}\beta_i x_i + \beta_{ii} x_{ii} \ldots + e \quad (4)$$

In the third equation, $x_{i,\ ii=}$indicators of environmental factors

y_i for all equations represented the dependent variable, public perception while *e* showed the error term. $\beta 0$ for equations 1, 2 and 3 represented the constant terms for each model run, at different instances. For model i, the constant term was derived from the regression analysis generated on inclusion of the indicators of social factors in the analysis whereas in models 2 and three, the constant terms emanated from the analysis containing indicators of cultural and environmental factors respectively.

Qualitative data gathered from the focus group discussions was transcribed and examined for correctness, coded and analysed in themes using the NVIVO software. The findings were presented as narratives to complement the data obtained from households.

3.8 Ethical Considerations

An introductory letter from the Department of Civil and Environmental Engineering, Meru University of Science and Technology was obtained which explained to whoever would be

concerned about the exercise and the researcher's details including the study's aim. Ethical approval was sought from the National Commission for Science, Technology and Innovation (NACOSTI).

Permission to collect data in the communities was sought from the relevant authorities in the County and the study areas. Participation in the study was on voluntary basis and those who were engaged for participation signed a consent form to ascertain their willingness to take part in the exercise. Confidentiality of the data collected was observed. The data collected using hardcopies were stored in a private lockable bag, accessible by the researcher alone. Participants would be taken through the aim of the study for an understanding of what it would entail. Any respondent who wished to withdraw from the participation was free to do so with no consequences.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents a comprehensive statistical analysis and discussion of results of the study conducted in Meru County. The objectives of the study were: to examine the influence of social, cultural and environmental factors on public perception towards sewerage treatment plants in Meru Count, Kenya. The chapter provides an examination of response rate, demographic characteristics of respondents and evaluates findings in light of study objectives and indicators of the dependent variable. Results are presented in tables and graphs and interpreted within the context of existing literature.

4.1 Response Rate

The number of questionnaires desired against the number returned was analysed and findings were as presented in Table 4.1.

Table 4. 1

Response rate

Area	Expected Questionnaires	Partially Filled	Not returned	Fully filled	Return Rate
Rwanyange	45	5	7	33	73%
Gakoromone	109	13	18	78	72%
Maua	232	30	39	163	70%
Total	**386**	**48**	**64**	**274**	**72%**

Source: Researcher 2024

Questionnaires had been distributed to 386 household heads in the study area. The questionnaires expected from Rwanyange were 45, Gakoromone 109 and 232 from Maua.

However, out of the total questionnaires distributed, only 274 were returned fully and correctly filled making the response rate to be 72%. According to Mugenda and Mugenda (2003), a response rate of 70% and above yields adequate data for analysis and reporting. One hundred percent (100%) return rate was not achieved due to non-response and return of partially filled questionnaires which were ignored during analysis.

It was observed that a number of residents were busy harvesting or cultivating their farms as the process of data collection was done a period when such agricultural activities were being done. Residents in Meru were mostly farmers and particularly those who resided in Maua, who did Miraa farming and hence were sometimes unavailable or busy for the survey making it difficult to participate.

4.2 Demographic Characteristics

The demographic characteristics of respondents engaged in the study were examined in terms of gender, age, education level, religion and occupation.

4.2.1 Gender of respondents

Table 4.2 shows the number of males and females who participated in the study.

Table 4. 2

Respondents' gender

Gender	Frequency	Percent
Male	123	44.9
Female	151	55.1
Total	**274**	**100.0**

Source: Researcher 2024

More females (55.1%) compared to males (44.9%) took part in the study. The dominance of female participants could be associated with differences in gender roles. Men might have gone to work for their families, or were busy looking after livestock away from homesteads while females were left at households doing usual chores such as children caregiving, washing and cooking at the time of survey. The gender roles could therefore explain why more women than men were available at their households at the time of data collection. According to a study by Strambo et al. (2021), women could be more concerned of sewerage treatment plants outcomes as a result of vulnerability to their possible negative impacts in relation to hygiene. Availability of women at the households meant that they needed to use household sanitation facilities, whose status could be a concern to them.

4.2.2 Age of respondents

Participants' age was examined in a range and the results were as shown in Table 4.3.

Table 4. 3

Respondents' age

Age	Frequency	Percent
18-28	43	15.7
29-39	88	32.1
40-49	84	30.7
50 and above	59	21.5
Total	**274**	**100.0**

Source: Researcher 2024

Participants' age mostly ranged between 29-39 years at 32.1% and 40-49 at 30.7%. Respondents who were aged 50 years and above were 21.5% and the least number of

respondents (15.7%) were between 18 and 28 years. Middle aged people between 29-39 and 40 up to 49 years were mostly found at the households possibly because they were at the age of having young families or active children rearing and had to stay around their households to look after the children. People aged below 28 years was the age of higher career development hence not at home at the time of the study. The perception or attitude of the older population towards sewerage treatment plants could differ from perception for the young people due to experience with the plants. A similar study by Strambo et al. (2021) also associated age with concerns on waste management.

4.2.3 Respondents' level of education

Respondents were requested to indicate their education level and the findings were as shown in Table 4.4.

Table 4. 4

Respondents' level of education

Level	Frequency	Percent
Primary	67	24.4
Secondary	81	29.6
Post-secondary	107	39.1
Never been to school	19	6.9
Total	**274**	**100.0**

Source: Researcher 2024

Results showed that 39.1% of the people who took part in the study had gone beyond secondary school, 29.6% and 24.4% of the participants had studied up to secondary and primary levels respectively. It was established that few (19%) had never been to school. The

findings signaled that most of the residents in the study area were literate as evidenced by the high number of participants who had attained at least basic level of education. Education in Kenya at primary level is free and the cost is subsidized to affordable levels at secondary and University levels which could explain why many residents were learned. Literate people are likely to understand the importance of safe management of human faeces in relation to prevention of sanitation-related diseases (Tarawneh et al., 2024).

4.2.4 Respondents' religion

People's religion could have an influence on certain sanitation behaviour and practices. The study sought to establish the respondents' religion and findings were as shown in Table 4.5.

Table 4. 5

Respondents' religion

Religion	Frequency	Percent
Christianity	244	89.1
Islam	19	6.9
None	11	4.0
Total	**274**	**100.0**

Source: Researcher 2024

Christianity was the predominant type of religion at 89.1% followed by Islam at 6.9% while just 4% were not affiliated to any religion. Religious teachings or beliefs could shape people's perception of purity and cleanliness. Religions which emphasize on the essence of cleanliness could promote a positive perception towards sewerage treatment plants due to their contribution to a sanitary environment (Akpan et al., 2020). Provision of facilities which suit user needs could promote acceptance and increased preference to the facilities.

4.2.5 Respondents' occupation

Participants were asked to indicate their occupation with an aim of understanding the sources of income for the residents and findings were as shown in Table 4.6.

Table 4. 6

Occupation of respondents

Occupation	Frequency	Percent
Employed	62	22.6
Not employed	96	35.1
Self employed	116	42.3
Total	**274**	**100.0**

Source: Researcher 2024

It was established that 42.3% of the participants depended on self-employment for income generation, 35.1% were unemployed and only 22.6% were salaried employees. It was observed that many people were self-employed in activities like farming of maize, beans, miraa, coffee, tea among other food crops, businesses, and livestock keeping. The fact that income from most self-employment opportunities may not be reliable and that a significant number of people lacked a source of income suggested that most of the residents struggled to meet their needs and could possibly struggle to attain safe sanitation if support in provision of sanitation solutions was not offered.

4.3 Public Perception on Sewerage Treatment Plants

The study sought to ascertain public perception on sewerage treatment plants through examining community acceptance, attitude and satisfaction towards the treatment plants in Meru County.

4.3.1 Acceptance of the sewerage treatment plants

Respondents were given several statements surrounding benefits and willingness to use waste water treated from the sewerage plants to find out whether the treatment plants were acceptable to the residents and results were as shown in Table 4.7.

Table 4. 7:

Acceptance of the sewerage treatment plants

Statement	True	False	Total
Treatment plant has more benefits than limitations	165(60.2%)	109(39.8%)	274(100%)
I am okay or would accept being serviced by the sewerage system	189(69%)	85(31%)	274(100%)
I can use treated waste water generated from the plant for farming	97(35.4%)	177(64.6%)	274(100%)
Sewerage plant is acceptable to community members	115(42.0%)	159(58.0%)	274(100%)

Source: Researcher 2024

When requested to compare the benefits of the treatment plants with limitations, many (60.2%) respondents supported the statement while 39.8% of the respondents were of the negative opinion. The findings suggested that residents mostly appreciated the importance of the sewerage treatment plants because they would purify contaminated water before its release to the environment and would protect aquatic life since water released could be less polluted as reported in the focus group discussion where participants said:

"In the absence of these water treatment technologies, we could be interacting with very dirty water containing traces of human faeces in our environment."

"Release of the water to rivers or water ponds containing fish is likely to make them die. At least water that finds its way to water bodies is safe for aquatic life."

Although most residents embraced the role of waste water treatment plants in treating waste water, more than a third of the population deemed the waste water treatment plants as non-beneficial. There could have been a lack of understanding about the complexities associated with the processes of waste water treatment making respondents to primarily focus on the visible aspects such as visual pollution or odour which could have created a negative perception towards the treatment plants. Instances of malfunction in the treatment plants could receive high media coverage, amplifying concerns which highlight the negative aspects rather than the benefits of treatment plants. The findings were explained in the focus group discussion where a respondent argued that:

"Last year everybody saw in the news that some people were demonstrating against the treatment plant located in Rwanyange. Due to its association with the possibility of promoting environmental or land pollution, most of these communities have fear that it would affect their lives. You know they move by what they hear."

On one side, these drawbacks could have been overshadowed by the benefits which made community members to prioritize the positive aspects of the plants in their assessments and perceptions. On the other hand, the limitations could have blocked out the benefits and made some residents view the treatment plants with a negative mentality. Similar findings were obtained by Msaki et al. (2022) in Tanzania where participants had mixed feelings regarding the benefits of waste water treatment plants. In Jordan, a study by Tarawneh et al. (2024)

established that participants were willing to accept waste water re-use, provided that experts had ascertained its safety which suggested that residents understood the benefits associated with waste water treatment plants.

Respondents were also asked to indicate whether they were or would be willing to get served by the treatment plants as shown in Table 4.7. The study showed that majority at 69% would agree to be serviced and 31% would be unwilling to be serviced by the treatment plant. The findings signified that the willingness or acceptance of many participants of being connected to the sewer systems was high but also low to some people. It was observed that most of the people who indicated willingness to get served were those that resided some distance away from the treatment plants while majority of those who were negative lived a few meters from the plants. The implication of the findings to the study was that sewerage treatment plants' positioning or location in relation to the distance from households is key for acceptance of sanitation projects as was also reported in a study by Fu et al. (2022) in China. People who were connected to the sewerage system, and were especially far from the plant, could have rarely minded about where their waste ended up to because it was conveyed by pipe drain systems. However, the people who were likely to face the impacts of the sewerage treatment plants were those who resided near the treatment plants. Participants in the focus group discussion explained that:

> *"I can't complain about being connected to the sewerage system. One thing about my waste is that I do not care where it ends up to. So long as I don't see it I don't care about it."*

"In fact it is the work of the County Government to ensure that waste generated by citizens is properly managed. If it fails, those who are near the treatment systems suffer the most from odours of our waste."

It was also established that 64.6% of the community members which represented 177 people from the sampled population would not accept reusing treated waste water generated from the plants. The results implied that majority of the population perceived the treatment plants as ineffective in ensuring complete treatment of waste water and that the water generated after treatment was unsafe for reuse in farming activities.

The use of unsafe waste water for crop production could facilitate accumulation of chemicals in plants endangering community health and could also alter the chemical and physical properties of soil making growth of subsequent food crops poor (Kesari et al., 2021). A respondent from the focus group discussion associated the waste water generated from the treatment plants with the ability to expose farm produce consumers to the risk of heavy metals as follows:

"You could be surprised about the number of cancer cases that would arise if we all used water generated from the plants to irrigate our crops. If you think that the water will be safe for irrigating farm produce, try it on vegetables. We will all be consuming dangerous heavy metals from the water which we think is efficiently treated."

The findings showed that participants were negative about the quality of waste water generated from the plant after treatment. Similar findings were observed in a study by Minhas et al. (2022) in India where participants believed that their waste water treatment plants were incapable of rendering waste water safe for reuse in agricultural activities.

Results in Table 4.7 also showed that in general, acceptance rate of the treatment plants was lower at 42% compared to 58% non-acceptance which implied that the treatment plants were unacceptable to a high number of residents. The findings concurred with the results from a study by Faria and Naval (2022) who established low acceptance rate of sanitation projects from the public as a result of the perception on inefficiencies of the plants to treat waste water.

4.3.2 Public attitude on the sewerage treatment plants

Participants' attitude on the sewerage treatment plants was examined through analysing their frame of mind on statements concerning ability of the plants to expose communities to diseases and the possibility of the plants affecting their environment. Participants who has a positive attitude reflected support or approval of the ideas or statements given while those who had a negative attitude showed disapproval of the ideas. The findings were as shown in Table 4.8.

Table 4. 8

Attitude on the treatment plants

Statement	True	False	Total
Treatment plant expose community to diseases	102(37.2%)	172(62.8%)	274(100%)
Sewerage plant is a source of pollution	180(65.7%)	94(34.3%)	274(100%)
Release of treated waste water to environment result	178(65%)	96(35%)	274(100%)

in environmental issues			
Community attitude towards the plant is positive	109(39.8%)	165(60.2%)	274(100%)

Source: Researcher 2024

From the findings, 62.8% of the participants indicated that the treatment plants did not expose the community to diseases while 37.2% deemed the treatment plants as potential sources of diseases. The perception of sewerage treatment plants as sources or non-sources of sanitation-related diseases could vary based on several factors such as access to accurate information regarding the treatment plants as confirmed in a study by Mela et al. (2022) in Greece. People who understood the role of sewerage plants in preventing diseases and who had an historical experience on the conditions prior to establishment of treatment plants were likely to respond positively as supported in the Focus Group Discussion where a participant said:

> *"People who knew how it was before and the positive change now cannot complain about the treatment plants not preventing us from exposure to diseases. Human faecal matter which used to be found all over can now be treated in the plants."*

When requested to indicate whether the treatment plants affected the environment, majority (65.7%) indicated that the treatment plants were sources of pollution and 65% associated the water generated from the plants after treatment with ability to promote environmental issues. Overall, many participants (60.2%) rated community attitude towards the waste water treatment plants as negative.

The findings suggested that the community's attitude towards the treatment plants was triggered by the community's take that waste water from the treatment plants was

inefficiently treated and that it would contaminate the environment. Residents might have worried about the release of untreated or partially treated waste water to ecosystems which caused communities' distrust on the sewerage treatment plants. Similar findings were reported in a study by Fu et al. (2022) in China. For waste water to be safe, quality parameters should be within the standard permissible limits by WHO (2022) such low faecal coliforms, PH between 6.5-7.5, 50mg/L Biological Oxygen Demand (BOD) and 250 mg/L Chemical Oxygen Demand (COD) and low quantities of Total Dissolved Solids.

4.3.3 Satisfaction with the sewerage treatment plants

The study also aimed at establishing whether the communities were satisfied with the sewerage treatment plants. Several prompts were made to understand the communities' take on ability of the plants to respond to their waste water management needs, on the plants' impacts on waste water bodies and on the location of the sewerage plants. The findings were as summarized in Table 4.9.

Table 4. 9

Satisfaction with establishment of the sewerage treatment plants

Prompt	Yes	No	Total
Treatment plants are effective in addressing community waste water management needs	115(42.0%)	159(58%)	274(100%)
Do you think that sewerage plants positively impact quality of water bodies?	135(49.3%)	139(50.7%)	274(100%)
Are you satisfied with the location of the treatment facility?	95(34.7%)	179(65.3%)	274(100%)
Are you satisfied with the establishment of the plant?	98(35.8%)	176(64.2%)	274(100%)

Source: Researcher 2024

Most of the participants (58%) deemed the treatment plants as ineffective in addressing the community's needs regarding waste water management compared to 42% who indicated its effectiveness in addressing needs. The findings could be explained by the fact that a portion of the respondents were not served by piped networks leading to the sewerage treatment plants. In addition, some of the treatment plants were outdated and overwhelmed, which resulted in sub-standard treatment processes. It was indicated in the Focus Group Discussion that one of the treatment plants (Gakoromone) was overwhelmed hence ineffective in handling the waste from the community. A Focus Group Discussion participant said that:

> *"Some pipe networks leading to Gakoromone, the old sewerage treatment plant, are faulty and sometimes leak. The treatment plant is also overwhelmed and cannot treat the high amount of waste generated in this area."*

A study conducted by Fu et al. (2022) in China also reported inefficiencies of treatment plants in handling waste from a large population. When poorly treated water is released to the environment, soil pollution as well as water contamination could occur, and could be a health risk to communities.

When requested to give their arguments on the impact of the treatment plants on water bodies, slightly more than 50% of the participants held that the treatment plants negatively impacted the quality of water bodies. Majority of the participants (65.3%) indicated that they were not satisfied with the location of the treatment plants compared to only 34.7% who reported satisfaction. Community could believe that waste water treatment plants may contaminate water sources based on their location. It was observed *(as shown in Appendix iv)* that several water sources were located near either the treatment plants or drains leading to the treatment plants which possibly made residents assume that any discharge from the systems affected nearby water bodies. Even if the process of treatment was to be efficient, the mere presence of the sewerage facilities could have raised concerns on water-related health risks hence reinforcing the community's fears.

Overall, 64.2% of the community members who participated in the study showed a lack of satisfaction with the treatment plants. The community's dissatisfaction could have been caused by the communities' perception on the impacts of the plants to their lives and their agricultural lands. In China, a study by Fu et al. (2022) reported residents' negative perception towards treatment plants because they were thought to be contaminants of backyards and the environment.

4.4 Influence of Social Factors on Public Perception Towards Sewerage Treatment Plants

The study examined how social factors like literacy level, awareness, age and community participation in the sewerage treatment plants' implementation processes affected public perception on sewerage treatment plants.

4.4.1 Influence of literacy level on public perception towards sewerage treatment plants

Participants were given statements in a Likert scale which ranged from strongly disagree-1 to strongly agree-5 with a neutral option-3 to find out whether literacy level influenced public perception on sewerage treatment plants. The findings were as shown in Table 4.10.

Table 4. 10:

Literacy level and public perception on sewerage treatment plants

Prompt	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree	Total	Mean (SD)
Literacy level affect public perception on sewerage plants	12(4.4)	75(27.4)	34(12.4)	127(46.4)	26(9.5)	274(100%)	3.29 (1.10)
I have knowledge that treated waste water has less impacts and can be recycled and re-used	27 (9.9)	80 (29.2)	59(21.5)	101(36.9)	7(2.6)	274(100%)	2.93 (1.08)

Source: Researcher 2024

At a mean of 3.29 (Standard Deviation, SD=1.10), participants agreed that literacy level affected public perception on sewerage treatment plants. The findings could be related with comprehension differences where people with higher literacy could have had a higher understanding of the essence of proper sewerage waste management thus appreciating their role compared to those with lower literacy. Findings from the Focus Group Discussion showed that people with low literacy were likely to be lured by misinformation and propaganda against the treatment plants due to poor understanding of their benefits. A participant in the Focus Group Discussion said:

> *"It is easy to convince a person who has never been to school that sewerage plants are not friendly. In fact, the people who have mostly been involved in boycotting some treatment plants are those who lack adequate education. Leaders take advantage of these and trigger fear on them regarding dangers of the plants."*

Similar findings were noted in a study by Ozimek and Pijanowska (2023) in Poland where residents' literacy levels influenced their attitude towards sanitation projects.

A statement that sought to find out participants' knowledge on the importance of treatment plants in rendering waste water safe for reuse recorded a near neutral mean of 2.93 (SD=1.08). The results showed that majority of respondents' knowledge on the ability of treatment plants to minimize impacts and render waste water effective for re-use was almost average. The neutrality of responses could have stemmed from an unclear understanding or little exposure to waste water treatment processes. Lack of sufficient information and firsthand experience on the treatment processes may make respondents feel uncertain, opting for neutral responses rather than giving uniformed arguments. The findings highlighted the

criticality of outreach initiatives aimed at educating the public on the importance of sewerage treatment plants to foster a positive perception towards the plants.

4.4.2 Influence of awareness on public perception towards sewerage treatment plants

The study examined awareness of the community on benefits and impacts of the treatment plants and participation in awareness creation campaigns. Table 4.11 shows responses from participants regarding awareness on benefits of the sewerage treatment plants.

Table 4. 11

Community is aware of benefits of sewerage treatment plants

Response	Frequency	Percentage	Mean (SD)
Strongly disagree	17	6.2	3.47(1.17)
Disagree	85	31.0	
Neutral	6	2.2	
Agree	63	23.0	
Strongly agree	103	37.6	
Total	274	100.0	

Source: Researcher 2024

At a mean of Mean=3.47, SD=1.17, participants agreed that the community was aware of the benefits of the treatment plants. The increased awareness on the plants' benefits could be tied to the increased literacy levels as hygiene and sanitation basics are usually taught in school, extended interaction with the treatment plants, or campaigns by health promoters concerning disposal of sanitation-related waste. The findings of the study concurred with results from a study by Tarawneh et al. (2024) who found out an association between knowledge and community attitude towards waste water management technologies.

Participants were also requested to give their contribution regarding awareness on impacts of the treatment plants and their concern on the impacts. The findings were as shown in Table 4.12.

Table 4. 12:

Overall impact of sewerage treatment plants

Response	Frequency	Percentage	Mean (SD)
Very negative	41	15.0	3.03(1.32)
Somewhat negative	68	24.8	
Neutral	51	18.6	
Somewhat positive	71	25.9	
Very positive	43	15.7	
Total	**274**	**100.0**	

Source: Researcher 2024

More participants rated the impacts of the treatment plants as positive compared to those who rated the impacts as negative as shown by a mean of 3.03, Standard Deviation=1.32. The difference was however slight implying that while a number of respondents emphasized on the positive impacts that the plants had, other residents stressed on the negative impacts. Residents' perception of impacts could have been dependent on their ratings where the positives outweighed the negatives and vice versa. In addition, community's previous experiences from the treatment plants, where some had various negative encounters such as unsightly environment contributed to the residents' stand on the impacts of the treatment plants as reported in the Focus Group Discussion where a participant said:

"There is a nearby pond where open drains leading to the treatment plant leak human waste to the environment especially when it rains. The place doesn't look good at all."

The results showed the need for monitoring and maintenance of waste water management systems in the study areas to ensure proper delivery of waste water to treatment plants. A study by Faisal et al. (2023) reported that effectiveness of waste water treatment plants could improve with periodic control and monitoring measures.

The degree of community concern on impacts of the treatment plants was measured in a five-point scale ranging from 1-for very unconcerned to 5- for very concerned as shown in Table 4.13.

Table 4. 13:

Degree of concern on the impacts of the sewerage treatment plants

Response	Frequency	Percentage	Mean (SD)
Very unconcerned	14	5.1	3.93(1.14)
Unconcerned	26	9.5	
Neutral	24	8.8	
Concerned	111	40.5	
Very concerned	99	36.1	
Total	**274**	**100.0**	

Source: Researcher 2024

Results showed that at a mean of 3.93 (SD=1.14), majority of the respondents were concerned of the impacts of the treatment plants. These findings suggested that to many respondents, the impacts of the treatment plants outweighed their benefits which might have caused a high concern of the plants' impacts to the community. According to the findings

obtained from the Focus Group Discussion, participants were concerned about contamination of the environment, their farms and dumping of any form of waste into waste water open drains which would result in diseases as indicated:

> *"Wait until it rains, the faecal matter you see in these treatment plants will be swept to our compounds if not our farms. We will then be walking over the faeces ourselves. Let children eat the soil that is contaminated, we will forever be taking them to hospitals because of diarrhea."*
>
> *"I do not know whether some people have waste pits in their homes, they dump even children's diapers, used menstrual materials and other dirty waste inside the open drains meant to direct rain waste water to treatment plants. They become too dirty and smelly for viewing."*

Similar findings were established in a study by Fu et al. (2022) in China where the community associated waste water treatment plants with the ability to contaminate backyards and produce which influenced their perception towards the treatment plants. As per the WHO (2022) guidelines, waste water released to the environment and that which is suitable for farm use must be free from faecal coliforms to avoid contamination of soil or produce and to prevent associated health risks. Increase in population could result in increased generation of waste water which if excess than the treatment plants can handle, the plants could be overloaded making them unable to effectively handle the waste directed to them.

The study further examined whether awareness creation campaigns regarding the treatment plants had been done when the treatment plants were being initiated as indicated in Table 4.14.

Table 4. 14:

Awareness campaigns were held during initiation of treatment plants

Response	Frequency	Percentage
Yes	135	49.3
No	70	25.5
Don't know	69	25.2
Total	274	100.0

Source: Researcher 2024

Many participants (49.3%) reported execution of awareness campaigns which implied that campaigns had been mostly done in the communities when the treatment plants were initiated to sensitize the community on the essence of the plants. The awareness creation campaigns likely made a number of community members prepared of the benefits or impacts associated with the treatment plants which might have boosted a positive perception to some respondents. Although campaigns were done community perception on the plant was mostly negative as residents might have politicized the treatment plants instead of understanding their true value. Other participants (25.5%) reported no campaigns probably because they might have been away from their households during the time of the campaigns and therefore did not witness them or maybe the campaigns were not done at every corner of the community especially the unreachable zones. The findings were explained in the Focus Group Discussion where an officer said that:

> *"We moved around most parts of the community mostly during political campaigns sensitizing them about the plan to initiate the treatment plants and the expected*

benefits that would be reaped when such plants are established. However, some areas were unreachable due to impassable roads."

Another participant argued that:

"Maybe I was away, I did not see any of the campaigns concerning the treatment plants. Had they been there, my children could have told me. So I think they were not held."

The findings suggested that although awareness creation campaigns had been done in some parts, other areas were not sensitized which could have affected their perception towards the sewerage plants due to lack of understanding of the benefits of the plants. The findings were consistent with results from a study by Mela et al. (2022) in Greece where awareness campaigns boosted residents' awareness on the importance of sanitation solutions, improving their acceptability. According to Mela et al. (2022), awareness creation campaigns should be inclusive where community members are allowed to air their views for increased acceptance of the sanitation solutions.

4.4.3 Influence of age on public perception towards sewerage treatment plants

Participants were requested to indicate whether age of community members influenced perception towards sewerage treatment plants. The findings were as presented in Table 4.15.

Table 4. 15:

Age of community members affect their perception on treatment plant

Response	Frequency	Percentage	Mean (SD)
Strongly disagree	10	3.6	3.83(1.02)
Disagree	74	27.0	
Neutral	70	25.5	

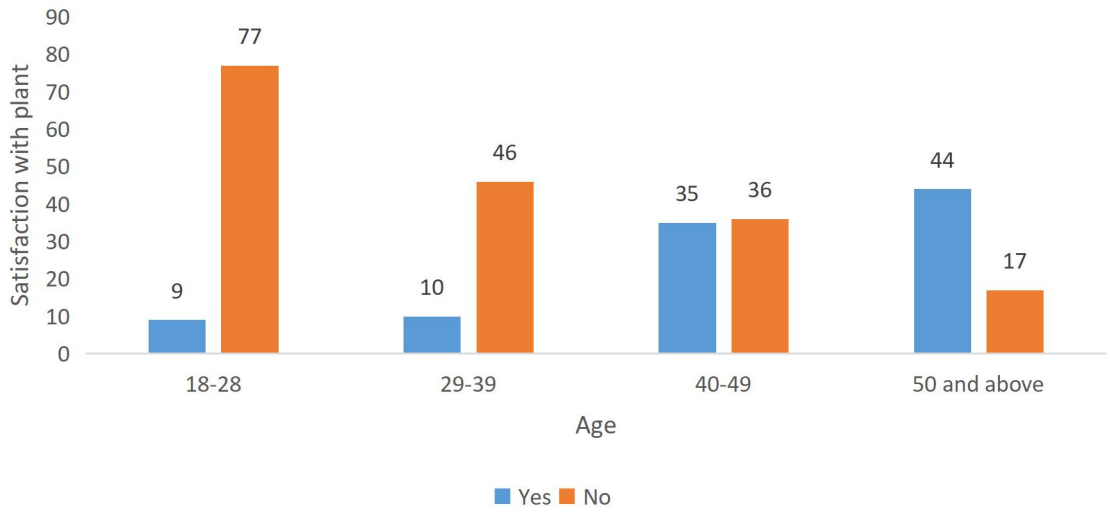
Agree	20	7.3
Strongly agree	100	36.5
Total	**274**	**100.0**

Source: Researcher 2024

The findings showed an overall mean of 3.83 (SD=1.02) which suggested that majority of the responses lied in the 'agree' category implying that age was a factor that influenced perception of the public towards sewerage treatment plants. A cross tabulation to find out the trend in satisfaction and attitude, which were variables of perception towards the treatment plants, and age of respondents was done and findings were as shown in Figure 4.1 and Figure 4.2.

Figure 4. 1

Satisfaction towards the treatment plant by age



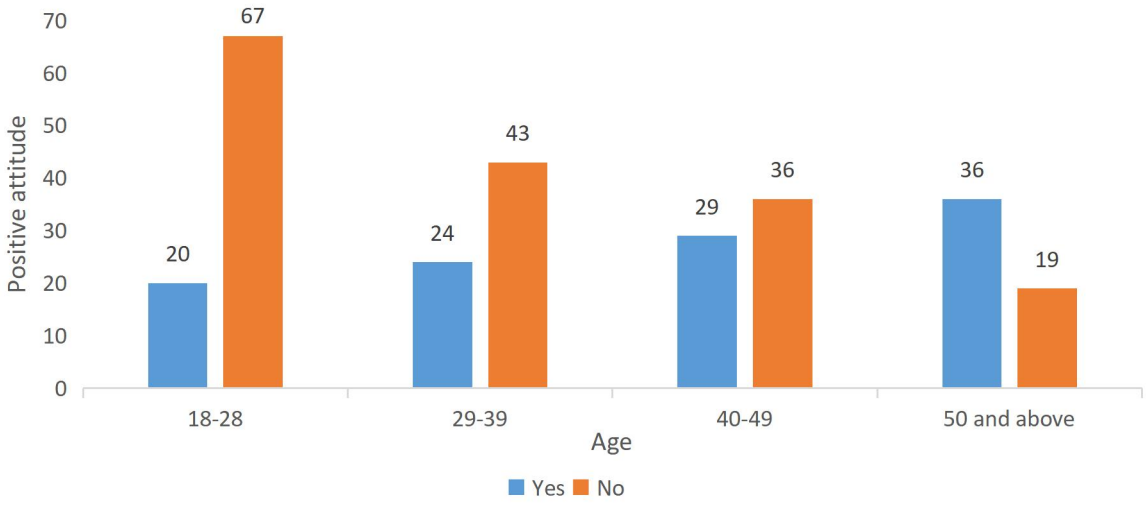
Source: Researcher 2024

Results from Figure 4.1 showed that satisfaction with the treatment plants increased with age, with a high number (44) of respondents who were aged above 50 years reporting

satisfaction with the treatment plant which decreased to 35 for people aged 40-49 years, 10 for participants between 29-39 years then 9 for people aged between 18-28 years. The suggestion of the findings was that the older population were more satisfied with the plants, hence a positive perception compared to the young. The decrease in satisfaction with the treatment plants by age could be related to the fact that young population had limited exposure to sewerage technologies and might have less understood their benefits to the community. Initial waste water treatment plants might have been built long before they were born or when young. The young population had grown and caught up with the treatment plants.

Figure 4. 2

Attitude towards the treatment plant by age



Source: Researcher 2024

Attitude on the sewerage treatment plants similarly ranged with age with the highest (67 participants) aged 18-28 reporting negative attitude, 43 aged between 29-39 years indicating negative attitude, 36 participants between 40-49 years and 19 respondents aged 50 years and above reporting negative attitude. The results showed that attitude towards the

treatment plants reduced with reduced age or increased with increasing age of residents. Further insight on the influence of age on public perception towards the treatment plants was sought from the Focus Group Discussion where participants indicated that the perception was more positive to the older population compared to the young population because of incitements by people in power. A Focus Group Discussion participant said:

> *"It is the young generation who hold protests against development projects. It does not emanate from them. They get easily incited by people with personal interests, people in power, to demonstrate against projects regardless of whether they are desirable or not."*

People at a higher age could, from an extended experience, be more familiar with the realities of nature and environmental issues and all it entails compared to young people who often get exposed to advanced technology in their daily lives. In addition, cartels and people with personal interests could mostly lure and engage the young population into demonstrations against developments compared to the older population. False impressions regarding developments could make the young generations to view beneficial projects from a negative perspective.

The findings concurred with the results in a study conducted in Greece by Mela et al. (2022) where increasing age directly correlated with acceptance to waste water treatment plants. In Tanzania, Msaki et al. (2022) also reported similar findings where participants from different age groups held varying views regarding waste water treatment plants. Politicized development projects could likely lack sustainability aspect (Huh et al., 2020) thus the need for community sensitization using multiple channels, including social media, to ensure that consistent information reach all residents.

4.4.4 Influence of community participation on public perception towards sewerage treatment plants

The aspect of community involvement in the processes of establishing the treatment plants was examined and findings were as shown in Table 4.16.

Table 4. 16

Community was involved in establishment of treatment plants

Response	Frequency	Percentage	Mean (SD)
Strongly disagree	20	7.3	3.35(0.82)
Disagree	75	27.4	
Neutral	14	5.1	
Agree	117	42.7	
Strongly agree	48	17.5	
Total	**274**	**100.0**	

Source: Researcher 2024

The statement on whether the community was involved in the process of establishing the treatment plants scored an overall mean of 3.35 (SD=0.82) implying a general agreement to the statement. The findings suggested that most of the community members had been involved in different ways when the treatment plants were being established. Active involvement of community members during establishment of projects has been associated with increased acceptance, ownership and sustainability of the projects (Faria & Naval, 2022). The methods of community involvement in the establishment of the treatment plants included involvement in provision of materials reported by 11.3% of participants, provision of labour (18.9%), provision of land (21.2%) and in decision making (8.8%) as shown in Table 4.17.

Table 4. 17:

How community was involved during establishment of treatment plant

Response	Frequency	Percentage
Provision of materials	31	11.3
Provision of labour	52	18.9
Provision of land	58	21.2
Decision-making	24	8.8
Community wasn't involved	95	34.7
I don't know	14	5.1
Total	274	100.0

Source: Researcher 2024

The least forms of community engagement were on involvement in decision-making (8.8%) and on provision of materials (11.3%). The treatment plants were constructed under funded projects thus contractors might have mostly sought materials from quality sellers, where accounting could be possible unlike when the materials were locally provided as reported by a participant in the Focus Group Discussion who said:

> *"The people who came with the project needed to give an account of expenditure to donors. Don't you think receipts and evidence of purchases would be needed?" I believe because we had various retail and wholesale shops around, they couldn't go for the simple materials like nails from where they originally obtained."*

The least percentage of respondents reported that the community was involved in decision-making processes regarding establishment of the sewerage treatment plants. As it is the usual decision-making procedure, few representatives, might have been selected as

participants in the decision-making committee who would make decisions on behalf of the community.

The community members to participate in decision-making processes must be chosen in transparent ways (democratically chosen, volunteering, appointment or based on skillset and expertise) (Hanif et al., 2022). Overall, the selection process of representatives ensure that the interests of the community members are effectively advocated, which could improve on perception of the community towards projects due to the feeling that their ideas count. However, satisfaction with the plants could be minimal for community members, whose wishes to become a decision maker in projects fail.

From the findings, 18.9% of the participants reported that the community had been engaged in provision of labour. The results suggested that sometimes the treatment plants implementers would consider community members as workers since the workers from the community offered cheaper labour as per the findings of the Focus Group Discussion than when other experienced people exported from elsewhere were to provide labour. A respondent from the Focus Group Discussion indicated that:

> *"You know bosses in the treatment plants were aware that if they targeted the community members as labourers they would save a good amount of money. You see employing unexperienced people was different from when they engaged other experienced people from outside the community."*

Although majority of participants agreed that the community was involved differently during establishment of the treatment plants, more than 30% of the members indicated that the community was not involved (Table 4.16). Their feelings could be associated with the fact that establishment of the plants required technical skills, which the community members

might not have had thus the need to obtain skilled workers from other areas. The findings were supported in the Focus Group Discussion where a participant argued that:

> *"I cannot deny that some community members were chosen to work in the treatment plants. But they were mostly manual workers. We didn't have a contractor ourselves so they came with theirs."*

A project's workers team should be composed of skilled personnel with the desired expertise in the work given (Oxfam, 2019). Absence of qualified people for provision of labour in waste water treatment plants could attract consideration of other people with the desired skills from other areas for quality projects to be executed.

On the other hand, the community members who reported non-involvement might have wanted to be involved, which could not have been possible since the projects could not involve every person in the community. The community might have had a feeling of entitlement which made them feel that they were less engaged in the treatment plant matters.

When asked if community participation in establishment of the treatment plants affected community perception towards the plants, a mean of 3.08(SD=1.05) was attained, showing that most of the responses lied in the agree category as shown in Table 4.18.

Table 4. 18:

Community participation affect perception on treatment plants

Response	Frequency	Percentage	Mean (SD)
Strongly disagree	17	6.2	
Disagree	74	27.0	
Neutral	69	25.2	
Agree	98	35.8	
Strongly agree	16	5.8	
Total	**274**	**100.0**	**3.08(1.05)**

Source: Researcher 2024

The findings in Table 4.18 suggested that increasing community involvement in the processes of establishing sewerage treatment plants could improve the perception of residents on the treatment plants. When the community is involved in the implementation of sewerage treatment plants, their esteem towards the plants goes high, they understand better the benefits of the treatment plants and feel that their views are considered and that they are part of the process thus boosting their acceptability to the projects. In China, a study by Zhang et al. (2021) reported similar findings where community involvement was a determinant of acceptance of waste plants.

4.5 Influence of Cultural Factors on Public Perception Towards Sewerage Treatment Plants

The study also aimed at establishing the influence of cultural factors such as beliefs, taboos, religion and gender on public perception towards sewerage treatment plants.

4.5.1 Influence of beliefs and taboos on public perception towards treatment plants

Participants were given statements in a Likert scale to indicate their level of agreement regarding existence of beliefs and taboos related to establishment of sewerage treatment plants as shown in Table 4.19.

Table 4. 19:

Beliefs/taboos and public perception towards sewerage treatment plants

Prompt	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree	Total	Mean (SD)
Beliefs discouraging establishment of sanitation projects	32 (11.7)	116 (42.3)	50(18.2)	68(24.8)	8(2.9)	274(100%)	2.65(1.06)
The taboo on mixing human faeces in this community affect perception of sewerage plants	46(16.8)	131(47.8)	57 (20.8)	32(11.7)	8(2.9)	274(100%)	2.36(0.99)
Cultural taboos affect the community's openness to adopting new	37 (13.5)	124(45.3)	60 (21.9)	45(16.4)	8(2.9)	274(100%)	2.50(1.01)

sanitation

options

Source: Researcher 2024

Findings in Table 4.19 in general showed a general disagreement to statements on existence of beliefs against establishment of sanitation projects (Mean=2.45, SD=1.02), taboos on faecal mixing (Mean=1.06, SD=1.08) and presence of cultural taboos affecting the openness of the community to new sanitation options (Mean= 2.50, SD=1.01).

Establishment of sanitation-related projects were not therefore mostly affected by any form of beliefs in the area. In addition, community members were less concerned about mixing of faeces, as usual in sewerage treatment plants, and communities were not tied to cultural taboos which could prevent their reception to new sanitation solutions. Beliefs and taboos were thus not important factors that affected residents' perception towards sewerage treatment plants. However, despite most respondents' general report regarding absence of beliefs and taboos associated with sanitation solutions, there still existed some, although few, beliefs and taboos related to sewerage plants as shown by the few individuals whose responses were in the 'agree' category.

The findings were explained in the Focus Group Discussion where the worry about what was 'dirty' or 'clean' was a concern for some community members. Some believed that another person's waste was more disgusting compared to one's own excrement and therefore knowing that such 'dirt' was in the treatment plant found within their surrounding was unpleasing. A Focus Group Discussion participant argued that:

"I believe that my own excrement has no issue, but when I know that we are surrounded by a treatment facility which contain faecal matter from other people, I can't take that in. I mean it feels disgusting.''

Beliefs surrounding human waste could trigger a sense of disgust which could likely influence residents' perception towards sewerage treatment plants. The influence of beliefs and Taboos were also noted in a similar study by Khalid (2018) in Pakistan.

4.5.2 Influence of religion on public perception towards sewerage treatment plants

Respondents were asked to indicate their extent of agreement to a statement on whether religion affected public perception on sewerage treatment plants. The findings were as shown in Table 4.20.

Table 4. 20:

Religion affect public perception on sewerage treatment plant

Prompt	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree	Total	Mean (SD)
Religion affect public perception on sewerage treatment plant	52 (19.0)	126 (46.0)	52 (19.0)	37(13.5)	7 (2.6)	274(100%)	2.35(1.02)
There are religions in this community which discourage situation of	49 (17.9)	97 (35.4)	65 (23.7)	59(21.5)	4(1.5)	274(100%)	1.06(1.08)

sanitation facilities near dwellings	

Source: Researcher 2024

At a mean of 2.35 (SD=1.02), participants showed a general disagreement to the statement meaning that the religions in the study area were rarely affecting people's perception on sewerage treatment plants. The statement on whether there existed religions in the community which discouraged situation of sanitation facilities near dwellings as shown in Table 4.20 recorded a mean of 1.06 (SD=1.08). The results implied that most of the religions in the area did not hold values which affected people's perception towards sewerage treatment plants and that situation of sanitation facilities near their residence was not an issue. However, slightly more than 15% of the respondents agreed that religion influenced public perception on sewerage treatment plants. Various religious teachings could prioritize spiritual purity over physical cleanliness which might attract indifference to the treatment plants among followers. Some religious values have been associated with shaping perception towards sewerage treatment plants as their teachings emphasize on cleanliness and environmental responsibility (Akpan et al., 2020).

The influence of religion on residents' perception towards sanitation systems was also reported in Pakistan by Akpan et al. (2020) but with a negligible impact. The two studies suggested that while religious values can shape perceptions of sewerage treatment by promoting cleanliness and environmental care, their actual influence may vary by context, being significant in some regions but negligible in others.

4.5.3 Influence of gender on public perception towards sewerage treatment plants

The study aimed at finding out the difference in perception towards the sewerage treatment plants between males and females. The results were as indicated in Table 4.21.

Table 4. 21

Gender effect on public perception on sewerage treatment plant

Prompt	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree	Total	Mean (SD)
Perception of men on the treatment plant is more positive compared to for women	29(10.6)	86(31.4)	90(32.8)	63(23.0)	6(2.2)	274(100%)	2.75(0.99)
Females are more affected by inadequate sanitation compared to men	17(6.2)	36(13.1)	49(17.9)	106(38.7)	66(24.1)	274(100%)	3.61(1.17)

Source: Researcher 2024

The study examined whether perception on the treatment plants was more positive for men compared to women. A mean of 2.75 (SD=0.99) suggested a general disagreement to the

statement implying that women were more positive about the plants compared to men. The findings could have been as a result of social norms where men might have felt pressured to conform to the traditional masculinity notions known to discourage engagement with sensitive topics like on faecal waste.

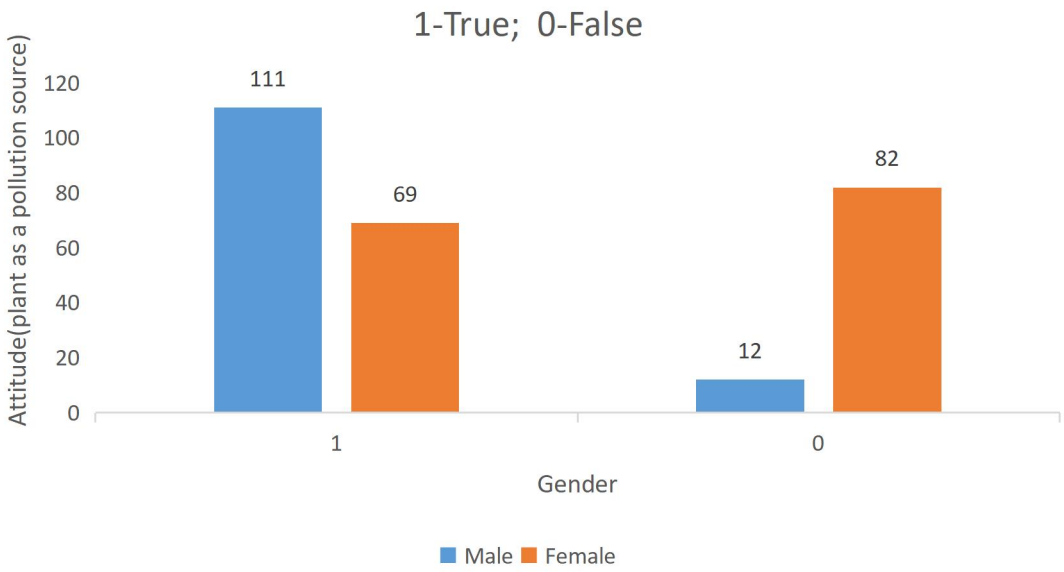
Women might have perceived the plants positively probably because they recognized their potential in improving the health of the public which aligned with values often related with caregiving well-being. On the other hand, the statement on whether females were more affected by inadequate sanitation recorded a mean of 3.61 (SD=1.17) implying a general agreement to the statement.

The findings could be explained by the fact that women often bore the basic responsibility for sanitation and hygiene, including the management of Water, Sanitation and Hygiene facilities. Consequently, they and the children they looked after could encounter amplified health risks when the facilities were inefficient or unavailable. In addition, inadequate sanitation could heighten women risk to sexual harassment particularly when they had to walk for long in search for basic sanitation services, which had been mitigated by the treatment plants.

A cross tabulation of perception in terms of attitude and acceptance of the sewerage treatment plants against gender was performed and findings presented in a graphical manner as shown in Figures 4.3 and 4.4 respectively.

Figure 4. 3

Attitude towards the treatment plant by gender



Source: Researcher 2024

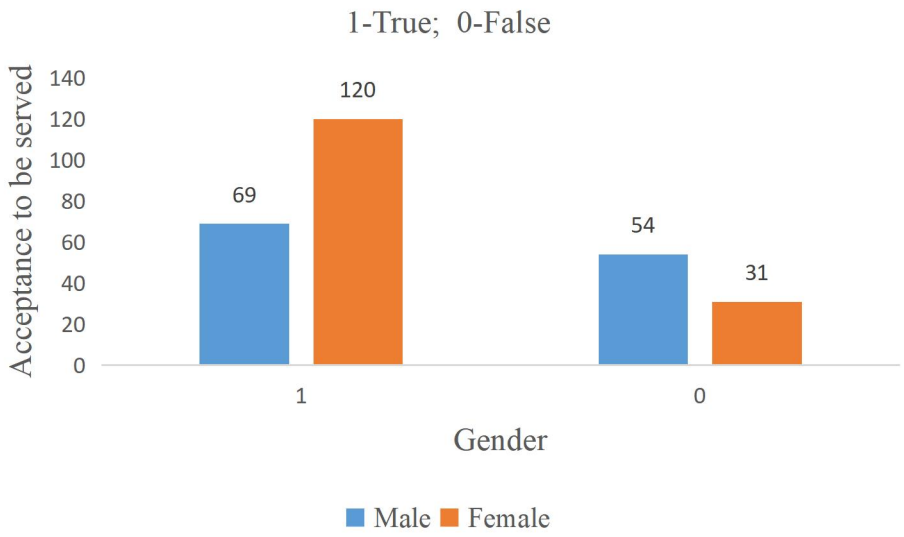
Results from a cross tabulation, shown in Figure 4.3, between attitude that the treatment plants were a source of pollution and gender showed a higher concern for 111 men compared to only 69 women. The implication of the findings was that attitude on the sewerage treatment plants was more negative for men than for women.

On the other hand, a cross tabulation between acceptance of the sewerage treatment plants versus gender revealed lower acceptance level for 69 men compared to 120 women as shown in Figure 4.4. The results suggested that acceptance towards the treatment plants was higher for women than for men which could have been as a result of appreciation of women on the important role of the sewerage treatment plants in managing household waste water, due to their high concern of the need for improved health. Generally, women are mostly left at households and may understand that the burden of lack of adequate sanitation facilities could result in unmanaged waste water which could be a source of diseases especially to

their vulnerable children. The influence of gender on people's perception towards waste water management systems was also acknowledged in a study by Saad et al. (2017).

Figure 4. 4

Acceptance towards the treatment plant by gender



Source: Researcher 2024

4.6 Influence of Environmental Factors on Public Perception Towards Sewerage Treatment Plants

The study assessed the influence of environmental factors such as changes in air, water or soil quality, impact on underground water and the environment.

4.6.1 Public perception on changes in environmental quality

The findings shown in Table 4.22 demonstrate participants' responses to a question on whether the treatment plants had brought about changes in air, water or soil quality in the areas surrounding the plants.

Table 4. 22

Changes in the quality of water or soil in the area surround the sewer plant

Response	Frequency	Percentage
Yes	216	78.8
No	32	11.7
I have never been to the plant	26	9.5
Total	**274**	**100.0**

Majority (78.8%) of the respondents thought that the plants had ability to cause changes in the quality of water or soil in the areas surrounding the plants. The processes of waste water treatment such as aeration, filtration or disinfection could have resulted in emission of odours especially when the plants were poorly maintained or uncontrolled, which might have attracted the negative perception on the plant's impacts on the air quality.

In addition, the process of transporting sewage to the treatment plants could have been thought to facilitate air pollution due to spillage and the bad smell of human waste. Moreover, the efficiency of treatment of waste water from the plants could have been doubted or questionable, which might have made participants think that trace quantities of pollutants such as heavy metals could find their way to water bodies which could cause water pollution. It was revealed in the Focus Group Discussion conducted in the area that public perception of the sewerage treatment plants negatively affecting water, soil or air quality arose from concerns on byproducts management, partial removal of contaminants as well as pollution emissions. Focus Group Discussion participants said:

"Treatment plants especially those constructed in local areas are not that effective in handling the waste directed to them. Try the water generated from the plants on farming. It will contaminate your agricultural land."

"See, you can't tell whether the treatment plants will be treating water as expected. The release of this water may bring water-related diseases because it will sometimes find its way to water sources. Kathita River is just around."

Overall, the findings showed that residents were concerned about the contribution of sewerage treatment plants to the quality of air, soil and water, which influenced their perception towards the treatment plants. Similar findings were reported in a study by Fu et al. (2022) in China where residents' rejection of treatment plants was as a result of the perception that they would release harmful and disgusting water to the environment and backyards.

4.6.2 Perception on odour resulting from the sewerage treatment plants

Respondents were asked to indicate their take on whether smell of air from the sewerage treatment plants influenced public perception towards the treatment plants as shown in Table 4.23.

Table 4.23

Smell of air from the plant influence public perception on the sewerage treatment plant

Response	Frequency	Percentage
Yes	233	85.0
No	41	15.0
Total	**274**	**100.0**

Source: Researcher 2024

Majority of the participants (85%) indicated that public perception towards the sewerage treatment plants could be influenced by smell of air from the plants. Odours emitted from sewerage treatment plants could have evoked negative associations or discomforts probably for residents who resided near the treatment plants or who regularly visited the plants. Smell to them might have been a prominent issue that shaped public opinion which possibly led to concerns on the smell from the sewerage plants.

4.6.3 Concern on impact to underground water and public perception towards sewerage treatment plants

Issues regarding possibility of seepage into underground water from the treatment plants were examined to find out whether they affected public perception on the sewerage plants. Table 4.24 summarizes the results obtained regarding underground seepage.

Table 4.24:

Public perception from concern on the impact of treatment plants on underground water

Prompt	True	False	Total
Seepage into underground water from the sewerage plant is possible and can cause water borne diseases	196 (71.5%)	78(28.5%)	274(100%)
Underground seepage from the sewerage plant affect community perception towards its establishment	190(69.3)	84(30.7%)	274(100%)

Source: Researcher 2024

When asked to give their take on possibility of underground seepage from the treatment plants and its ability to cause water borne-diseases, the opinion for 71.5% of the respondents

was ‘true’ while 28.5% selected the ‘false’ option. Overall, the results suggested that the community held perceptions that treatment plants would contaminate underground water which could consequently lead to spread of water borne diseases. Residents showed concerns of the potential breaches or possibility of leaks from the sewerage infrastructure into ground water which facilitated fears of the contamination reaching the underground water sources as reported by Focus Group Discussion participants that:

> *“Wait until it rains a lot, some of these lagoons will be filled with water, I believe sometimes they even leak contaminated water to the underground water. It is important to be keen on the design and maintenance of their floors.”*
>
> *“Sometimes we talk of drying beds. Where does the remaining water in sludge drain to? Is it not going down the earth?”*

The results implied that perception of residents towards the treatment plants could be influenced by the feeling that they endangered underground water sources.

4.6.4 Concern on harm to the environment

The study also examined the residents’ degree of agreement to a statement on whether the sewerage plants harmed the environment and the findings were as shown in Table 4.25.

Table 4.25

Sewer plant harms the environment

Response	Frequency	Percentage	Mean(SD)
Strongly disagree	39	14.2	3.08(1.19)
Disagree	42	15.3	
Neutral	75	27.4	
Agree	95	34.7	
Strongly agree	23	8.4	
Total	**274**	**100.0**	

Source: Researcher 2024

At a mean of 3.08 (SD=1.19), participants showed a general agreement to the statement meaning that majority of the respondents believed that the plants were potential sources of ecosystem disruption in terms of pollution. The results were explained in the Focus Group Discussion where participants believed that construction of sewerage plants was not only having direct impacts related to environmental quality but also promoted displacement of people from their original residences:

> *"Where the treatment plants are located was once a land for community members. It means that some were displaced from their habitats."*

A focus group discussion participant associated the waste water treatment plants with ability to contaminate their surroundings with faecal matter as follows:

> *"If you look at the water that pass through the drains and is directed to the sewerage treatment plants you can tell that there are traces of human faeces. It is always blackish. They sometimes block because of the huge clothes and stones thrown in them. This water comes to our environment. It is the one which contaminates even*

household surroundings. You cannot leave your children to play around with the household soil because they will eat it and suffer from diarrhea."

Another participant in the Focus Group Discussion showed concern on the location of the sewerage treatment plants away from the community dwellings to minimize interaction with odour that was perceived to emanate from the plants. The participant said:

"Sewerage treatment plants should be located in abandoned places where people don't live due to the bad odour likely to come from the treatment plants. We are not sure of the measures that the County Government will take to ensure that sewage is fully treated so that what is released does not harm our environment."

Contamination of surroundings with faecal matter could position the community members at a risk of acquiring sanitation-related diseases such as diarrhoea. The results meant that residents in the study area deemed the waste water treatment plants as having the potential to negatively interfere with the environment and livelihood, which affected their perception towards the plants.

4.6.5 Measures for mitigation of environmental issues for sewerage treatment plants

Views were sought from respondents on the measures that could be taken to minimize the perceived environmental impacts of the sewerage treatment plants as shown in Table 4.26.

Table 4.26

Measures that can be taken to reduce environmental impacts of the plant

Response	Frequency	Percentage
Increase public awareness and education	50	18.2
Increase regulation and enforcement	40	14.6
Improve treatment technology	173	63.1

None of the above	11	4.1
Total	**274**	**100.0**

Source: Researcher 2024

The measure that was majorly suggested was the need for improvement of the treatment technology at 63.1%. The other measures like public awareness and education and strategizing on regulations and enforcements took 18.2% and 14.6% of the responses respectively. Many respondents might have deemed the treatment plants as ineffective in the way they would handle sewerage waste hence suggesting an improvement of the treatment technologies to enhance effective sewage waste treatment. Other participants suggested the essence of awareness creation and education probably because they believed that some community members less appreciated the benefits of the treatment plants and therefore the need for a sensitization. Others, although few, deemed enforcement and regulations as absolute solutions for reducing environmental impacts as laws could easily dictate proper management of sewerage waste in the treatment plants.

Further, the researcher enquired from the participants whether they were satisfied with the actions that the Government had taken to address the environmental impacts of the sewerage treatment plants. Table 4.27 summarizes the findings obtained.

Table 4.27

Satisfaction with Government actions to address environmental impacts of the sewer plant

Response	Frequency	Percentage	Mean(SD)
Very dissatisfied	104	38.0	2.50(1.43)
Somewhat dissatisfied	48	17.5	
Neutral	25	9.1	
Somewhat satisfied	75	27.4	
Very satisfied	22	8.0	
Total	**274**	**100.0**	

Source: Researcher 2024

Although about 1/3 of the population studied reported being satisfied, the results showed an overall mean of 2.50 (SD=1.43) which demonstrated that respondents were generally dissatisfied with government actions to address the issues. The dissatisfaction could have emanated from inadequate transparency and low community involvement in making decisions regarding the treatment plants which undermined public confidence and mistrust of Government efforts. The results were emphasized in the Focus Group Discussion where a participant said:

> *"Had the implementers actively involved the benefiting people in decisions and sensitization on actions taken to ensure that they were safe, the community's satisfaction with the plants could be high."*

Inadequate access to information or limited understanding on monitoring data, mitigation and enforcement actions could leave residents feeling powerless in influencing decisions related to policies. Addressing the concerns therefore required enhanced public participation for sustainable sewage management.

4.7 Logistic Regression Findings

The study explored the relationship between the dependent variable (public perception towards sewerage treatment plants) and independent variables (social, cultural and environmental factors). Both univariable (unadjusted) and multivariable (unadjusted) analyses were performed and results are presented as odds ratio at 95% Confidence Intervals (CIs). The results were adjusted for the multivariable analysis to show the ideal impact and significance level of each factor independently.

4.7.1 Odds of public perception on sewerage treatment plants

Table 4.28 summarizes the logistic regression results obtained from the univariable and multivariable analyses for the relationship between public perception on sewerage treatment plants and all the indicators of the independent variables (social factors, cultural factors and environmental factors). In particular, the analysis shows the contribution of social factors like literacy, awareness, age and community participation; cultural factors like beliefs, taboos, religion and gender and environmental impacts or concerns on public perception towards sewerage treatment plants. The reference categories were omitted from the table for instance ‘men’, ‘age 18-29’, and so on.

Table 4. 28:

Odds of perception of sewerage treatment plants in Meru (n=274)

Variable	**Perception of sewerage treatment plants**					
	Unadjusted ORs (95% CI)	**P-value**	**Adjusted ORs (95% CI)**	**P-value**	**S.E**	**Constant (β_0)**
Literacy	1.52 (0.61-3.79)	0.008	1.09 (0.52-3.49)	0.018	0.47	0.42
Awareness	1.10 (0.34-2.89)	0.191	0.85 (0.27-2.89)	0.986	0.55	1.91
Age						
29-39	2.98 (1.19-7.52)	0.020	1.47 (0.62-6.10)	0.000	0.47	1.09
40-50	3.04 (0.18-5.02)	0.012	2.06 (0.65-5.01)	0.020	0.43	1.19
>50	3.19 (0.26-4.99)	<0.001	2.76 (0.44-3.18)	0.000	1.65	1.37
Community participation	7.84 (2.66-4.78)	0.000	5.95 (1.29-5.24)	0.002	0.53	1.61
Beliefs	0.64 (0.52-1.89)	0.563	0.65 (0.54-1.78)	0.055	0.48	0.28
Taboos affecting openness to new ideas	0.36 (1.30-14.53)	0.017	0.66 (1.13-9.78)	<0.001	0.60	0.93
Religion						
Christianity	3.04 (0.79-12.70)	0.127	2.86 (0.13-6.76)	0.281	0.05	1.12
None	1.23 (0.12-1.13)	0.765	0.86 (0.56-3.36)	0.234	0.24	1.54

Gender:

Female	3.63 (0.31-1.54)	0.003	3.04 (0.14-2.88)	0.120	1.41	0.54
Impact on environment (soil)	0.69 (1.38-9.53)	0.009	0.75 (0.86-3.08)	0.041	1.43	1.29
Undergroun d seepage	0.44 (0.13-4.42)	0.000	0.48 (0.54-4.30)	0.000	0.62	0.27
Air quality	0.32 (0.13-0.78)	0.013	0.40 (0.21-0.93)	<0.001	1.46	0.15

Source: Researcher 2024

Regression analysis for social factors

In the univariable results for the odds of public perception towards sewerage treatment plants in Meru (Table 4.28), increased literacy was associated with 1.52 significant likelihood of promoting positive perception towards the sewerage treatment plants (unadjusted OR=1.52, 95% CI:0.61-3.79; P=0.008<0.05). The odds of positive perception increased by 1.10 with increased public awareness on the benefits and impacts of the treatment plants (unadjusted OR=1.10, 95% CI:0.34-2.89). The relationship was however non-significant (P=0.191>0.05). The perception proved more positive with increasing age of respondents.

The probability of community members aged above 50 years of having positive perception was 3.19 times higher than residents in the reference category (18-28 years) (unadjusted

OR=3.19, 95% CI:0.26-4.99; P=<0.001). As well, people aged 40-50 years and 29-39 years were 3.04 and 2.98 times more likely to exhibit positive perception towards the treatment plant compared to people from the reference category respectively (unadjusted OR=3.04, 95% CI: 0.18-5.02; P=0.012; unadjusted OR=2.98, 95% CI: 1.19-7.52; P=0.020). The relationship between community participation and public perception was found to be positive and significant (unadjusted OR=7.84, 95% CI: 2.66-4.78; P=0.000<0.05).

Results for the adjusted (multivariable) model shown in Table 4.28 showed that all factors that appeared significant in the univariable model were also significant in the multivariable model. The influence of literacy (adjusted OR=1.09, 95% CI: 0.52-3.49, P=0.018); Age (adjusted OR=2.76, 95% CI:0.44-3.18, P=0.000 for >50 years; adjusted OR=2.06, 95% CI: 0.65-5.01, P=0.020 for 40-50 years and adjusted OR=1.47, 95% CI: 0.62-6.10, P=0.000 for 29-39 years); and community participation (adjusted OR=5.95, 95% CI: 1.29-5.24, P=0.002) was statistically significant. The influence of awareness was not significant (P=0.986>0.05). The findings implied that improved residents' literacy would facilitate positive perception towards treatment plants because residents would understand thus appreciate the role played by the plants. Findings also suggested that the lower the age of residents, the more the negativity towards the treatment plants as young people were influenced by external forces to reject the treatment plants. The results also revealed the essence of ensuring community participation at all stages of establishment of treatment facilities for increased public acceptance and ownership.

Regression analysis for cultural factors

Results in Table 4.28 for the univariable model showed a non-significant negative relationship between beliefs and public perception towards sewerage treatment plants (unadjusted OR=0.64, 95% CI: 0.52-1.89, P=0.563). The odds of positive public perception significantly reduced by 64% due to existence of taboos affecting openness to new ideas (unadjusted OR=0.36, 95% CI: 1.30-14.53, P=0.017). Findings also showed that residents who belonged to the Christian faith and who did not have any religious affiliation had 3.04 and 1.23 higher chances of having positive perception towards the treatment plants compared to the reference category (Muslims) respecively (unadjusted OR=3.04, 95% CI: 0.79-12.70; unadjusted OR=1.23, 95% CI: 0.12-1.13). However, the relationship was not significant (P>0.05). Residents who were females had 3.63 chances of having a positive perception towards the sewerage treatment plants compared to males. The relationship in the unadjusted model was significant (P=0.003<0.05).

Findings from the adjusted model as summarized in Table 4.28 showed a significant relationship for the cultural variables which tested significant in the univariable model (Taboos affecting openness to new ideas (adjusted OR=0.66, 95% CI: 1.13-9.78, P<0.001) other than gender which had a significance level of 0.120>0.05. The variables which showed a non-significant relationship in the unadjusted model (beliefs and religion) also had a non-significant impact in the adjusted model for the odds of public perception (P value>0.05).

The results implied that the probability of having positive perception among residents who had taboos which affected openness to new ideas was 34% lower than for those who did not have such taboos. Non-open-minded people could likely reject and lowly embrace establishment of new waste water treatment plants.

Regression analysis for environmental factors

Findings from the univariable analysis for the odds of public perception on sewerage treatment plants shown in Table 4.28 showed a significant negative relationship between association of plants with impact on the environment (unadjusted OR=0.69, 95% CI: 1.38-9.53, P=0.009<0.05), public notion on possibility of the plants to cause underground seepage (unadjusted OR=0.44, 95% CI: 0.13-4.42, P=0.000<0.05) and concerns on air quality (unadjusted OR=0.32, 95% CI: 0.13-0.78, P=0.013).

From the results in the multivariable analysis, the odds of public perception with regard to the plants' impact on the environment, public notion on possibility of underground seepage and concerns on air quality were also negative and statistically significant (adjusted OR=0.75, 95% CI: 0.86-3.08, P=0.041; adjusted OR=0.48, 95% CI: 0.54-4.30, P=0.000; adjusted OR=0.40, 95% CI: 0.21-0.93, P<0.001 respectively).

The findings suggested that the odds of public perception towards sewerage treatment plants was 25% lower when residents deemed the plants as sources of environmental pollution than when they did not. Additionally, the odds were 52% lower when residents associated the plants with ability to cause underground seepage compared to when they did not and by 60% when residents had feelings that the treatment plants affected air quality. Overall, the implication of the findings was that concerns regarding the influence of the treatment plants to the environment made residents to be against the treatment plants. The fact that people do not often like living in a contaminated environment due to fear of contracting diseases which can possibly emanate from such an environment might have facilitated the negative reactions.

4.7.2 Model summary for the influence of social, cultural and environmental factors on public perception towards waste water treatment plants

The model summary in Table 4.29 summarized the overall contribution of social factors (model 1), cultural factors (model 2) and environmental factors (model 3) on public perception towards sewerage treatment plants.

Table 4. 29:

Model summaries

Step 0	**β_0**	**S.E.**	**df**	**Sig.**
Model 1	0.47	0.05	1	0.018
Model 2	0.88	0.05	1	0.041
Model 3	1.06	0.05	1	0.000

Source: Researcher 2024

The findings along with those presented in Table 4.28 for individual variables were summarized in model equations i, ii and iii to show the contribution of each variable on public perception. Overall, the relationships between social, cultural and environmental factors on public perception towards sewerage treatment plants were statistically significant ($P<0.05$). In the model equations, y_i represented the dependent variable (public perception), B_0= constant value, $B_{i, ii}$ coefficients for indicators of the independent variables (social, cultural and environmental factors) and e was the standard error. The B_0 constants for the models differed because the models had different predictors and each model captured a different relationship between predictors and the binary outcome.

Model equation for social factors and public perception on sewerage plants

The relationship between public perception and the indicators of social factors was as presented in Equation i.

$$y_i = \beta_{0+}\beta_i x_i + \beta_{ii}x_{ii} \ldots + e \quad (5)$$

$$Perception = 0.47 + 1.09Literacy + 0.85Awareness + 1.47Age + 5.95C.participation + 0.05$$

From the equation, positive perception was possible with increased literacy (1.09), reduced awareness on benefits and impacts (0.85), increased age (1.47) and community participation in the treatment plants implementation processes (5.95). The model showed that when all predictor (independent indicators for social factors) variables were held constant at zero, public perception towards the treatment plants was 0.47 which implied that the value was the baseline level of dependent variable before introducing the impacts of the independent variables.

Model equation for cultural factors and public perception on sewerage plants

The relationship between public perception and cultural factors was as summarized in Equation ii:

$$y_i = \beta_{0+}\beta_i x_i + \beta_{ii}x_{ii} \ldots + e \quad (6)$$

$$Perception = 0.88 + 1.65\ Beliefs + 0.66Taboos + 2.86\ Religion + 3.04\ Gender + 0.05$$

The model shows that beliefs, religion and gender contributed to a positive influence on 1.65, 2.86 and 3.04 on public perception towards sewerage treatment plants. However, taboos had a negative influence of 0.66 (34%) on public perception towards sewerage treatment plants. When all independent (indicators for cultural factors) variables were held constant at zero,

the baseline level of dependent variable before introducing the impacts of the independent variables was 0.88.

Model equation for environmental factors and public perception on sewerage plants

The contribution of environmental factors to public perception towards sewerage treatment plants was as summarized in Equation iii.

$$y_i = \beta_{0+}\beta_i x_i + \beta_{ii} x_{ii} \ldots + e \quad (7)$$

$$Perception = 1.06 + 0.75 Impact\ on\ environment + 0.48 Seepage + 0.40\ Air\ quality + 0.05$$

The values in the equation suggested that environmental factors had a negative influence on public perception towards the sewerage treatment plants. The contribution was more negative as a result of concerns regarding the plants on quality of air (60%), followed by concerns of underground seepage (52%) then notion on the ability of the plants to impact the environment (25%). Based on the value of the constant term, the baseline level of perception towards sewerage treatment plants before introducing the impacts of the independent variables (environmental factors) was 1.06.

CHAPTER FIVE: CONCLUSION, RECOMMENDATIONS AND PUBLICATION

5.1 Introduction

This chapter covers the conclusions made from the findings obtained in the study, recommendations based on the conclusions and publication. The chapter begins with a summary of the research and also gives suggestions for future studies.

5.2 Summary of the Study

The study assessed the influence of social, cultural and environmental factors on public perception towards sewerage treatment plants. Previous reports had indicated that despite the Meru County Government's efforts to promote safe sanitation access in Meru, establishment of solutions like sewerage treatment plants has been facing rejection. The study was critical as it explained the contribution of the factors to public perception towards sewerage treatment plants. Data was obtained data was obtained from households and focus group discussions. From the findings, public perception regarding sewerage treatment plants was found to be generally negative and was influenced by various social, cultural and environmental factors, which needed to be addressed if the County Government had to realize a significant progress towards safe management of human waste. Results on how each variable contributed to public perception towards the sewerage treatment plants.

5.2.1 Summary on the influence of social factors on public perception towards sewerage treatment plants

Residents' literacy levels affected public perception towards waste water treatment plants in that people with increased literacy understood the essence of sewage management and were unlikely to be lured by misinformation unlike those with low levels of literacy. Residents were mostly aware of the benefits and impacts of the treatment plants and awareness level did not mostly affect their perception towards sewerage treatment plants. However,

perception to some residents was influenced by the notion of impacts such as leakage of drains leading to the plants and incidences of overflow of waste water from the plants especially during rainy seasons which was thought to contaminate the households.

Further, results also showed that perception towards the treatment plants varied with age where increasing age was associated with increased chances of positive perception towards the plants. At a mean of 3.35, residents reported that the community was involved in the processes of establishing the treatment plants mostly through provision of land (21.2%) and as laborers (18.1%). Other forms of participation included provision of materials and decision-making. However, due to the technical nature of the treatment plants which needed technical skills, it was noted that majority of the experienced laborers were ferried from other places, which might have made some residents uncomfortable. Community participation in establishment of the plants influenced perception due to its contribution to ownership and acceptability of facilities.

5.2.2 Summary on the influence of cultural factors on public perception towards sewerage treatment plants

There mostly existed no beliefs to discourage establishment of sewerage treatment plants. However, some respondents in the focus group discussion reported beliefs on what was regarded ‘clean’ and what was ‘dirty’ where people believed that their faecal matter, and not another person’s, was clean. Being surrounded by treatment plants which handled a range of individuals’ faecal matter was considered disgusting. Although religion was not mostly a significant contributor to public perception, slightly more than 15% of participants reported that some religions like Islam, which emphasized on purity and cleanliness, could exhibit a

negative perception towards the treatment plants due to the feeling that they were dirty and contaminants of environment.

Gender significantly influenced people's perception towards the treatment plants with women being more positive to the establishment of the plants compared to men. The findings were associated with women's caregiving roles where cleanliness of the surrounding was key for their own health and the health of the environment since treatment plants handled faecal matter, which could otherwise have been found in their compounds, away from the households.

5.2.3 Summary on the influence of environmental factors on public perception towards sewerage treatment plants

Findings showed that 78.8% of the participants deemed the plants as potential sources of environmental contamination as efficiency in the waste treatment processes was untrusted. Results also showed that 85% of the residents associated the treatment plants with ability to contribute to odours which evoked discomforts especially to the residents who lived in households which were very near the treatment plants. The belief that the plants would cause contamination of underground water due to seepage of waste water to the ground also attracted a negative perception from the communities.

5.3 Conclusion

The study aimed at examining the perception of residents towards sewerage treatment plants. The study concluded that public perception towards the treatment plants was generally negative. Provision of suitable sanitation solutions require an understanding on the dynamics of the communities and contexts in which they are established. Sewerage treatment plants may be supported or rejected based on the perception of the public. Negative perception has

the possibility of blocking planned investments from moving ahead. Positive perception among communities, which attract acceptance to solutions provided, is a key element in promoting the success of waste water treatment plants.

The first objective sought to establish the influence of social factors on public perception towards the sewerage treatment plants. The study concluded that perception of the community towards the sewerage plants was influenced by literacy levels, age and community participation. Active and fair involvement of the community in all the processes of implementation of the sewerage treatment plants could be a bold step towards increased acceptance of the plants. The team should be composed of both males and females and people across various ages and ability statuses.

Objective 2 aimed at exploring the contribution of cultural factors on public perception towards sewerage treatment plants. It was concluded that cultural concerns surrounding new community sanitation options including gender affected participants' perception towards sewerage treatment plants. Incorporation of preferences related to culture during planning of sanitation solution could be a worthwhile strategy.

The third objective assessed the influence of environmental factors on public perception towards sewerage treatment plants. The study concluded that concerns regarding the impacts of the treatment plants on soil, underground water and air quality highly attracted negative perception towards the treatment plants. A transparent process of conducting Environmental Impact Assessment of sanitation solutions in the early stages of implementation could be key in mitigating environmental issues that could likely arise as a result of establishment of the sanitation solutions.

5.4 Recommendations

The study recommends the need for concerted efforts by sanitation implementers in provision of public education on the essence of sewerage treatment plants in their initial stages of implementation for increased acceptability and a positive perception towards the treatment plants.

A two-sided contribution during establishment of sewerage treatment plants, of project implementers and the community, is needed for sanitation projects to foster trust and transparency to the benefiting residents. Embracing the views of community members and addressing needs per their desires other than the way implementers desire could be more practical in addressing community matters so that the community suggestions can be based on solutions which can best suit their needs. In addition, there is need for advocacy of compulsory community involvement during all stages of development of community sanitation projects.

Communities are comprised of people from different cultural orientations. Achievement of the desired outcomes in a community with deep rooted cultures related to sanitation require a good comprehension of cultural issues. There is therefore need for the County Governments and planners of sanitation solutions to cultivate a culture of conducting reconnaissance studies that focus on understanding issues related to culture before implementation of sanitation solutions to ensure provision of context-specific sanitation solutions which fit the target communities.

There is need for policies that substantiate environmental awareness to promote more sustainable sanitation solutions. In addition, the County ministries of Water and Sanitation

should target frequent inspections to ensure maintenance and proper functioning of the treatment plants for increased treatment efficiency and reduced environmental concerns.

5.4.1 Suggestion for further studies

From the findings of this study, social, cultural and environmental factors influenced public perception towards sewerage treatment plants. However, public perception could be influenced by other innumerable factors not explored in this study and may require investigation. Future studies should explore societal structures and the influence of psychosocial factors on public perception towards sewerage treatment plants in not only Meru County but also in other regions facing similar issues with the study area to broaden the scope through determining more contributing factors. A deeper understanding of behavioural-related factors could enlighten policy makers and sanitation implementers on the practical strategies of implementing acceptable sanitation projects.

5.5 Publication

Raphael Kimathi Kinoti, Lilian Mukiri Kirimi, Kirema Nkanata Mburugu, Grace Kasiva Eliud Influence of environmental factors on public perception towards sewerage treatment plants in Meru County, Kenya" *African Journal of Science, Technology and Social Sciences*. 4 (2) 2025, SS 131-141. https://doi.org/10.58506/ajstss.v4i2.252

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APPENDICES

Appendix A:Informed Consent

The aim of this study is to investigate influence of social cultural and environmental factors on public perception towards establishment of sewerage treatment plants in Meru County. The information that you will give will be treated with strict confidentiality and will not reach to a third party. Please note that participation in the study is on voluntary basis and you will be free to withdraw participation at any point of the survey if you so wish with no consequences whatsoever. The survey will take approximately 30 minutes. If you agree to participate in the study please indicate by signing in the spaces provided after declaration.

Participant declararion:

I acknowledge that I have comprehensively read and comprehended the research details provided by the researcher. I hereby affirm that I have willingly agreed to participate in this research and will furnish the requested information of my own volition. I also understand that any data that could reveal my identity will be kept confidential and will not be disclosed to the public.

Signature…… Date…….

Appendix B:Questionnaire

SECTION A: DEMOGRAPHIC INFORMATION

Question	Choice
1. What is your Gender?	a) Male { } b) Female { }
2. Age	a) 18-28 { } b) 29-39 { } c) 40-49 { } d) 50 and Above { }
3. Which is your highest Education level	a) Primary { } b) Secondary { } c) Past secondary { } d) Never been to school { }
4. Which is your religion?	a) Christianity { } b) Islam { } c) Hindu { } d) Budhist { } e) None { }
5. Please select the option which best describes your occupation	a) Employed { } b) Self employed { } c) Not Employed { }

SECTION B: PUBLIC PERCEPTION ON SEWERAGE TREATMENT PLANTS

In the following section, please select the most appropriate choice for the questions or statements given on acceptance, satisfaction and attitude on sewerage treatment plants

A. Acceptance of the sewerage treatment plant

1. Please indicate by a tick (√) your most appropriate answer for the statements provided.

Statement	True	False
The treatment plant has more benefits than limitations		
The sewerage plant is acceptable to community members		

I would accept to be serviced by the sewerage system		
I can use treated waste water generated from the sewerage plant for farming purposes		

2. What would prevent one from accepting treated waste water for reuse?

    a) It is polluted

    b) Not effectively treated

    c) Others…..specify……..

B. Attitude on the sewerage treatment plant

1. Please indicate by ticking (√) in the boxes provided your most appropriate answer for the statements provided.

Statement	**True**	**False**
The treatment plant expose the community to the danger of diseases		
The sewerage plant is a source of pollution to the community		
The community's attitude towards the waste water treatment plant is positive		
Release of treated waste water to the environment can result in environmental issues		
Establishment of the sewerage treatment plant will contribute to a reduction in waterborne diseases in the community		

C. Satisfaction with the sewerage treatment plant

1. Are you satisfied with establishment of the sewerage treatment plant?

    Yes ☐ b) No ☐

2. Do you think that the sewerage plant will be effective in addressing community wastewater management needs?

    Yes ☐ b) No ☐

3. Do you feel that the sewerage treatment plant will positively impact the quality of water bodies in your community?

   Yes ☐ b) No ☐

4. Are you satisfied with the location of the sewerage treatment facilities in your community?

   Yes ☐ b) No ☐

SECTION C: SOCIAL FACTORS AND PUBLIC PERCEPTION TOWARDS SEWERAGE TREATMENT PLANTS

1. **Please select the most appropriate choice for the statements provided below:**

Statement	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Literacy level affects the community's perception on the treatment plant					
I have knowledge that treated waste water has less impacts and can be recycled and reused					
The community is aware of the benefits of the sewerage treatment plant					
Age of community members affect their perception on the treatment plant					
The community are/were involved in the processes of establishment of the treatment plant					
Community participation in establishment of the treatment plant affects their perception on the sewerage treatment plant					

2. Were there any awareness campaigns held in this community when the treatment plant was being initiated?

   a) Yes ☐ b) No ☐ c) I don't know ☐

3. Was the community involved at any stage of the treatment plant's establishment? If yes, how?

a) In provision of materials ☐ b) Provision of labour ☐ c) In decision-making ☐

d) Provision of land ☐ e) The community was not involved ☐

4. How would you rate the overall impact of the sewer plant on your community?
   a) Very positive { }
   b) Somewhat positive { }
   c) Neutral { }
   d) Somewhat negative { }
   e) Very negative { }
5. How concerned are you about the potential impacts of the sewer plant on the community?
   a) Very concerned { }
   b) Somewhat concerned { }
   c) Neutral { }
   d) Unconcerned { }
   e) Not at all concerned { }
6. How would you rate people's perception of the treatment plant in relation to age given the following statement?

   Perception on the treatment plant is more positive for the elderly compared to the young people
   a) Strongly disagree { }
   b) Disagree { }
   c) Neutral { }
   d) Agree { }
   e) Strongly agree { }

Section D: Influence of cultural factors on public perception towards sewerage treatment plants

1. Please provide the most appropriate choices for the following statements

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The community has beliefs which discourage establishment of sanitation projects					
It is a taboo to mix human faeces in this community which affect perception of sewerage plants					
Cultural taboos affect the community's openness to adopting new sanitation options					
Religion affect public perception on sewerage treatment plants					
There are religions in this community which discourage situation of sanitation solutions near dwellings					
The perception of men on the treatment plants is more positive compared to for women					
Females are more affected by inadequate sanitation compared to men					

Section E: Influence of Environmental factors on public perception towards sewerage treatment plants

1. How often do you visit the area around the sewer plant?

    a) Daily { }

    b) Weekly { }

    c) Monthly { }

    d) Rarely { }

    e) Never { }

2. Have you noticed any changes in the quality of air, water and soil in the area around the sewer plant in the past year?

    a) Yes { } b) No { }

3. **Please select the most appropriate response**

Statement	True	False
Bad odor smell of the air in the community influence public perception on establishment of sewerage treatment plants		
Underground seepage into the soil from the sewer plant affect community perception towards its establishment.		
Seepage into the underground water from the sewer is possible and can cause water bone diseases		

4. Have you noticed any changes in the natural habitats and wildlife in the area around the sewer plant in the past year?
    a) Yes { }
    b) No { }
5. What is your opinion on the statement: sewer plant harms the environment?
    a) Strongly disagree { }
    b) Disagree { }
    c) Neutral { }
    d) Agree { }
    e) Strongly agree { }
6. What measures do you believe can be taken to reduce the environmental impact of the sewer plant?

a) Improve treatment technology { }
b) Increase regulation and enforcement { }
c) Increase public awareness and education { }
d) None of the above { }

7. Please indicate your degree of agreement to the following statement

How satisfied are you with the actions taken by the government to address the environmental impact of the sewer plant?

a) Very unsatisfied { }
b) Somewhat satisfied { }
c) Neutral { }
d) Somewhat dissatisfied { }

e) Very dissatisfied { }

Appendix C:Focus Group Discussion Guide

1. Can you say that the sewerage treatment plant is acceptable to the community? Explain your answer

   .....

   .....

   .....

2. Can you claim that the community is satisfied with the sewerage treatment plant? Explain your answer

   .....

   .....

   .....

3. Are there environmental factors that affects/affected establishment of the sewerage plant? Which ones?

   .....

   .....

   .....

4. Are there beliefs, religious values, taboos or issues of gender that affect establishment/acceptance of the plant? Which ones if any?

   .....

   .....

   .....

5. Were members of this community involved in the initial process of the urban sewerage system project implementation? If yes, how were they involved? Do you think their involvement influences the implementation of the project?

   .....

   .....

   .....

6. What is your view on the importance of community participation in the sewerage sanitation project?

   .....

   .....

.....

7. How can you describe the general view of the community concerning the treatment plant in terms of benefits/disadvantages?

   .....

   .....

   .....

8. Were members of this community involved in deciding on the location of sanitation project? If yes, how were they involved? Do you think their involvement could influence the public perception on the treatment plant?

   .....

   .....

   .....

9. How has community knowledge and awareness affected establishment of the sewerage treatment plant?

   .....

   .....

   .....

10. What recommendations can you give which can or could have ensured successful establishment of the sewerage treatment plants?

    .....

    .....

    .....

Appendix D:Waste water discharge into water bodies and the environment

a)Waste water in a seasonal river

b) Waste water in a pond

c) Open drain near a residential leading to Sewerage plant

Appendix E:Journal article publication

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Influence of Environmental Factors on Public Perception Towards Sewerage Treatment Plants in Meru County, Kenya

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ABSTRACT

Effective wastewater management is among the Sustainable Development Goal 6.2 targets as it ensures proper disposal of wastewater, nature conservation, and promotion of health. Although Government efforts in supporting establishment of waste water treatment plants have been shown, the projects are at times rejected by the community leading to wastage of resources, unsolved sewage disposal problems, and the spread of diseases emanating from poor sewage management. This study examined the influence of environmental factors on public perception toward sewerage treatment plants in Meru County, Kenya, whose solutions have often been facing rejection from the communities. The study targeted residents around Rwanyange, Gakoromone and Maua sewerage treatment plants in Meru County, Kenya. Mixed methods approach was used with a convergent study design. A sample of 386 household heads was targeted. Cluster and simple random sampling techniques were used for selection of the areas and household heads respectively. Quantitative data was collected from households using structured questionnaires and analysed in descriptive statistics and in logistic regression using the Statistical Package for Social Sciences (SPSS) version 26. Logistic regressions were carried out in univariable and multivariable tests to show the relationship between dependent and independent variables and findings presented as odds ratio with 95% Confidence Intervals (CI). Qualitative data was obtained from focus group discussions, analysed based on themes and presented in narratives. Overall, the public perception towards sewerage treatment plants was negative. Perception varied with age with people aged > 50 years being 2.78 times more likely to exhibit positive perception towards the treatment plants compared to those aged 18-28 years ($P<0.05$). Participants especially those who resided very near the treatment plants were concerned of the odour that resulted from the treatment plants and the impacts of the plants on soil contamination (adjusted OR=0.75, 95% CI: 0.86-3.06, $P<0.001$). Public notion on the possibility of the treatment plants to result in underground seepage and concerns on the quality of air due to pollution significantly lowered perception by 52% and 60% respectively ($P<0.05$). The study concluded that public perception towards the treatment plants was affected by participants' concerns on their impact on the environment. The study recommends community involvement in all implementation stages of sanitation projects for increased acceptance, ownership and trust of solutions by beneficiaries. There is also need for policies that substantiate environmental awareness for sustainable solutions. A transparent process of conducting Environmental Impact Assessment of sanitation solutions in the early stages of implementation could be key in mitigating environmental issues that could likely arise as a result of establishment of the sanitation solutions.

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Appendix F:Plagiarism Report

DrillBit

The Report is Generated by DrillBit Plagiarism Detection Software

Submission Information

Author Name	Raphael Kinoti Kimathi
Title	INFLUENCE OF SOCIAL, CULTURAL AND ENVIRONMENTAL FACTORS ON PUBLIC PERCEPTION TOWARDS SEWERAGE TREATMENT PLANTS IN MERU COUNTY, KENYA
Paper/Submission ID	2082871
Submitted by	mmusungu@must.ac.ke
Submission Date	2024-07-05 09:28:51
Total Pages, Total Words	118, 25359
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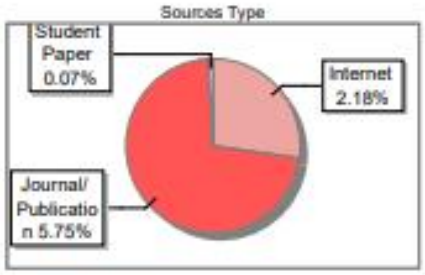
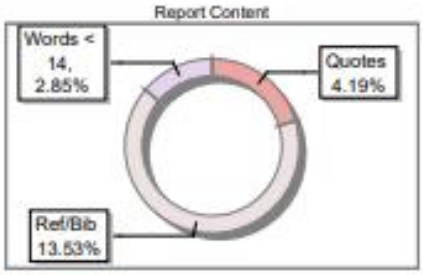
Result Information

Similarity 8 %





Exclude Information

Quotes	Not Excluded
References/Bibliography	Excluded
Source: Excluded < 14 Words	Not Excluded
Excluded Source	0 %
Excluded Phrases	Not Excluded

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Language	English
Student Papers	Yes
Journals & publishers	Yes
Internet or Web	Yes
Institution Repository	Yes

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