POLITICAL ECONOMY ANALYSIS FOR SANITATION DELIVERY IN INFORMAL SETTLEMENTS: A CASE STUDY OF MUKURU KWA REUBEN, KENYA

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A Thesis Submitted in Partial Fulfillment of Requirement for Conferment of the Degree of Master of Science in Sanitation of Meru University of Science and Technology

2025

DECLARATION

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

EG407/201058/20

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DECLARATION BY SUPERVISORS

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DEDICATION

I dedicate this thesis to my parents, Mr. and Mrs. David Ngeno who have supported me in the research journey**.** My dedication also goes to my wife Mrs. Winrose Muthoni and my son Ethan Kibet Maina who have supported me immensely during the journey of writing this thesis**.**

ACKNOWLEDGEMENT

In this thesis, I acknowledge my supervisors, Dr. Joy N. Riungu and Dr. Kirimi Lillian Mukiri, and my mentors, Mrs. Caroline Karani, and Ms. Yvonne Wairimu for the advice, guidance, and mentorship. I acknowledge Prof. Anna Mdee, and Dr. Alesia D. Ofori from University of Leeds for their advice and mentorship.

Moreover, I acknowledge the support from the School of Engineering staff led by Mr. Simon Mirara, the chairman Department of Civil and environmental engineering. I also acknowledge the support from Sanergy staff, community health promoters, and public health officers, for their contribution in enabling me to collect data. I acknowledge support from Eng. Kennedy Musumba from the Ministry of Water and Sanitation who accepted my invitation for the interview. I also acknowledge the financial and psychological support from my family during the research journey.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADB	Africa Development Bank
ANOVA	Analysis of Variance
BMGF	Bill and Melinda Gates Foundation
BSF	Black Soldier Fly
CBD	Central Business District (CBD)
CBS	Container-Based Sanitation
DFID	Department for International Development
DoC	Drivers of Change
Ecosan	Ecological Sanitation
EMCA	Environmental Management and Coordination Act
FGD	Focus Group Discussion
FS	Fecal Sludge
FSM	Fecal Sludge Management
FSMA	Fecal Sludge Management Alliance
GoK	Government of Kenya
GoTN	Government of Tamil
IWK	Indah Water Konsortium
KESHP	Kenya Environmental Sanitation and Hygiene Policy
KESSF	Kenya Environmental Sanitation and Hygiene Strategic Framework
KISIP	Kenya Informal Settlement Improvement Programme
KNBS	Kenya National Bureau of Statistics
KNHCR	Kenya National Commission on Human Rights
MIRERC	Meru University Institutional Research Ethics Review Committee

MoH	Ministry of Health
MoWSI	Ministry of Water, Sanitation, and Irrigation
NACOSTI	National Commission for Science, Technology, and Innovation
NEMA	National Environmental Management Authority
NGO	Non-governmental Organization
NRW:	Non-Revenue Water
NWSC	Nairobi Water and Sewerage Company
PEA	Political economy analysis
PHO	Public Health Officer
PPPs	Public-Private Partnerships
SDG	Sustainable Development Goals
SSA	Sub-Saharan Africa
SWE	Small Water Enterprises
UN:	United Nations
UNICEF	United Nation Children Emergency Funds
VIF	Variance Inflation Factor
WASREB	Water Services Regulatory Board
WHO	World Health Organization
WSP	Water Service Providers
WWDAs	Water Works Development Agencies

OPERATIONAL DEFINITION OF TERMS

Accessibility	Evaluated the perceived ease of access of physical sanitation facilities to the community, considering factors like proximity, safety and infrastructure
Accountability	Determined the frameworks and mechanisms in place to ensure transparent and responsible sanitation service provision
Affordability	Assessed the perceived cost-related factors that affect the affordability of sanitation services for different population segment
Availability	Investigated the perceived sufficiency and presence of sanitation services and infrastructure to gather for the needs
Container Based Sanitation	Sealable containers used to transport excreta/sludge.
Excreta	The mixture of urine and feces.
Fecal Sludge Management	The process of collecting, emptying, transporting, treating, and safely disposing of fecal sludge from onsite sanitation systems
Formal Actos	The providers or agents identified by laws and regulations to deliver sanitation services and technologies
Informal Actors	Individuals or groups involved in sanitation service provision without formal recognition or regulation by legal authorities
Onsite Sanitation Systems	Sanitation solution options where waste is safely managed and treated at or near the point of generation, and includes pit latrines, septic tanks, and composting toilets
Political Economy	The study of how political and economic factors interact to shape

	policies, decision-making, and implementation in the sanitation sector
Political Will	Encompass degree of commitment and support from governmental and non-governmental actors to improve sanitation services
Sanitation Delivery	This entailed the accessibility, availability, affordability and accountability in provision of sanitation services and technologies.
Sludge	The fecal waste contained from an onsite sanitation technology.
Sanitation Technology	This detailed the type of sanitation technologies used for containment, emptying, transportation, treatment and disposal of sludge/excreta

ABSTRACT

The Sustainable Development Goals agenda 6.2 aims to increase access to equitable and adequate sanitation by 2030. However, sewer systems serve only 17 % of the Sub-Saharan African population in informal settlements. Possible interventions and options to address sanitation issues in informal settlements have been advanced through research. However, upscaling and improving fecal sludge management in slums has been a challenge because of overpopulation, land tenancy issues, complex roles of stakeholders, and technical and political constraints. This study examined the political economy of sanitation delivery in Mukuru Kwa Reuben, focusing on technologies used, the role of actors, and policy–practice gaps. Using a convergent mixed-methods design, data were collected from 152 participants—100 household heads via cluster random and simple random sampling, and 52 stakeholders through purposive and snowballing techniques. Quantitative data were analyzed in SPSS and qualitative data in NVivo. Reliability of instruments was moderate (Cronbach's alpha = 0.62). Findings showed that the type of toilet and construction/installation processes significantly influenced accessibility, affordability, and availability. Costs of installation, emptying, and sludge transport were major barriers, with landlords citing high sewer connection fees (KSh 5000). It was observed that operation of sanitation systems was constrained by the presence of cartels who controlled water provision. Despite the devolution of sanitation functions, the County Government was perceived as unwilling to service loans for sanitation infrastructure. Manual sludge operators faced poor pay, while water cartels and limited county support further constrained services. Policy gaps included weak enforcement, partial devolution, inadequate partnerships, and informal service delivery. The study concludes that governance of sanitation is inadequate and fragmented. It recommends adopting innovative and context-appropriate technologies, formalizing and regulating informal services, and harmonizing sanitation policies. The results provide insights for residents, utilities, policymakers, NGOs, and urban planners seeking to improve sanitation in informal settlements.

CHAPTER ONE: INTRODUCTION

1.1 Background Information

The Sustainable Development Goals agenda 6.2 aims to increase access to equitable and adequate sanitation by 2030 (UNICEF & WHO, 2020a). Access to equitable and adequate sanitation is essential in preventing sanitation-related diseases like diarrhea responsible for an estimated 2.2 billion deaths among children under 5 years in Sub-Saharan Africa (World Water Quality Alliance, 2021). Despite concerted efforts to achieve the goal, access to equitable**,** adequate and safely managed sanitation still remain a challenge particularly in slums of developing countries. A report by (UNICEF & WHO, 2020a) showed that globally, 7.68% of the population use unimproved sanitation facilities with 23 % living in slums. In Sub Saharan Africa, the majority 56.2% of urban population live in slums, but only 17 % of slum dwellers use safely managed sanitation facilities with 18% still defecating in the open (UNICEF & WHO, 2020).

The use of unsafely managed sanitation facilities and open defecation contaminate the environment and expose the population to pathogenic microorganisms (Baia et al., 2022). Although various interventions like container-based sanitation systems, ecological sanitation technology, and Kenya Informal Settlement Improvement Programme (KISIP) have been made to address sanitation challenges, in Mukuru Kwa Reuben, upscaling and improving ways of managing fecal sludge remain complex due to complex stakeholders' dynamics Simiyu et al., 2021a; Tsinda et al., 2021a), technical obstacles (Russel et al., 2019a; Tilmans et al., 2015a) and political constraints (Dixon, 2018; Mallory et al., 2021a; Ofori et al., 2021). Although political economy could influence sanitation delivery, it has not received the attention it deserves which this study sought to address.

Technologies for fecal sludge management play a crucial role in addressing the sanitation challenges along the sanitation service chain. Container Based Sanitation transports excreta/sludge in a sealable container and has emerged as potential sanitation solutions due to their faster installation, adaptability, and ability to cater to limited spaces and individual preferences (Mansour et al., 2017a; Russel et al., 2019a). In Cap Haitien, Haiti, a study by Tilmans et al., (2015a) established that Container Based Sanitation reduced unmanaged feces by approximately 3.5-fold and was beneficial to 9,300 residents living in the area. However, only 70% of residents living within the range of 100-220 meters used the facility. Moreover, Tilmans et al. (2015) established the high capital costs of $ 18,742, and collection and conveyance cost for household CBS at $ 22/ household/month for the Container Based Sanitation during the pilot phase.

There was limited access to long-term financing strategies (Evans et al., 2017; Williams, 2021a), and lack of capital expenditure on conveyance equipment (Ferguson et al., 2021; Gitonga et al., 2021a). The installation of onsite sanitation is politically difficult and is occasioned with some landlords having illegitimate land ownership (Russel et al., 2019b; Tilmans et al., 2015).Therefore, more research was needed to understand the role of political economy in influencing the availability, accessibility, and affordability of sanitation technologies in Kenya's slums.

Private and public sector actors are increasingly involved in creating alternative solutions to the fecal sludge management in urban slums in low-income countries. The private and public partnership in sanitation increase innovative solutions, technologies and economic opportunities (van Welie et al., 2018a, 2018b). In Philippines, a study by Abeysuriya et al. (2019) established that the public-private partnerships between national government and

private company led to concessionaire agreements on improving universal access to sanitation as by 2028, but larger cities were missing the target due to poor sanitation planning outcomes. Despite the commitment on increasing by 70% the sanitation budgets at the national level by the Philippines' National Sewerage and Septage Management Program in 2012 following waterborne disease outbreaks, realization of the commitment was undermined by the failure to increase sanitation budgets and the lack of explicit initiatives to achieve set targets (WSP, 2015; DoH Philippines, 2010). Local leaders who emerged as champions played a pivotal role in driving progress at the city level (Abeysuriya et al., 2019). However, the question remained, what factors and dynamics at both the national and local levels influence the effective implementation of sanitation programs and policies, especially in informal settlements was unclear? Therefore, a comprehensive investigation was necessary to bridge these research gaps and provide a deeper understanding of the political economy of sanitation delivery in Kenya's informal settlements.

In Kenya, the 2016 Water Act legislation outline that the responsibility for fecal sludge management lies primarily with the Water Service Providers. Under the Water Act 2016 Section 72 (1) a, b, c and d, the WSP is empowered to set standards for water service provision, recommend sewerage and water tariffs, accredit and license water service providers. However, due to a lack of necessary equipment for emptying and transportation, fecal sludge management (FSM) operations is undertaken by the private sector with the government acting as a regulatory body (Mansour et al., 2017a), which make mechanical emptying services unaffordable and encourage unregulated emptying services (Okoth et al., 2017). Unregulated emptying of faecal sludge result in illegal dumping of faecal matter into the environment making it unaesthetic and contaminated. To bridge this gap in knowledge, it

was essential to investigate the line of responsibility and accountability for fecal sludge management in Kenya.

Sanitation remains a significant public health concern in Mukuru Kwa Reuben due to limited access to safely managed sanitation facilities. As per the Kenya National Bureau of Statistics Housing Survey, Mukuru Kwa Reuben has a population of 65,691, yet only 7.6% of residents are connected to a sewer system (KNBS, 2019). A cross-sectional study by Kariuki et al. (2024) indicates that income levels significantly influenced the type of sanitation women acess. Moreover, container-based sanitation was the most common method, and accounted for 51% of all sanitation options in the area. These findings show a glaring infrastructural gap and underscore the role of political economic factors in shaping sanitation delivery. With a majority of residents relying on informal solutions such as container-based toilets, sanitation becomes not just a technical issue but also a matter of social equity and gendered access. Understanding the types of sanitation technologies used in Mukuru Kwa Reuben was therefore essential.

The literature reviewed clearly demonstrates that partners, the government, and other stakeholders made efforts to provide technologies, policy strategies, and capacity building in Mukuru slums to address the challenges of fecal sludge management. While these initiatives aimed at increasing the demand for fecal sludge management solutions, it is evident from existing research and reports by Abeysuriya et al. (2019); Strande et al. (2014); UNICEF & WHO, (2020) that the desired level of success has not been achieved. This highlights a significant research gap in understanding through political economy lens the factors and challenges that hinder the full implementation and sustainability of fecal sludge management practices in informal settlements, despite substantial support from development partners.

Further research was needed to explore the complexities of politics, economic, and infrastructural factors which may influence the effectiveness of sanitation interventions in Mukuru Kwa Reuben informal settlement.

1.2 Problem Statement

The Sustainable Development Goal agenda 6.2 calls for the UN member states to take transformative and bold steps to safely managed sanitation by 2030 (UNICEF & WHO, 2020a). In Kenya, initiatives such as Kenya Informal Settlement Improvement Programme (KISIP) have been implemented to strengthen institutions, service delivery and infrastructure in the informal settlements (van Welie et al., 2018). However, despite these interventions, only 17 % of Sub-Saharan African population in informal settlements are served by sewer system (UNICEF & WHO, 2020a). In Mukuru Kwa Reuben, a cross-sectional survey to assess the utilization of sanitation facilities by women revealed a significant proportion 88.6% of women disagreed with the statement that they utilized the sanitation facilities provided (Kariuki et al., 2024). Inadequate sanitation standards lead to chronic health risks and a disgrace to human dignity (Heller, 2022).

While Container Based Sanitation (CBS) is recognized as a viable option for low-income area, it still faces numerous challenges. The Container Based Sanitation providers are still dependent on donor funding for its services and operates at an early stage of development. The pit latrines are still discharging al large volume of untreated faecal waste and there is a limited space to dig new pits and bury old ones in Mukuru Kwa Reuben (Brands et al., 2022; Corburn et al., 2017.; Ofori et al., 2021). Despite the interventions, drives, and campaigns by partners and stakeholders for upscaling the adoption and use of the sanitation facilities are unsustainable, and untreated fecal sludge is discharged into the environment (Mallory et al.,

2021b). Although political economy influence sanitation delivery in terms incentivizing the provision and use of sanitation technology, it has not received the attention it deserves which this study sought to address. Therefore, there was a need to establish the interplay between the type of sanitation technology, formal and informal actor, and policy and practice and its influence in terms of accessibility, availability, affordability and accountability in the service provision. This study, therefore, analyzed the type of sanitation technologies, analyzed how formal and informal actors influence sanitation delivery, and assessed the gaps between policy and practice.

1.3 Objectives

1.3.1 General objective

To investigate the political economy for sanitation delivery in informal settlements; case of Mukuru Kwa Reuben.

1.3.2 Specific objectives

i. Establish the technologies used in sanitation delivery in Mukuru Kwa Reuben.
ii. Examine the role of formal and informal actors in sanitation delivery in Mukuru Kwa Reuben.
iii. Examine the gaps between policy and practice in sanitation delivery in Mukuru Kwa Reuben.

1.4 Research Questions

i. Which are the technologies used in sanitation delivery in Mukuru Kwa Reuben?
ii. What is the role of formal and informal actors in sanitation delivery in Mukuru Kwa Reuben?

iii. What are the gaps between policy and practices in sanitation delivery in Mukuru Kwa Reuben?

1.5 Significance of the Study

The study's findings on sanitation technologies provides insight into the accessible, affordable, suitable and available sanitation technologies and options for the informal settlements. By examining the role of formal and informal actors, the study generated evidence-based recommendations on the line of responsibility and accountability in sanitation delivery. The findings on policy and practices inform the development of policies, strategies, and plans for the implementation of improved technologies and practices in informal settlements.

1.6 Scope of the Study

This study only focused on the political economy analysis of sanitation delivery in informal settlements, and more specifically in Mukuru Kwa Reuben, Kenya. The scope included an analysis of the sanitation technologies used, the role of formal and informal actors, and the gap between policy and practice in sanitation delivery. This study was only limited to the key stakeholders and households within Mukuru Kwa Reuben. The research period covered 2022 to 2025.

1.7 Limitations of the Study

The study acknowledges that there were limited logistical and financial resources, which restricted the scope of data collection and analysis. Moreover, the study focused on sensitive matters of economic and political factors, which resulted in resistance from some of the key stakeholders. Also, the informal nature of the Mukuru Kwa Reuben settlement led to difficulties in getting the data, especially the informal sanitation services. Lastly, the

findings from Mukuru Kwa Reuben are not be generalizable to other informal settlements due to unique socio-economic and political contexts.

1.8 Delimitation of The Study

This study was delimited to Mukuru Kwa Reuben informal settlement in Nairobi County, Kenya. The focus was on households and key stakeholders directly involved in sanitation delivery, including public health officers, NGOs, landlords, manual and mechanical fecal sludge operators, and relevant government agencies. The analysis concentrated on sanitation technologies, the roles of formal and informal actors, and the gaps between sanitation policies and practices. The timeframe of the study was 2022–2025, and the study only considered ten purposively selected villages within Mukuru Kwa Reuben. The findings, therefore, may not be representative of all informal settlements in Kenya, but rather provide context-specific insights into the political economy of sanitation delivery in this area.

1.8 Assumptions of the Study

The study assumed that respondents provided honest, accurate, and reliable information during surveys, focus group discussions, and interviews. It further assumed that the key informants and the selected household heads adequately represented the broader community and stakeholder perspectives in Mukuru Kwa Reuben. The instruments used, including observation checklists, questionnaires, and interview guides, were presumed valid and capable of capturing the intended data. Political, economic, and social conditions in Mukuru Kwa Reuben remained relatively stable during the data collection period. Finally, the study assumed that sanitation policies and frameworks under review were accessible, accurate, and reflective of government and stakeholder positions.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

In this section, the study reviewed the recent journal articles and papers which discuss the political economy, technologies, formal and informal actors, policies, and practices in fecal sludge management. The practices, policies and actors reviewed in the articles were addressing the fecal sludge management service chain. The fecal sludge management (FSM) service chain starts from the containment to the end use/disposal of the fecal sludge/excreta. The relevant sources of information in the section were from Google Scholar, verified website domains, Cochrane, and Medline. The Boolean operators (NOT, OR, AND) were used during the search of articles. The articles with more than 10 years and those with secondary data were excluded from the review, while recently published papers were included.

Political economy analysis (PEA) plays a great role in the provision of sanitation services. Department for International Development (DFID) defines political economy analysis as concerned with the interaction of political and economic processes in a society (Mallory et al., 2021c; Tsinda et al., 2021b). It encompasses the distribution of power and wealth between different groups and individuals, and the processes that create, sustain and transform these relationships over time (Mansour et al., 2017a; Tsinda et al., 2021a). In sanitation delivery, politics incentivize the use or neglect of public toilets and which informed the study.

2.2 Fecal Management Service Chain

The basic sanitation service regime is commonly described by spatial uniformity, a dominating regulating body, and uniformly high-quality standards (International Water

Association, 2015; Ren et al., 2020). Conversely, recent approaches to socio-technical transformation models have shown this is certainly not the case in emerging cities of low-income countries. Given the complexities of the fundamental services and the extremely unbalanced dispersal of infrastructures in such cities, typical conceptions of social-economic systems are oversimplified in such circumstances. For instance, many configurations of individuals, objects, and spaces in urban East Africa do not accommodate locals' requirements for water, sanitation, and hygiene (Ono & Kidokoro, 2020).

The effective management of fecal sludge should address the entire sanitation service chain and which comprises all activities of containment, collection, storage, conveyance, treatment, and end-use Gitonga et al. (2021a); Okoth et al. (2017a); Peal et al. (2013b) checked the quality of urban sanitation services in 12 Sub-Saharan Africa (SSA) Countries and the findings illustrated the importance of FSM models of service delivery that conform with the sanitation service chain. Similarly, a city service delivery assessment of fecal sludge management services recommended the need for a well-functioning service chain in Dhaka, Bangladesh (Ross et al., 2016; Scott, Ross, & Hawkins, 2016a)

2.3 Technologies used in Sanitation Delivery

2.3.1 Technologies for containment

Globally, onsite sanitation technologies commonly serve low-income areas in urban areas. Globally, the onsite sanitation system is estimated to serve 2.8 billion people (UNICEF & WHO, 2020a). A similar survey carried out by UNICEF and WHO (2020) in Bangladesh in low-income settings found that 92.7% of households rely on onsite containment facilities such as pit latrines. UNICEF and WHO (2019) survey confirms the population in low and

middle-income settings with latrines or toilets was estimated at 99%. Reuben slums, 100,561 families were only served with 3863 pit latrines (World Water Quality Alliance, 2021).

In Malawi, Ecological sanitation (EcoSan) technology has gained significant attention among stakeholders. In Malawi, many stakeholders have adopted Ecological sanitation (EcoSan) technology. The residents of Chikwawa perceived Ecological sanitation (EcoSan) technology as relatively cheap and very simple to construct toilets, and reduced the risk of spreading diseases (Banks et al., 2014a). However, Ecological sanitation (EcoSan) technology experienced challenges of acceptability and correct utilization despite receiving full-funding from donors (Mara & Evans, 2018a). The findings by (Banks et al., 2014b) show it is not only the issue of cost and availability of onsite. availability of Ecological sanitation (EcoSan) technology onsite. However, political and economic incentives and disincentives was not fully studied and which informed the present study to show the role of political economy in influence the availability, accessibility, and affordability of technology of fecal sludge management in Mukuru.

In Kisoro, Uganda 'PEE POWER®' toilet was mostly used by 94% of school girls during the day and at night due to lights (You et al., 2020). In a recent study conducted by (You et al., 2020), one female participant expressed appreciation for the Pee Power toilets, noting that it provided an added sense of safety. The participant remarked: "*I like the Pee Power toilets because I could see a man hiding at night*", and further elaborated that the presence of lights around the toilet block made them safer than other school toilets, allowing for any potential intruders to be easily spotted. These findings highlight the potential benefits of implementing innovative technologies, such as Pee Power toilets, in enhancing user safety and security. Despite this innovative design, 55% of girls interviewed reported it was still

unsafe to use 'PEE POWER®' toilet alone at night they could be raped and assaulted (You et al., 2020).

2.3.2 Technology for emptying and transportation

In Cape Town, sanitation experiences a contemporary sanitation syndrome. A study by McFarlane & Silver, (2017) established the politicization of the human waste which was linked to urban politics of blockage, sabotage, historical and racialized segregation, and entitlement of sanitation services and infrastructure. A study in Cape Town by Russel et al. (2019a) found that emptying and transportation service was funded by the Municipal government which contracts private providers to conduct the services. However, A report by Social Justice Coalition (SJC) (2014) in Cape Town showed that urban politics led to inequalities of sanitation infrastructure and especially informal settlement with 500,000 getting inadequate services. Access to inadequate sanitation services has led to lowering of the dignity and rising risks among the vulnerable population in the informal settlement, and informed the present study to understand the politics of blockages and sabotage of sanitation services.

In Kenya's context, the high cost associated with fecal sludge emptying and transportation give rise to the emergence of private entrepreneurs and unregulated manual emptiers as alternatives to formal sanitation services. The cost of faecal transportation and storage was solely the responsibility of households, in Mombasa. However, the high cost of USD 15/m^3 of emptying and transportation led to emergence of private entrepreneurs and nonregulated manual emptiers. As a result, people resorted to cheap options, such as open defecation and indiscriminate discharge of sludge to water bodies which resulted in public health and environmental hazards (Genter et al., 2021). In Mukuru and Kibera settlements, Mallory et

al. (2021b) found that the pit emptiers were physically and institutionally outside the sanitation service delivery and 50% of pit emptiers in Mukuru Kwa Njenga have interacted when disposing sludge with Sanergy, whereas in Mukuru Kwa Reuben reported the contrary. Open defecation and indiscriminate disposal of faeces could contaminate water bodies thus putting the population at risk of interacting with pathogens found in excreta (Mackinnon, 2019). This study was carried out to investigate forces determining the availability and accessibility of cost -effective sanitation services in slums.

In Khulna city, Bangladesh, Ross et al. (2016); Zaqout et al. (2020a) found 'scheduled emptying' as unsafe, untimely, and reactive while Mehta *et al.* (2019) reiterate that fecal sludge desludging services are done by unskilled people with inadequate personal protective equipment. In Kibera, the onsite sanitation systems depend on manual and mechanical means for emptying and the equipment is a bucket, a gulper, and a foot or hand-operated pump (Mallory et al., 2021d). Manual emptying may fail, as the fecal sludge operators are emptying which poses an environmental and public health risk(Strande et al., 2014).

The cost of sewers determines its availability and usability. To function effectively, traditional sewerage systems necessitate a considerable large capital investment as well as consistent electricity and water supplies (Corburn et al., 2017). Traditional sewers require well-resourced utilities and are highly professionalized, to operate and maintain. However, simplified sewers, which have been successfully deployed in Pakistan and Brazil at cheaper costs than traditional sewers, require sufficient water sources as well (van Welie et al., 2018a). Sewer installation can also be politically difficult, as it can give legitimacy to squatter settlements, upsetting the integrity of property laws (McFarlane & Silver, 2017).

According to UNICEF and WHO (2020b) report, of the 17% of urban population, only 7.6% are connected to sewers in Sub-Saharan Africa. (African Population and Health Research Center (APHRC) (2014); Ono and Kidokoro (2020); and Ren et al. 2020) found that the sewer systems are not installed in informal settlements due to technicalities and high cost, and are unsuitable for the topography and terrain in the informal settlements. The major sanitation system used in the settlements are onsite systems such septic tanks and pit latrines (Peal et al., 2013; Tilmans et al., 2015).

In five cities in the Global South, onsite sanitation technologies inferred as "non-networked" serve low-income countries and discharged fecal sludge to the local area and irrigation channels (Scott, Ross, & Hawkins, 2016a). In Tamil Nadu India, onsite sanitation systems such as improved pit latrines and septic tanks serve 42% of the population (Devaraj et al., 2021a).In Kenya's informal settlements, onsite sanitation systems are predominant, whereas in Kibera a slum 28% of households empty pit latrines manually, and 33% use mechanical means (Okoth et al., 2017a). The fecal sludge from networked onsite technologies is taken to the transfer station in Mukuru and Kibera slums (Mallory et al., 2021a). The major onsite sanitation facilities serving low-income areas are pit latrines and septic tanks.

2.3.3 Technology for treatment/enduse/disposal

The attention of donor to sanitation sector has increased with development partners and sanitation enterprises introduced off-grid sanitation options to solve sanitation challenges in Sub-Saharan Africa (SSA) (Bhagwan et al., 2019). Black Soldier Fly (BSF) Sanitation option is preferred due to its cost effectiveness, affordability, flexibility for upscaling in low-income countries (Mertenat et al., 2019). However, Black Soldier Fly (BSF) Sanitation option is still small-scale and is dependent on donors funding despite increased financial

investment in Middle and low-income countries (Dortmans et al., 2017; Müller et al., 2017; Mutuku et al., 2022a). This dependency on donors' funds to take to scale the Black Soldier Fly (BSF) technology informed this study.

The effectiveness of Black Soldier Fly (BSF) in fecal sludge management, particularly in low-income countries, has been a subject of interest in recent studies. A study by (Mertenat et al., 2019) found that out that Black Soldier Fly (BSF) attractive fecal sludge management option due to its cost effectiveness, affordability, flexibility for upscaling in low-income countries. According to (Banks et al., 2014b) , the Black Soldier Fly (BSF) larvae's gut microbiota is highly distinctive, allowing them to digest a variety of foods such animal manure, fresh fecal waste, and pit latrine fecal sludge. Supporting this perspective, (Mutuku et al., 2022b) delved into the practicality of BSF larvae (BSFL) venture within counties like Nairobi, Nakuru, Machakos, Muranga, Kajiado, and Kiambu.

The findings of the study by (Mutuku et al., 2022b) shed light on the profitability of ventures involving BSFL, with an impressive enterprise gross margin of 93.6%. Black Soldier Fly (BSF) process large amounts of organic waste efficiently, reduce overall costs (Mertenat et al., 2019). However, Mutsakatira et al. (2018) and Mutuku et al. (2022a) found out that Black Soldier Fly (BSF) sanitation option was still small-scale and dependent on donors funding despite increased financial investment in Middle and low-income countries. Also, as per Singh et al. (2017) Black soldier fly larvae (BSFL) treatment option is dependent on donors funding which informed the study. These findings underscore the importance of addressing the funding and scalability issues to fully harness the potential of BSF in biowaste treatment and was the focus of this study to understand the role of political economy in influencing sanitation delivery.

2.3.4 Availability of technology and options

In low-income areas, there have been an increased understanding and interest in FSM services, by local and national agencies, development by partners, and WASH sector organizations (Scott, Ross, & Hawkins, 2016b). The Government of Tamil Nadu (GoTN) preferred FSM services as it complements the 27% networked sewerage systems for Town Panchayats and smaller municipalities (Devaraj et al., 2021a). However, In Brazil and Indonesia, there is persistent concern that governments at all levels are not giving sanitation services enough resources and attention, especially when compared to spending on infrastructure services and water delivery (de Quadros Rodrigues et al., 2014; Scott, Ross, & Blackett, 2016). Okoth et al. (2017), on the other hand, links household preference for onsite sanitation facilities with the affordability, effectiveness, and practicality of solutions for changing the toilets. It appears onsite sanitation systems are common in low-income areas of urban areas, but an understanding of the enabling environment remains unclear, as the FSM services and technologies have stagnated.

2.3.5 Accessibility of technology/options

The gap in accessibility to fundamental networked sanitation services between informal and formal settlements has a lot to do with the consequences of policies that make it very difficult to develop infrastructure in informal settlements (Mansour et al., 2017b). As per Ofori et al. (2021) the adoption of international policies of formal institutional control and good governance has correspondingly failed to materialize in the local context since they could not adhere to the local standards.

Due to the rapid growth and growing wealth and poverty disparity, Nairobi City is currently experiencing serious sanitation infrastructure challenges. For both local officials as well as

the city's residents, providing sufficient sanitation facilities is a serious concern, particularly in Nairobi's informal the 36% of the population resides (Mansour et al., 2017a). The colonial state of segregation and discrimination led to the uneven quality of sanitary arrangements that has intensified and exacerbated in during the post-revolutionary period (Vliet et al., 2014). In Nairobi, 84% of formal households have a connection to a water supply system within the home, compared to 36% in informal settlement households (Babijes, 2016). All other infrastructure and network services, such as roads, solid waste collection, and sanitation, are subject to the same inequality.

The criteria set by the Kenya National Commission on Human Rights KNHCR, (2017) specify sanitation facilities should be adequate with no more than four households sharing a single facility and be within reach of each household. Despite these guidelines, a baseline study carried out by Practical Action in Mukuru revealed a significant disparity whereby merely 11% of families had access to a private household toilet and that 16% of residents shared toilets with their neighbors (Peal & Evans, 2013).

An overwhelming 73% of the population resided in communal blocks managed by landlords or Small Water Enterprises (SWE) with sanitation options characterized by overcrowding, poor maintenance, high costs, inconvenience, and scarcity. Pit latrines are recognized as the most accessible and economically viable sanitation choice in informal settlements across sub-Saharan Africa (Sklar, 2017). However, research by Banks et al., (2014a) established that even this alternative comes with a significant expense due to the substantial cost of constructing new pit latrines. This highlighted a clear disparity in the availability and affordability of sanitation facilities within informal settlements with few exceptions, it also holds in metropolitan areas.

2.3.6 Operation and maintenance

The conditions of onsite sanitation systems depend on their operation and maintenance. In the door-to-door survey in Panchayat, India, the majority of septic tanks were not water-tight, and only 9.1% were plastered. The fecal sludge were transported through a narrow path with a wheelbarrow and disposed of in canals, lakes, and low-low-lying areas in urban areas (Devaraj et al., 2021b; Sclar et al., 2022a; Sorensen et al., 2016). Scott, Ross, & Hawkins, (2016a) carried out a desktop study in 12 cities in East Asia and concluded that the poorly built latrine led to fecal sludge going to the local area, which was also caused by weak transportation chain, treatment, and disposal.

Across Mukuru, the community groups and NGOs own pit latrine communal toilets which are not connected to sewerage lines and are closed at night. As for the yard-shared toilets, they are owned by the structure owners and are usually shared by the residents of the structures and with poor operation and maintenance (Corburn et al., 2017).

In Dhaka City Bangladesh, the Kallyanpur Bastee septic tanks are disludged when the toilet or the tank overflows (Ross et al., 2016). In Nairobi, onsite sanitation facilities lack efficient and effective management of fecal sludge and with only 5% of sewage being effectively treated and 65% ending up in the environment (Mansour & Esseku, 2017; Strande et al., 2014). It appears that poorly managed, constructed, and designed onsite sanitation systems are common in urban cities and do not conform with the FSM service chain in low-income areas.

There are recurrent challenges in the FSM management and Water Service Providers (WSP) operations. The key issues are the rising cases of non-revenue water (NRW) and high levels of water losses. The loses are estimated at 43% in non-revenue water (NRW) and which are attributed to either commercial losses (fault metering, illegal vendors, or water theft by cartels) or physical losses (pipe leakages). Due to the rapid growth and growing wealth and poverty disparity, Nairobi City is currently experiencing serious sanitation infrastructure challenges (Williams, 2021b). The financial actor in water sector and sanitation services are currently considering investment in sanitation as a high risks venture.

Therefore, the development organizations and state actors are using de-risking of water services to woo investors and cultivate the markets and which is unreliable at the long run (De Vincenti, 2022; Nyirenda & Holm, 2015a). considering the for both local officials as well as the city's residents, providing sufficient sanitation facilities is a serious concern, particularly in Nairobi's informal the 36% of the population resides (Mansour et al., 2017a). The colonial state of segregation and discrimination led to the uneven quality of sanitary arrangements, that has intensified and exacerbated in during the post-revolutionary period (van Welie et al., 2018b).

2.4 The Role of Formal and Informal Actors in Sanitation Delivery

The literature review in this section examined the articles on role of formal and informal actors in the sanitation services delivery chain**.** It examined demand and supply, regulation, coordination, and financing of sanitation services.

2.4.1 Demand and supply of sanitation

The providers of FSM services have diverse interests and competing demands. As per the case study carried out in Kenya and Haiti, Moya et al. (2019) found that the involvement of

institutions is important to incentivize the use and sale of fertilizer to achieve safely managed sanitation systems. The scholars also found that it is hard to find a market for human excreta-derived fertilizer due to poor roads. However, the case study by Mallory et al. (2021e) in Kibera and Mukuru confirms that there is an overlap in sanitation service provisions by the government ministries and departments.

World Bank and Bill and Melinda Gates Foundation investors provided resources to facilitate the management of fecal sludge in Mukuru slums, including capacity building for pit emptiers. The investors undertook capacity building for pit emptiers to ensure the collection, transportation, treatment, and disposal of fecal sludge in informal settlements.

While this increased the demand for FSM solutions, the practice never reached its desired level of success in these informal settlements (Abeysuriya et al., 2019) and which Mallory et al. (2021b) and Strande et al. (2014) found that lack of capacity building of pit emptiers lead to indiscriminate disposal of waste which compromise population health and safety. Therefore, it is evident that despite investors initiatives, there remained a critical research gap in achieving the desired level of success in fecal sludge management in Mukuru slums and further research was needed to investigate the persistent challenges through political economy lens.

2.4.2 Regulation of sanitation Services

Mallory et al. (2021b) acknowledges fragmented regulatory and enforcement services of urban water and sanitation services. National Environment Management Authority (NEMA) is tasked with enforcing fines for disposal of waste and licensing sanitation providers, Water Services Regulatory Board (WASREB) set required standards for sanitation and licensing utilities, and Water Works Development Agencies (WWDAs) charged with making sure that

sanitation services are implemented as per Water Act 2016 (Mallory et al., 2021c). Contrary to Mallory et al. (2021c) findings, Mansour et al. (2017) and Moya et al., (2019) findings concluded that the unclear line of responsibility has led to local government experiencing challenges when offering financial support.

The presence of cartels in prevent or control the provision of basic services such as sanitation. Vested local interest from the 'cartels' controlled the installation new technology in Kibera settlements without adhering to the regulation. In Kibera, the possession and access of land is complicated with unlicensed and unregulated building activities (Williams, 2021b).The land informality controlled by land cartels affect the social and physical/technical infrastructure (Ofori et al., 2021).

The onsite sanitation technologies in informal settlements misalign with the minimum standards of setbacks 1.5m, access width 3m, frontage 6m, height 2.4m, and other sanitary provisions of latrine accommodation and siting as specified under p. 87, 88, and 89, p. 331(1), p.246 (1), p.261(3), (5), and p.258 (1) (8) of the (National Building Code, 2022). Therefore, this study was initiated to investigate the complexities of informalities and the dynamics of these 'cartels' in sanitation delivery in Mukuru Kwa Reuben.

2.4.3 Coordination of sanitation services

The role of actors in the fecal sludge management chain comprises a complex mix of actors. Mansour et al. (2017a) and Simiyu et al. (2021b) allude that the mandates and responsibilities for the provision of basic sanitation services are overlapping and unclear in Kenya. The confusion in the basic sanitation services delivery created a conglomerate of informal and formal actors Mansour et al. (2017a) as a result, the lines of responsibility and accountability remain blurred (Criqui, 2020). Similarly in Tanzania, the institutional

constraints led to the failure to implement the provisions in the sanitation policies, but the common narratives were blame games (Mdee & Mushi, 2021). Therefore, it is apparent that the complex mix of actors jeopardizes the sustained provision of basic sanitation services.

The informal small-scale networked operators frequently fill the void, especially for pit emptying in informal settlements.

Despite the importance of informal pit emptiers in the sanitation value chain, the effort, particularly physical work, is frequently overlooked by policymakers and sponsors (Blackett & Hawkins, 2016a). In Mukuru and Kibera found pit emptiers were physically and institutionally outside the current delivery of sanitation services paradigm (Mallory et al., 2021c). Pit emptiers operated without wearing protective gear, financial incentives, and other forms of support (Gitonga et al., 2021b; Okoth et al., 2017b). The unlicensed pit emptiers tasked with the transportation of fecal sludge did not have the necessary equipment or training, and they frequently work overnight (Aquaya & WSUP, 2019). Although there were formal manual operators, the work was generally limited (Mallory et al., 2021c).

2.4.4 Financing of sanitation delivery services

In India, fiscal balance and decentralization rules mandate incremental financing devolution for the local authorities. The sanitation funding was mostly centralized and the cabinet ministers-maintained power and control rather than delegate responsibility to the local level as the federal-local power dynamic works out (South Asia et al., 2021). In Malaysia, after Indah Water Konsortium Sdn Bhd (IWK) got granted a 28-year monopoly to maintain, operate, and manage septage and sewerage services, that had formerly used to be the responsibility of local governments. Malaysia took a unique approach to the delivery of

urban sanitation services where the local governments saw FSM and sewerage services as a "difficult function" (Devaraj et al., 2021a).

2.5 Gaps Between Policy and Practice in Sanitation Delivery

The Constitution of Kenya, 2010, provides immutable and clear guiding values and principles. All parties engaged in the creation, management, and execution of public policy, as well as the state, are bound by the Constitution. Article 6 (3) of the Constitution contains guiding principles for governmental policy, including sanitation policy. According to these guidelines, a national state entity must, given the nature of the service, guarantee fair access to its services across the Republic of Kenya.

The Bill of Rights, which forms the foundation for social, economic, and cultural policy in Kenya and is essential to the country's democratic state, is established by Article 19. The objectives of devolution are outlined in Article 174, which also calls for the recognition of diversity, the democratic and accountable use of authority, the grant of popular self-governance, and more public participation in decision-making processes that impact the populations. The Constitution's Articles 201 and 202 place a strong emphasis on the ideas of transparency and accountability, public involvement in financial concerns, the advancement of an egalitarian society, and equitable tax burden distribution. It emphasizes fair revenue distribution between the government agencies, encouraging equitable growth, and making allowances for underserved communities and regions.

The goal of 2010 devolution is to safeguard and advance the rights and interests of marginalized groups and minorities. It aims to advance social and economic advancement, guarantee fair resource distribution, and make it easier for state institutions to become decentralized. It also emphasizes communities' rights to self-govern and advance their own

development. The KESHP and its objectives is based on these fundamental values and principles of the constitution.

Kenya Environmental Sanitation and Hygiene Policy (KESHP) (2016–2030) and Kenya Environmental Sanitation and Hygiene Strategic Framework (KESSF) (2016–2020) constitute the primary frameworks for managing sanitation and hygiene. It offers comprehensive guidelines for state and non-state actors, such as civil society organizations, development partners, the private sector, and communities. The Kenya Environmental Sustainability Plan (KESHP) is in line with the Sustainable Development Goals of 2030 and addresses the constitutional amendments made by the Kenyan Constitution of 2010.

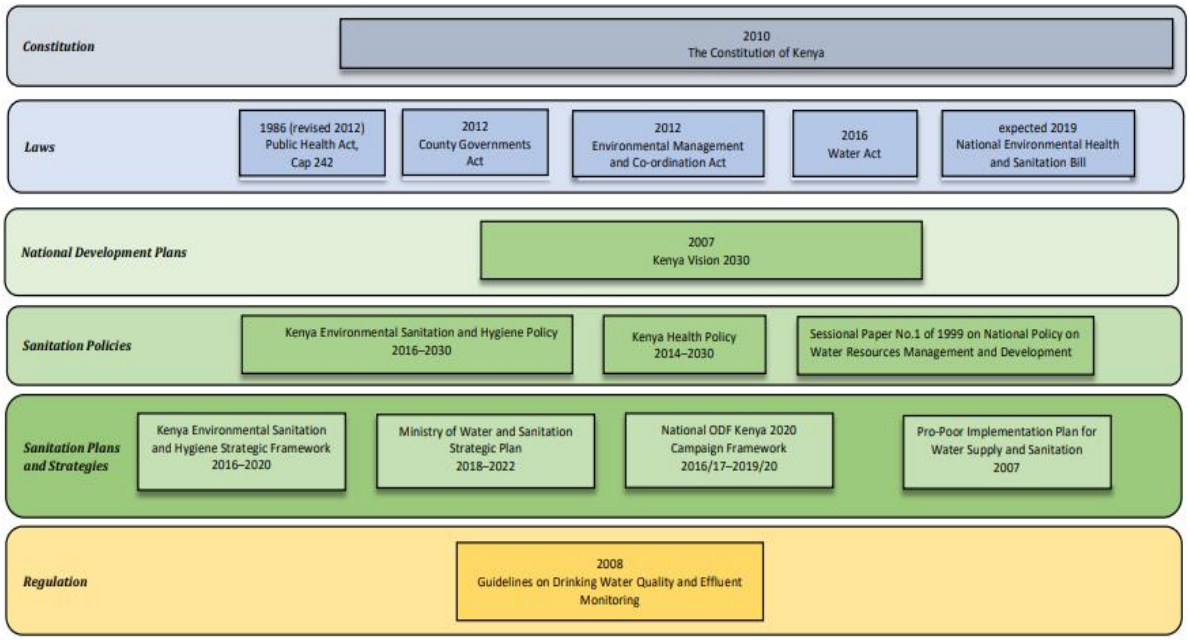
Policy framework guarantees efficient and effective delivery of sanitation services. The Constitution of Kenya, 2010 as captured in figure 2.1, devolved some of the government functions and services. Under article 21 of Kenya's constitution, the state is obligated to take steps to achieve rights to sanitation through standard setting, policy, and legislative framework (Rights, 2017). Article 43(1)(c) of the Constitution states, "*Every person has the right to accessible and adequate housing and to reasonable standards of sanitation*," (GoK, 2010). The adoption of the 2010 Constitution resulted to the new changes in plans, policies and laws. One of the new policy and framework includes the Kenya Environmental Sanitation and Hygiene Policy (2016-2030) and Kenya Environmental Sanitation and Hygiene Strategic Framework (KESSF) 2016-2020. Despite the devolution of functions, services and development of new policies and frameworks, were fragmented and incoherent.

> "*A key challenge in the sanitation sector has been the institutional fragmentation, unclear allocation of roles and responsibilities, weak institutional alignment and poor coordination within and across the sector especially in the context of a*

devolved system of government. At the national level, this is complicated by an institutional context in which policy and strategy development and implementation is shared between the Ministry of Health, Ministry of Water and Irrigation and Ministry of Environment and Natural Resources," (Health, 2016).

Figure 1:

Sanitation Policy and Planning Frameworks in Kenya (Rights, 2017)



Source: Rights (2023)

In Kenya, sanitation is regulated by legislation such as the Public Health Act 2012 (Cap 242, 126A), County Government Act 2012, Environmental Management and Coordination Act 2012, Water Act 2016, and the National Environmental Health and Sanitation Bill 2019. The Environmental Management and Coordination Act 2012 stipulates all pit emptiers must possess a waste authorization license and which prevents environmental pollution from unregulated desludging practices. Although the regulations on sanitation have been provided,

a study by Gitonga et al., (2021a) established that illegal “night soil men” indiscriminately dumped fecal sludge indiscriminately in rivers or in shallow hand-dug pits posing health risk. In Malawi, legislative antagonism exists in the implementation of policies on sanitation whereby Part 1, clause 37 section 1 and 2 of the Environmental Management Act (EMA) outlines the council is tasked with regulation of collection, transportation and disposal of fecal sludge. However, Public Health Act, under Clause 61 and Waterworks Act strips power the council in oversighting the health risk from fecal sludge from the trade premises and the limited the mandate of Water Boards in handling the waste water management (Nyirenda & Holm, 2015a).This research therefore, sought to investigate the gap in policy framework in delivery of sanitation services in Kenya context.

In Kenya, strategy and policy development for the sector is handled by different actors at the national level. The Ministry of Health is in charge of the entire sanitation portfolio, although rural sanitation is its major role (A. Peal et al., 2013). The Ministry of Water and Irrigation is the primary agency in charge of developing strategies and policies for urban water and sewerage, Water and Sanitation for the Urban Poor, as well as investment planning (van Welie et al., 2018a). The National Environmental Management Authority, under the Ministry of Environment and Natural Resources, is in charge of environmental regulation (Mansour et al., 2017b). Despite the division of responsibilities significant overlap exists between the state agencies, leading to a network of cartel who limited access to water supply and toilet use (Mallory et al., 2021b; Williams, 2021a).

While the division of responsibility of sanitation actors has brought benefits, there exist limited research on the power dynamics of these institutions and cartels. Therefore, more

studies were needed to better understand the implications of this institutional fragmentation on the provision of basic sanitation services.

Policies are important in regulating and controlling the fecal sludge management chain. A case study in Dhaka, Bangladesh reiterated that public policy on FSM services is in severe shortage, which has caused many challenges such as missing the FSM framework, and latrines discharging fecal sludge to drains (Scott, Ross, & Hawkins, 2016a). OneWASH National Program was incorporated into the Integrated Urban Sanitation and Hygiene Strategy in Ethiopia, which indicates that FSM is a priority. As for Dar es Salaam where the majority of the onsite facilities are toilets, the municipal bylaws regulate the FS (Scott, Ross, & Blackett, 2016). However, in Kenya and Haiti, policies are unclear and fail to incentivize the use and sale of fertilizer (Moya et al., 2019). Similarly, the urban sanitation situational analysis in Nairobi by Mansour et al. (2017a) in Kenya, affirmed that sanitation policy frameworks are fragmented.

In Malawi, Nyirenda & Holm, (2015b) indicated that little was done in formulating policy to inform the stakeholders charged with ensuring that the fecal sludge management service chain is provided. The legislative antagonism existed in the FSM services between the public health Act and National Environmental Act (Nyirenda & Holm, 2015b). However, Mansour et al. (2017a), asserted that sanitation frameworks exist with diverse service provision models, but significant overlap and fragmentation of roles exist between the ministry of water and the ministry of health. The Kenya Environmental Sanitation and Hygiene Strategic Framework (KESSF) 2016-2020 formulated by the ministry of health envisages the roadmap for improved urban sanitation sustainability. However, fecal sludge

management in Kenya is disregarded within the legislative and frameworks and is less likely to be operationalized in the plans of government (Nyirenda & Holm, 2015a).

The uneven power distribution (power imbalance) through policy negotiation procedures impacts the effectiveness of policy. In Senegal, the allocation of the budget to sanitation is prevented by competing for investment priorities such as road networks in Dakar and challenges at the planning, capture, clientelism, and exclusion at the FSM policy level (World Bank, 2016). In Rwanda, skilled and qualified professionals and particularly in the lower levels of government are scarce (Tsinda et al., 2021b).

2.6 Theoretical Framework

This study adopted the theoretical framework based on the Department for International Development's comprehensive approach to understanding the multifaceted factors affecting service provision, as outlined in the 2009 framework (Harris et al., 2011). The Department for International Development's framework emphasizes the complex interplay of social, political, technological, and economic factors that either hinder or facilitate the delivery of services (Harris et al., 2011b; Mallory et al., 2021b; Tsinda et al., 2021b).

The analysis was guided by the Department for International Development's Political Economy Analysis framework, and which included macro-level tools, sectoral-level tools, and problem-focused tools. Macro-level analysis explores the national-level dynamics, considering the roles of formal and informal actors and their interactions within the broader social and economic context that influence sanitation provision. Sectoral-level analysis tool delves into the relationships among various actors, both formal and informal, and the institutions governing sanitation services. It identifies their responsibilities, roles,

motivations, and incentives, while also uncovering how these actors influence the policy-making process.

Department for International Development's (DID) Drivers of Change (DoC) tool assists in analysing agents, institutions, and structures at different levels to identify key drivers of change within the sanitation delivery system (Harris et al., 2011). The study adopted the DoC framework since it provided the tools of analysing the role of institutions, power structures, formality and informality of service provision, and agents which influenced the sanitation provision.

2.7 Conceptual Framework

The conceptual framework in figure 2.2, illustrates the relationships among independent variables, intervening variables, and dependent variables that collectively influence sanitation delivery in Mukuru Kwa Reuben.

2.7.1 Independent variables

The technology, role of actors and policy and practice are the independent variables of the study. The technology will include the various types and options available for fecal sludge management, providers of technologies, operation methods, and maintenance practices. The role of actors will involve examining the active participation and influence of various stakeholders, including demand and supply dynamics, regulatory bodies, coordination mechanisms, and financial institutions. Whereas for policy & practice, it will involve the examination of formulation, framework, and implementation of sanitation policies and practices at both formal and informal levels.

2.7.2 Intervening variables

The intervening variables of the study includes the political will, access to capital, capacity of actor, and regulatory framework. The political will encompass degree of commitment and support from governmental and non-governmental actors to improve sanitation services. The access to capital entails examining the availability of financial resources that can be directed towards development and maintenance of sanitation infrastructure. The capacity of actors will encompass examining the ability of various actors, including governmental bodies and community organizations, to execute their roles effectively. While the regulatory framework will establish the rules and regulations governing sanitation service provision and enforcement.

2.7.3 Dependent variables

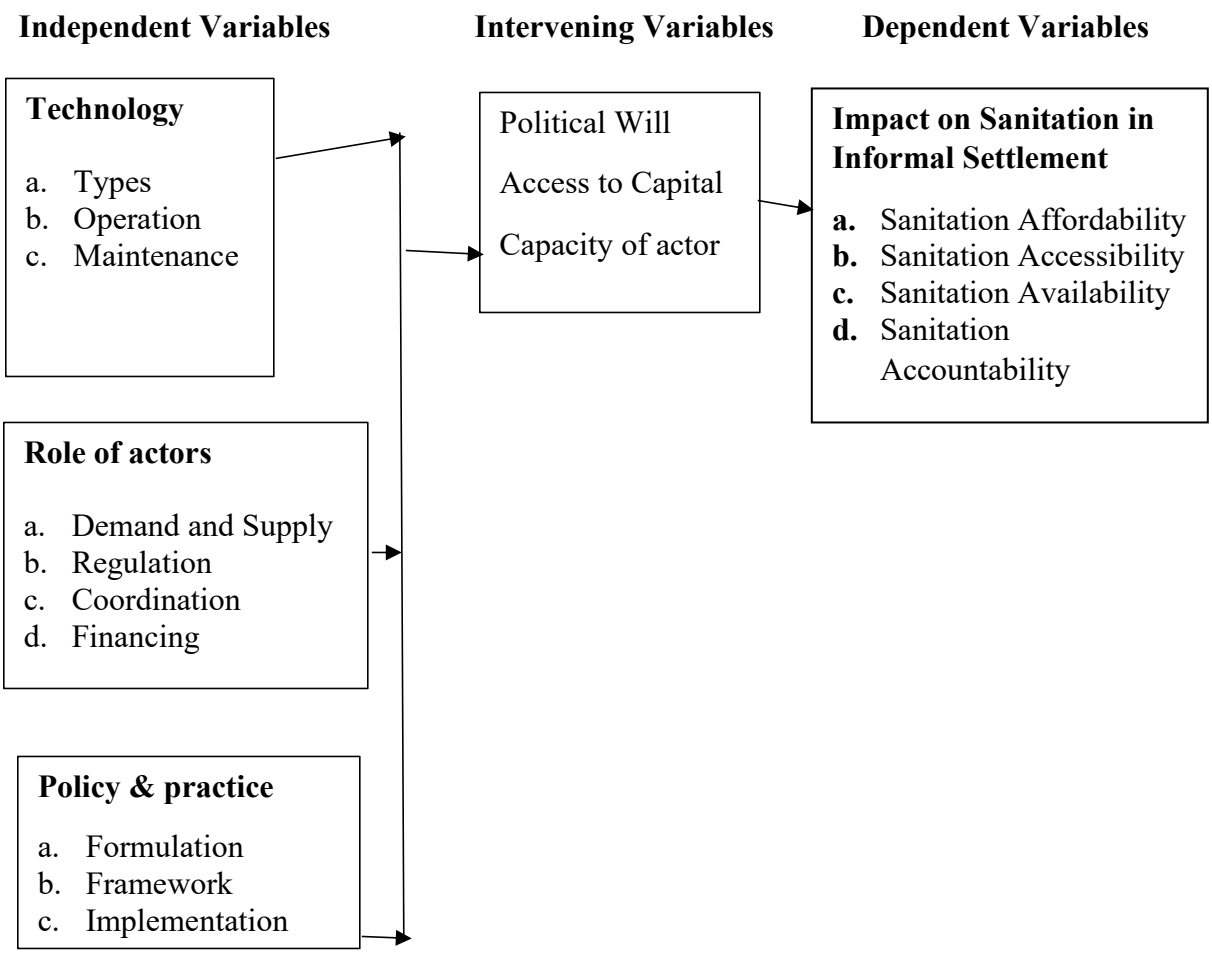
The dependent variables of the study included examining affordability, accessibility, availability and accountability of sanitation services for the population. The sanitation affordability included the cost-related factors that affect the affordability of sanitation services. The sanitation accessibility detailed the physical accessibility of sanitation facilities to the community, considering factors like proximity, safety and infrastructure. The sanitation availability investigated the overall availability of sanitation infrastructure. While the sanitation accountability entailed the mechanisms in place to ensure accountability in sanitation service provision.

The framework aimed to provide a comprehensive understanding of the political economy of sanitation delivery in informal settlements. It emphasized the interconnectedness of various factors and their impact on the overall sanitation situation in Mukuru Kwa Reuben. The overall effectiveness and efficiency of sanitation services in informal settlements in

Mukuru Kwa Reuben, including aspects of affordability, accessibility, availability, and accountability.

Figure 2:

Conceptual Framework



Source: Researcher (2023)

2.8 Research Gap

Despite the numerous studies reviewed and interventions on sanitation in the informal settlements, there was a glaring gap in understanding the how political economy influenced sanitation delivery. The studies reviewed primarily focused on sanitation technology solutions and the role of formal actors, however there was a limited concentration on the

nexus between political, economic, and social factors. This study therefore, aimed to fill this gap by examining how political economy influences the availability, accessibility, affordability, and accountability of sanitation services and technologies in Mukuru Kwa Reuben. Moreover, the study evaluated the gaps between policy and practice, which had not been adequately addressed in previous studies.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This section captures the study area, research design, study population, determination of sample size and sampling techniques, and data collection and analysis used.

3.2 Study Area

The study was conducted in Mukuru Kwa Reuben with 16 administrative villages of Paradise, Gatope, Railway, Bins, Diamond, Simba Cool, Wesinya, Mombasa, Kosovo, Jamaica, Lunga Lunga, Sanai, Reuben Kijiji Mpya, Feed the Children, Rurie, and Falcon. This study site was chosen due to the fecal sludge management (FSM) challenges yet there have been innovative sanitation technologies piloted in the informal settlement (Mansour et al., 2017; van Welie et al., 2018).The informal settlement is located in Embakasi East Constituency, East of Nairobi. Mukuru Kwa Reuben is one of the Mukuru slums and is located adjacent to the industrial area of Nairobi city. The Mukuru Kwa Ruben informal settlement developed in the 1980s and 1990s after independence in Nairobi's Industrial area, as people began to build makeshift dwellings surrounding the factories where people worked. The people are living in corrugated iron shacks averaging 10 × 10 feet (African Population and Health Research Center (APHRC), 2014).

Mukuru Kwa Reuben was chosen as the study location due to its status as one of the Nairobi's second largest informal settlements, with significant sanitation challenges. Mukuru Kwa Reuben has been the focus of various innovative sanitation interventions such as container-based sanitation provided by Sanergy, however, these technologies are not efficiently being upscaled. Therefore, the study location was chosen to study sanitation delivery through the political economy lens. Moreover, the settlement's complex land tenure

issues, lack of formal infrastructure, high population density Mallory et al, (2022), provided a rich context for understanding the political economy for sanitation service delivery.

3.3 Research Design

The study utilized a convergent research design, employing a mixed-methods approach which integrate both qualitative and quantitative data collection methodologies (Creswell, 2014; Doyle et al., 2016a). Descriptive survey design was used to collect quantitative data. The descriptive survey design used questionnaires and structured observation guide in the household. Questionnaires and structured observation were used to gather data on sanitation service and technology access, affordability and sustainability. The qualitative data approaches employed key informant interviews, and Focus Group discussions (FGD), with the stakeholders in the fecal sludge management (FSM) service chain was used to gain a better understanding of the social, political and economic factors that influenced sanitation delivery.

The mixed-methods approach combines the strengths of both quantitative and qualitative research. It offered a more holistic perspective on the complex dynamics surrounding sanitation (Creswell, 2014; Doyle et al., 2016b). It ensured a robust exploration of not only the measurable aspects of sanitation but also the contextual factors that contribute to a deeper understanding of the political economy of sanitation delivery (Sclar et al., 2022b).

3.4 Study Population

As per KNBS (2019), Mukuru Kwa Rueben had a total population of 65,691, with 36,402 men, and 29,288 women who inhabited 26,699 households. The unit of analysis for the survey was the household level, with a focus on household heads as the primary respondents. The target population included household heads and the key stakeholders. 100 households

and 52 key stakeholders which included public health officers, non-governmental organization representatives, landlords, and manual and mechanical fecal sludge operators, were selected.

The study population was heterogeneous comprising of the stakeholders involved in the sanitation delivery. The heterogeneous population has variability, dissimilarities, and diversity in the elements under study (Saunders et al., 2018). The target population comprised of stakeholders involved in containment, emptying, transportation/conveyance, treatment, and end-use/disposal in ten purposively selected villages. The villages included Railway, Diamond, Simba Cool, Wesinya, Mombasa, Kosovo, Reuben Kijiji Mpya, Feed the Children, Rurie, and Riverside. The key informants comprising of service providers, landlords, city authorities, regulators, private enterprises, and non-governmental organizations (NGOs) were interviewed.

3.5 Determination of Sample Size and Sampling Techniques

In this section, the researcher determined the method of computing sample size, calculated the sample size and discussed the sampling technique.

3.5.1 Determination of Sample Size

The computation of sample size followed the Yamane's (1967) formula. A 10% margin of error corresponds approximately to a 90% confidence level, which is commonly accepted in exploratory and mixed-method studies where qualitative validation strengthens the finding. The margin of 10% conform with Eliud *et al*. (2023) study which also triangulated the finding with qualitative and quantitative findings. The sample size was calculated using the formula:

$$n = N / (1 + N (e^2)) \quad (1)$$

Where;

n = Sample size

N = Population size = 26,699

e = Margin of error = 0.1

$$n=\frac{26,699}{1+26,699x0.1^{2}}$$

$$n = 100$$

The sample size for the study was 100 households' respondents, plus 52 respondents from the key informant and the focus groups interviewed

The total sample size was 100 + 52 = 152.

The required sample size for each of the focus group discussion and Key informant interviews was informed by the saturation point where there was no new emerging theme (Saunders et al., 2018). A total of 52 respondents was achieved for the stakeholders after arriving at thematic saturation where no new themes were emerging and that is where the interviews and focus group discussion was stopped. However, the maximum number of participants for each focus group discussion and Key informant interviews was based on Ray's (1994) (8-12) participants and Smith, Flowers & Larkin's (2009) (3-10) participants. The table 3.1 shows the sample size of the key stakeholders that informed the focus group discussion and Key informant interview in the study as per the (Ray's, 1994) and (Smith, Flowers & Larkin's, 2009) estimated sample size formula.

Table 1:

Sample size of interviewees

Stakeholders	Number of interviewees
Public Health Officer	1
NEMA officials	4
NGO employees	3
Sanitation enterprises Employees	4
Manual fecal sludge operators	12
Nairobi Water and Sewerage Company employees	3
Ministry of Water Employee	1
Mechanical fecal sludge operators	12
The Landlords	12

Source: Researcher (2023)

3.5.2 Sampling Techniques

The sampling techniques used in this study included snowballing, cluster random sampling and purposive sampling. The study utilized a cluster and simple random sampling to select participants from ten administrative villages purposively chosen since it had received sanitation interventions but upscaling was challenging in Mukuru Kwa Reuben (Mara & Evans, 2018b). The study utilized cluster random sampling due to the nature of the households which existed in clusters (Devaraj et al., 2021a). There was a total of 100 households sampled from the ten village proportionately. The ten villages were treated as clusters, and a simple random selection was made within each cluster to sample the household heads as captured in Table 2. To enroll the key informants, the study used snowballing and purposeful sampling techniques. The snowballing technique was used to select 12 pit emptiers and the 12 landlords from the ten clusters. The snowballing technique

was used due to the unique and difficult traits of pit emptier and landlords were difficult to be traced as some feared due to the illegality of their land tenures and nature of their work (Mallory et al., 2021c, 2021b; Mansour et al., 2017b). Purposeful sampling was used for the representatives from the public health department, water utility, NGO, Nairobi Water, and Sewerage Company, NEMA, fecal sludge operators, Ministry of Water, Sanitation, and Irrigation. The purposeful sampling was used since the key informants had skills and knowledge in fecal sludge management and which was important for the study (Zheng et al., 2012).

Table 2:

Sampling Frame for Quantitative Data

Clusters (villages)	**Households (N)**	**Sample Size (n)**
Kosovo	2,136	8
Diamond	4,538	17
Mombasa Zone	2,670	10
Simba cool	3,204	12
Gateway	4,272	16
Rurie	1,602	6
Railway	1,602	6
Feed the Children	2,937	11
Riverside	1,602	6
Transformer	2,136	8
Total	26,699	100

Source: KNBS (2019).

3.6 Eligibility Criteria

This section details the criteria used in the inclusion and exclusion of the participants in the study.

3.6.1 Inclusion Criteria

People aged 18 years and above and who had lived for more than five years in the ten villages of Mukuru Kwa Reuben were included in the study.

3.6.2 Exclusion Criteria

People aged 18 years and above and who had not lived for more than five years in the ten villages of Mukuru Kwa Reuben were excluded in the study.

3.7 Research Instruments

This section tabulates the research instruments and methods used in the study.

Table 3:

Research Instruments

Research method	Data collection instrument
Key informant interview	Interview guide, sound recorder
Observation	Structured observation guide
Focus group discussion (FGD)	FGD guide, sound recorder
Household Survey	Questionnaire

Source: Researcher (2023)

Table 3 shows the data collection tools and instruments that were used in brief in the study.

3.7.1 Piloting

The pilot study assessed the comprehensiveness and clarity of the research tools. It aimed to identify any logistical challenges in data collection and ensured the validity and reliability of the research tools. The researcher piloted the research instruments with 10 respondents in Mukuru Kwa Reuben before enumerating the other study participants. The pilot study recruited 10 respondents to make sure that the research instruments were tested on a small but representative sample. It was chosen since it was sufficient to show any major issues

with the questionnaire while keeping the pilot study manageable within the available resources. The feedback from the pilot study was used to refine the questionnaire before the main data collection. After piloting, the questionnaire was found to be well structured and comprehensive. However, minor adjustments were made to improve relevance and clarity. The Cronbach's Alpha reliability coefficient was 0.62, indicating moderate internal consistency.

3.7.2 Validity and Reliability

To ensure validity of research instruments, the researcher involved WASH specialist who reviewed the research tools. To examine the reliability of the instruments, the investigator used Cronbach's Alpha formula with 10 respondents and coefficient of 0.62 was achieved. The questions were categorized into sections A, B, C, and D. Section A on demographics detailed the basic information about respondents and included gender, age, level of education, religion, employment status, and residence.

The section provided context for understanding the socio-economic and demographic background of the respondents. Section B on technology focused on the types of sanitation technologies, construction and installation, operation and maintenance, their accessibility, affordability, and availability. The section aimed to understand the types of sanitation technologies in the study area. Section C on the role of actors investigated the roles of formal and informal actors in sanitation delivery, and included demand and supply, regulation, coordination, and financing. The section identifies the key stakeholders and their influence on sanitation services. Section D on policy and practice evaluated the gaps between policy and practice in sanitation delivery and examined the implementation of

sanitation policies. This section highlights the discrepancies between policy frameworks and the realities on the ground.

The questionnaire was then distributed to 20 respondents of the target population. The responses were then entered, coded and analyzed using the Cronbach's Alpha in SPSS to measure the internal consistency of the questionnaire items within each section. The analysis resulted in a reliability coefficient of 0.62 for the entire questionnaire, indicating moderate reliability in measuring the constructs. The Cronbach's Alpha value of 0.62 suggests a moderate level of internal consistency among the items in the questionnaire sections. If necessary, future iterations of the questionnaire might involve revisiting certain items or sections that contribute less to the overall reliability score. As per Daud et al. (2018), the Alpha Cronbach's value between 0.60 to 0.70 is considered moderate and acceptable, and also triangulation was used to complement the quantitative data.

Qualitative data obtained from key informant interviews (KIIs) and focus group discussions (FGDs) validated the quantitative findings. Thematic analysis was carried out on the qualitative data to pinpoint the recurring patterns and themes. The themes were then compared with the quantitative results to ensure reliability and consistency. Qualitative findings on the role of landlords in sanitation provision for example, were cross-checked with quantitative data on maintenance and toilet ownership and which validated the quantitative findings.

3.8 Data Collection Techniques

The study used both primary and secondary data to answer the research question. The data collection tools were first pre-tested to understand if the study questions were well understood. The primary data was collected by holding a questionnaire, focus group

discussion, key informant interviews, and structured observation. The focus group discussion was suited to participants who are not willing to give information and are not easily reachable through interviews (Simiyu et al., 2021c).The questionnaire was administered to the household heads. The focus group discussion was held with the mechanical pit emptiers, the landlords, and the manual pit emptiers. The FGD was conducted with a moderator and a team leader who ensured a sound recorder was used.

The work of the moderator was to guide the process of discussion while ensuring a sound recorder was used to record the FGD. The team leader was responsible for solving any problem and clarifying any questions or issues to maintain the quality of the data. The structured observation complemented the FGD to collect the data from mechanical pit emptiers, the landlords, and manual pit emptiers.

The key informant interviews were carried out with representatives from the public health department, water utility, NGO, Nairobi Water, and Sewerage Company, NEMA, and Ministry of water, sanitation, and irrigation. The secondary data was collected by reviewing published documents, government policies, reports, and legislation. The Kenya Environmental Sanitation and Hygiene Policy (KESHP) (2016 – 2020), and Kenya Environmental Sanitation and Hygiene Strategic Framework (KESSF) (2016 – 2020) was used in the study (Health, 2016; Kenya Environmental Sanitation and Hygiene Policy, 2016). The FGD and Key informant interview questions used are captured in the appendices.

3.9 Data Analysis

Quantitative data was analyzed using SPSS software version 25. The data were analyzed using descriptive and inferential statistics at 95% confidence interval. Before undertaking the regression analysis, Pearson correlation analysis was carried out to assess the direction

and strength of associations between the independent and dependent variables. The correlation analysis identified the potential multicollinearity and informed the model specification.

Given the panel structure of the data, panel regression analysis was commissioned and determined the relationship between the dependent and independent variables. Multiple regression analysis was employed to assess the relationship between the dependent variables; affordability, accessibility, availability, and accountability of sanitation services and the independent variables.The diagnostic tests of normality, multicollinearity and homoscedasticity before carrying out regression analysis. The multicollinearity was tested using the Variance Inflation Factor (VIF)), normality of residuals evaluated Kolmogorov-Smirnov and Shapiro-Wilk test), and homoscedasticity assessed using the Breusch-Pagan test). Four panel regression models were estimated and each corresponded to the four dependent variables. The multiple regression model applied was structured as follows:

$$\text{Acessibility} = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + .. + \beta nXn + \varepsilon \quad (2)$$

$$\text{Availability} = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + .. + \beta nXn + \varepsilon \quad (3)$$

$$\text{Affordability} = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + .. + \beta nXn + \varepsilon \quad (4)$$

$$\text{Accountability} = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 .. + \beta nXn + \varepsilon \quad (5)$$

β1, β2, β3 and βn are the slopes or coefficients associated with the independent variables X1, X2, X3, ..., Xn, while β0 is the constant term or intercept. The term (ε) in the equation represented the error term, signifying the difference between the predicted and observed values of the dependent variable. It encompassed all unexplained factors influencing the dependent variables that were not accounted for by the included independent variables. The indicators included usability, costs, access and coverage, availability and affordability.

To complement the interpretation of quantitative data, qualitative analytical approach was used. Thematic analysis is a qualitative approach to collecting and analyzing themes with patterned meaning or response (Creswell, 2014; Taherdoost, 2018).The data from the focus group discussion, structured observation guides, and key informant interviews were analysed thematically in NVivo version 12 and IBM version 24 SPSS software. Data analysis began during and after the data collection process. The researcher reviewed the data by listening to the recordings immediately after the fieldwork. The recorded data from the key informant interviews and focus group discussion were transcribed into the Microsoft word. The transcripts in Kiswahili were translated into English and errors cross-checked. The structured observation guides were compiled and transcribed using NVivo 12. The transcripts were assigned a unique identifier to facilitate informed analysis and enhance anonymity. The transcripts were coded and analyzed using the NVivo 12 software. The study used the guidelines and procedures established by (Creswell, 2014) to analyze the data. The six steps of the thematic analysis of data familiarization, coding, producing themes, reviewing themes, defining themes, naming themes, and writing up were used for analysis in the study.

3.10 Ethical Consideration

Ethical approvals were sought from Meru University Institutional Research Ethics Review Committee (MIRERC). Permission from the community, sub-county, and county authorities were obtained before beginning the study activities. Participants were briefed on the methods, purpose, and how the study findings will be utilized. The participants were informed that their participation was voluntary, the duration of their participation being 30 minutes, procedures, benefits and risks, right to withdraw at any point in the study was

explained. They were also allowed to sign the consent form voluntarily and were availed with the duplicate and signed copy. The transcripts, photos, and recordings captured were stored in a computer and devices protected with passwords and fingerprints which ensured data collected were kept confidential and secure and whereby only authorized personnel had access to the data. The participants were also briefed that data was published anonymously in journals.

3.11 Operational Definition of Variables

This section captures how the variables of the study were measured. Table 4, 5 and 6 details how the three variables were measured using the indicators and the scale of measurement and analysis used.

Table 4

Operational Definition of Variable (Technology)

Variable	Type of Variable	Indicators	Means of Measuring	Measurement Scale	Data Analysis
Sanitation Technology	Independent	Type of Toilets	Frequency Count Proportion	Nominal	Frequency Distribution, Pearson correlation Analysis, ANOVA, Multiple regression analysis (stepwise)
Sanitation Technology	Independent	Construction Process	Frequency Distribution, Likert Scale	Ordinal	Frequency Distribution, Pearson correlation Analysis, ANOVA, Multiple regression analysis (stepwise)
Sanitation Technology	Independent	Type of Sludge Emptying and Transportation	Frequency Count Proportion	Nominal	Frequency Distribution, Pearson correlation Analysis, ANOVA, Multiple regression analysis (stepwise)
Sanitation Technology	Independent	Accessibility of Sanitation Tech.	Frequency Count, Likert Scale	Ordinal	Frequency Distribution, Pearson correlation Analysis, ANOVA, Multiple regression analysis (stepwise)
Sanitation Technology	Independent	Availability of Sanitation Tech.	Frequency Count	Nominal	Frequency Distribution, Pearson correlation Analysis, ANOVA, Multiple regression analysis (stepwise)
Sanitation Technology	Independent	Affordability of Sanitation Tech.	Frequency Count, Likert Scale	Ordinal	Frequency Distribution, Pearson correlation Analysis, ANOVA, Multiple regression analysis (stepwise)

Source: Researcher (2023)

Table 5:

Operational Definition of Variables (Role of Actors and Policy and Practice)

Variable	Type of Variable	Indicators	Means of Measuring	Measurement Scale	Data Analysis
Role of Actors	Independent	cost, subsidies, PPPs, fiscal decentralization, revenue, financial products, budgetary allocations, incentives, coordination, accountability, affordability, accessibility	Policy document (KESHP) & (KESSF) Frequency Count (survey)	Nominal, Ordinal, Themes	Frequency Distribution, Pearson Correlation Analysis, Thematic analysis, Multiple regression analysis (stepwise)
Policy and Practice	Independent	User fees, Cost, Subsidies, PPPs, Regulatory framework, Implementation, accountability, affordability, accessibility,	(KESHP), Frequency Count (survey), Policy document; (KESHP) & (KESSF)	Ordinal Nominal Themes	Thematic analysis, Pearson correlation Analysis,

Source: Researcher (2023)

Table 6:

Operational Definition of Variables (Dependent)

Variable	Type of Variable	Indicators	Means of Measuring	Measurement Scale	Data Analysis
Sanitation Affordability	Dependent	Subsidies, cost, PPPs, fiscal decentralization, revenue, financial products, budgetary allocations, incentives, Investment	Frequency Count (survey) Policy document,	Nominal, Ordinal, Themes	Frequency Distribution, Pearson Correlation Analysis, Thematic analysis,
Sanitation Availability	Dependent	Types/options, coverage, financial products, budgetary allocations, incentives	Policy documents, Frequency Count	Ordinal Nominal Themes	Thematic analysis, Pearson correlation Analysis,
Sanitation Accessibility	Dependent	User Fees, Costs, Quality, Distance to Facilities, Coverage, Maintenance	Policy document, Frequency Count	Ordinal Nominal Themes	Thematic analysis, Pearson correlation Analysis,
Sanitation Accountability	Dependent	Coverage, quality, Coordination, Regulatory Framework, Government Commitment	Policy document, Frequency Count	Ordinal Nominal Themes	Thematic analysis, Pearson correlation Analysis,

Source: Researcher (2023)

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This section captures the findings and discussion. This chapter discussed the response rate from questionnaire, respondent's demographics, and findings on the technologies/options, role of formal and informal actors, and gap between policy and practice in sanitation delivery.

4.2 Questionnaire Return Rate

The data was obtained after administering 100 questionnaires to the heads of households, out of which a total of 100 responses were received and which gave a response rate of 100%.

4.3 Demographic Information of Respondents

Tables present the demographic statistics of the respondent such as gender, age, education levels, religion, employment status and residency of the respondents interviewed.

4.3.1 Respondents' Gender

This section presents the findings on the role of gender in sanitation delivery.

Table 7:

Respondents' Gender

Gender	Frequency	Percentage
Female	43	43.0
Male	57	57.0
Total	100	100.0

Source: Researcher (2023)

The table 7 show the gender of the respondents whereby out of the 100 respondents the majority 57.0% were male while 43.0% were female. This delineates the gender variation in the decision making of sanitation services. You et al. (2020) found disparities in Pee Power

Toilet usage as girls reported safety and security issue, signifying failure to involve them during the construction.

Table 8:

Respondents Age

Age	Frequency	Percentage
18-25	24	24.0
26-35	33	33.0
36-45	18	18.0
46-55	15	15.0
56-65	10	10.0
Total	**100**	**100.0**

Source: Researcher (2023)

The Table 8 shows the frequency and proportion of the respondent. The majority of the respondents were within the age bracket of (26-35) 33.0%, while 10.0% were between 56-65 years. It is evident that respondents were within the middle age bracket in concurrence with Alelah, (2017) who found 59% of respondents were within 31-40 years age bracket.

Table 9:

Level of education

Level	Frequency	Percent
No education	4	4.0
Primary	16	16.0
Secondary	60	60.0
Tertiary	20	20.0
Total	**100**	**100.0**

Source: Researcher (2023)

The finding on the level of education shows the majority 60.0% of the respondents had secondary education, and only 4.0% had no formal education. The finding conforms with Alelah, (2017) who found that 54.1% of respondents had secondary level of education in

Rhonda Slums, Nakuru. In support of the findings, Corburn et al. (2017) found the average age of people in Mukuru was 27 years.

Table 10:

Religion

Religion	Frequency	Percentage
Christian	91	91.0
Muslim	9	9.0
Total	100	100.0

Source: Researcher (2023)

The majority of respondents (91.0%) were Christians, while a smaller proportion of 9.0% were Muslims. In agreement, Corburn et al. (2017) findings indicate 95% of the population were Christians and 2% Muslims.

Table 11:

Employment Status

Employed	Frequency	Percentage
Yes	41	41.0
No	59	59.0
Total	100	100.0

Source: Researcher (2023)

The majority of the respondents 59% were not employed while 41.0% were employed.

Table 12:

Employment Status

Residence	Frequency	Percentage
Kosovo	8	8.0
Diamond	17	17.0
Mombasa Zone	10	10.0
Simba cool	12	12.0
Gateway	16	16.0
Rurie	6	6.0
Railway	6	6.0
Feed the Children	11	11.0
Riverside	6	6.0
Transformer	8	8.0
Total	100	100.0

Source: Researcher (2023)

In terms of residence of the respondents, there were 11.0% from Feed the Children, Riverside 6%, Mombasa Zone 10%, Rurie 6%, Railway 6%, Kosovo 8%, Diamond 17%, Simba cool 12%, Gateway 16%, and Transformer 8%.

4.4 Technologies for Sanitation Delivery

4.4.1 Descriptive Analysis

This section presents the descriptive results which established the type of sanitation technology used for sanitation delivery in Mukuru Kwa Reuben.

Table 13:

Type of Sanitation Technology and Options

Type of Sanitation Technology and Options	Frequency	Percentage
Containment Options		
No toilet	15	15.0
Container-Based Sanitation	18	18.0
Pour Flush	13	13.0
Pit Latrine	40	40.0
Cistern Flush	12	12.0
Composting	2	2.0
Excreta Emptying and Transportation		
Buckets	34	34.0
Hand Cart	30	30.0
Trucks	24	24.0
Sewers	12	12.0
Excreta Treatment and Disposal		
Open Ground	39	39.0
Septic Tanks	18	18.0
Landfills	10	10.0
Treatment plant	17	17.0
Rivers	16	16.0

Source: Researcher (2023)

Table 13 lists the types of toilets, along with available technologies and methods for managing fecal sludge. The majority 40% of respondents reported using a pit latrine, when compared to just 2.0% who used a composting toilet. The findings are consistent with studies by Scott et al., (2016) and Simiyu et al. (2021a) who found that pit latrines were amongst the most popular type of onsite sanitation options in informal settlements since they were cheap and easy to maintain. However, as per Corburn et al. (2017) , only 1% of Mukuru residents had home toilet while the majority used yard-shared toilet.

The table also shows the method used for emptying and transporting the excreta/sludge. Notably, 34.0% of respondents reported using buckets, while only 12.0% relied on sewer systems. It is apparent there is a lower sanitation coverage in Mukuru against the SDG target 6.2 which calls for safely managed sanitation. McFarlane and Silver (2017) established the

politicization of the human waste which is linked to urban politics of blockage, sabotage, historical and racialized segregation, and entitlement of sanitation services and infrastructure. A study in Cape Town by Russel et al. (2019a) found that emptying and transportation service was funded by the Municipal government which contracted private providers to conduct the services.

Table moreover captures the excreta/sludge treatment/disposal practices whereby the majority of the respondents 39% reported they desludged in open grounds, 16 % in rivers, and 10 % disposed to landfills. The majority of the respondents were not treating and disposing the excreta/sludge using the correct ways. The unsafe practices are explained by Russel et al. (2019b), who found fecal sludge desludging services were done by unskilled people with inadequate personal protective equipment.

Table 14:

The Providers of Sanitation Technology

Providers	Frequency	Percentage
County Government	5	5.0
Private companies	28	28.0
Non-governmental Organization	12	12.0
Community-based Organization	8	8.0
Landlord	47	47.0
Total	100	100.0

Source: Researcher (2023)

In Table 14, the majority of the respondents 47% indicated the landlords as the providers of the sanitation technology, whereas only 5% mentioned County government. The findings illustrate the limited role of the County government commitment in the provision of sanitation technology. This resonates with findings by Abeysuriya et al. (2019); Dixon (2018); Mallory et al. (2021a); Ofori et al. (2021) who found political constraints, technical obstacles and insecure land tenures was preventing service provisions in informal

settlements. Corburn et al. (2017) indicated Mukuru Slums were not adequately integrated into the Nairobi Integrated Urban Development Master Plan, which segregated the informal settlement from service provision.

Table 15:

Maintenance and Operation

Sanitation facilities are maintained	Frequency	Percentage
Strongly Agree	7	7.0
Agree	20	20.0
Neutral	13	13.0
Disagree	28	28.0
Strongly Disagree	32	32.0
Total	100	100.0

Source: Researcher (2023)

The respondents in 15 rated the maintenance and operation of sanitation technologies. The majority 32.0% strongly disagreed with the statement while only 7% strongly agreeing. The findings illustrate the limited maintenance and operation plan of sanitation facilities. This conforms with findings by Peal et al. (2013) who found the majority of septic tanks were not water-tight, and only 9.1% were plastered in Panchayat, India.

Table 16:

Who Determined the Siting of toilet

Who determined the toilet site	Frequency	Percentage
Landlord	68	68.0
Caretaker	6	6.0
Nyumba Kumi Leader	3	3.0
Chief	8	8.0
Service Provider	10	10.0
Public Health Officer	3	3.0
Users	2	2.0
Total	100	100.0

Source: Researcher (2023)

In Table 16, the majority of respondents 68.0% attributed the siting of toilet to landlords, with only 2.0% indicating the user's involvement in the decision. It is clear that landlords have power to make decisions on where to site the toilets.

Table 17:

Construction/installation Process

Ease of installation	Frequency	Percentage
Very easy	20	20.0
Easy	37	37.0
Not easy	37	37.0
Not very Easy	6	6.0
Total	100	100.0

Source: Researcher (2023)

Table 17 presents the perceptions of respondents regarding the ease of construction and installation process of sanitation technologies. A significant proportion 37.0% indicated the process to be easy, while another 37.0% considered it not easy. The installation of onsite sanitation is politically difficult and is occasioned with some landlords having illegitimate land ownership (Russel et al., 2019b; Tilmans et al., 2015).The majority of landlords are unwilling to provide access to sanitation technologies due to the costs associated with such services (van Welie et al., 2018b). As per Mansour et al. (2017b), construction and installation of toilets in informal settlements is carried out by small and medium enterprises and Water Service Regulatory Board (WASREB) is not regulating them.

Table 18:

Accessibility to Sanitation

Ease of Access	Frequency	Percentage
Very Accessible	21	21.0
Moderately Accessible	22	22.0
Slightly Accessible	39	39.0
Not Accessible	18	18.0
Total	100	100.0

Source: Researcher (2023)

In Table 18, the respondents rated the accessibility of sanitation technologies where the majority 39.0%, indicated as slightly accessible, while 18.0% rated as not accessible. It is clear there was disparities in accessing sanitation facilities. Similarly, in Cap Haitien, Haiti, a study by Tilmans et al. (2015) established that 70% of residents living within the range of 100-220 meters used Container-Based Sanitation.

Table 19:

Accountability

Accountability of sanitation providers	Frequency	Percentage
Very Accountable	24	24.0
Moderately Accountable	22	22.0
Slightly Accountable	20	20.0
Not Accountable	34	34.0
Total	100	100.0

Source: Researcher (2023)

In Table 19, the findings show concerns regarding the accountability of sanitation service providers. The majority of the respondents 34.0% rated sanitation providers as not accountable, while 20.0% indicated slightly accountable. These findings raise concerns regarding the reliability and effectiveness of sanitation service providers in delivering sanitation services and technologies. In Nairobi, onsite sanitation facilities lacked efficient and effective management of fecal sludge and with only 5% of sewage being effectively

treated and 65% ending up in the environment (Mansour et al., 2017a). Further, poor accountability was studied by Roehrdanz et al. (2017) & Zaqout et al. (2020b) who found there were recurrent challenges in the Water Service Providers (WSP) operations.

Table 20:

Affordability

Affordability of sludge management services	Frequency	Percent
Very affordable	17	44.0
Moderately affordable	16	16.0
Slightly affordable	23	17.0
Not affordable	44	23.0
Total	100	100.0

Source: Researcher (2023)

Table 20 shows that the majority, 44% of respondents, considered sanitation services to be "not affordable," and only 16% considered it "moderately affordable." The limited affordability of the sanitation options and facilities was alarming. Genter et al. (2021) found that the high cost of USD 15/m³ of emptying and transportation led to emergence of private entrepreneurs and nonregulated manual emptiers. As per Mallory et al. (2021b) , pit emptiers were physically and institutionally outside the sanitation service delivery in Mukuru and Kibera informal settlements.

Table 21:

Cost of Emptying and Transportation

Cost emptying and transportation	Frequency	Percent
Very affordable	23	23.0
Moderately affordable	16	16.0
Slightly affordable	17	17.0
Not affordable	44	44.0
Total	100	100.0

Source: Researcher (2023)

Table 21 shows the respondents' perceptions on the cost of emptying and transporting excreta. The majority 44% rated not affordable, and only 16.0% indicated moderately affordable. It is evident that the majority of respondents rated sanitation services as not affordable in Mukuru. This is in agreement with (Tilmans et al., (2015b) who found that the high capital costs of $ 18,742, and collection and conveyance cost for household CBS at $ 22/ household/month for the Container Based Sanitation during the pilot phase.

4.4.2 Inferential Analysis

This section presents the inferential results which established the type of sanitation technology used for sanitation delivery along the service chain in Mukuru Kwa Reuben.

Analysis of Variance (ANOVA)

This section presents the results of the Analysis of Variance (ANOVA) which established the type of sanitation technology used for sanitation delivery along the service chain in Mukuru Kwa Reuben. It identifies the significant differences in sanitation outcomes across technology types.

Table 22:

ANOVA on Toilet Technology and its Accessibility, Affordability, Availability and Accountability

		Sum of Squares	df	Mean Square	F	Sig.
Accessibility Toilet	Between Groups	49.020	5	9.804	11.557	.000
	Within Groups	79.740	94	.848		
	Total	128.760	99			
Accountability Toilet	Between Groups	65.463	5	13.093	16.864	.000
	Within Groups	72.977	94	.776		
	Total	138.440	99			
Availability Toilet	Between Groups	5.094	5	1.019	8.330	.000
	Within Groups	11.496	94	.122		
	Total	16.590	99			
Affordability Toilet	Between Groups	67.711	5	13.542	15.585	.000
	Within Groups	81.679	94	.869		
	Total	149.390	99			

Source: Researcher (2023)

The ANOVA results in table 22 indicate a significant mean difference in accessibility, accountability, availability, and affordability of toilet technologies (F (5, 94) = 11.55, p = .000), (F (5, 94) = 16.86, p = .000), (F (5, 94) = 8.330, p = 0.000), and (F (5, 94) = 15.585, p = 0.000) respectively. The ANOVA outcomes and Post Hoc Test in table 4.20 reveals the type of toilet used influenced the accessibility, accountability, availability, and affordability of sanitation technologies and services. This is in agreement with findings by Genter et al. (2021) and Mansour et al. (2017) who found a glaring disparity in the accessibilities, availability, affordability and accountability of toilet facilities due to limited spaces, routes, insecure land tenures, ‘cartels’, political sabotage and limited governance structures in informal settlements.

Table 23:

Post Hoc Tests on Type of toilet

Dependent Variable	(I) Sanitation Technology	(J) Sanitation Technology	Mean Difference (I-J)	Std. Error	Sig.
Accessibility Sanitation Technologies and Services	No toilet	Fresh Life	2.386*	.663	.007
		Pour Flush	1.053	.685	.641
		Pit Latrine	1.412	.689	.322
		Cistern Flush	.333	.841	.999
		Composting	.500	.921	.994
	Fresh Life	No toilet	-2.386*	.663	.007
		Pour Flush	-1.333*	.244	.000
		Pit Latrine	-.974*	.255	.003
		Cistern Flush	-2.053*	.546	.004
		Composting	-1.886	.663	.059
	Pour Flush	No toilet	-1.053	.685	.641
		Fresh Life	1.333*	.244	.000
		Pit Latrine	.359	.307	.851
		Cistern Flush	-.719	.572	.807
		Composting	-.553	.685	.966
	Pit Latrine	No toilet	-1.412	.689	.322
		Fresh Life	.974*	.255	.003
		Pour Flush	-.359	.307	.851
		Cistern Flush	-1.078	.577	.427
		Composting	-.912	.689	.771
	Cistern Flush	No toilet	-.333	.841	.999
		Fresh Life	2.053*	.546	.004
		Pour Flush	.719	.572	.807
		Pit Latrine	1.078	.577	.427
		Composting	.167	.841	1.000
	Composting	No toilet	-.500	.921	.994
		Fresh Life	1.886	.663	.059
		Pour Flush	.553	.685	.966
		Pit Latrine	.912	.689	.771
		Cistern Flush	-.167	.841	1.000

Source: Researcher (2023)

The results in Table 23 indicate the mean difference between the type of toilet, along with the statistical significance. The significant mean difference was reported between people using fresh life, pour flush, cistern flush and those without toilet (p = 0.000, p = 0.000, p =

0.004, p = 0.007) respectively. However, there was no significant difference in composting toilet (p = 1.000). The findings show a significant mean difference in accessibilities of a specific type of toilet technologies as reported by (Genter et al., 2021), (Mansour et al., 2017) and (Ferguson et al., 2022).

Table 24:

Emptying and Transportation of Sludge/Excreta

		ANOVA Sum of Squares	df	Mean Square	F	Sig.
Accessibility Sanitation Technologies and Services	Between Groups	13.695	3	4.565	3.809	.013
	Within Groups	115.065	96	1.199		
	Total	128.760	99			
Accountability sanitation technologies and services	Between Groups	30.550	3	10.183	9.061	.000
	Within Groups	107.890	96	1.124		
	Total	138.440	99			
Availability Sanitation Technologies and Services	Between Groups	1.315	3	.438	2.754	.047
	Within Groups	15.275	96	.159		
	Total	16.590	99			
Affordability sanitation technologies and services	Between Groups	7.106	3	2.369	1.598	.195
	Within Groups	142.284	96	1.482		
	Total	149.390	99			

Source: Researcher (2023)

The results in table 24 indicate the significant mean difference in the accessibility (p=0.013), availability (p=0.047), and accountability (p=0.000) in the provision of sanitation technologies for emptying and transportation of sludge/excreta. However, there was no significant difference in the affordability of sanitation technologies and services (p = 0l.195).

Table 25:

Post Hoc Test on Emptying and Transportation of Excreta/Sludge

Dependent Variable	(I) Emptying and Transportation of Excreta/sludge	(J) Emptying and Transportation of Excreta/sludge	Mean Difference (I-J)	Std. Error	Sig.
Accessibility Sanitation Technologies and Services	Buckets	Hand Cart	.486	.274	.293
		Trucks	.436	.292	.445
		Sewers	-.647	.368	.299
	Hand Cart	Buckets	-.486	.274	.293
		Trucks	-.050	.300	.998
		Sewers	-1.133*	.374	.016
	Trucks	Buckets	-.436	.292	.445
		Hand Cart	.050	.300	.998
		Sewers	-1.083*	.387	.031
	Sewers	Buckets	.647	.368	.299
		Hand Cart	1.133*	.374	.016
		Trucks	1.083*	.387	.031
Accountability sanitation technologies and services	Buckets	Hand Cart	.814*	.266	.015
		Trucks	.689	.283	.077
		Sewers	-.853	.356	.085
	Hand Cart	Buckets	-.814*	.266	.015
		Trucks	-.125	.290	.973
		Sewers	-1.667*	.362	.000
	Trucks	Buckets	-.689	.283	.077
		Hand Cart	.125	.290	.973
		Sewers	-1.542*	.375	.000
	Sewers	Buckets	.853	.356	.085
		Hand Cart	1.667*	.362	.000
		Trucks	1.542*	.375	.000

Source: Researcher (2023)

The ANOVA output in table 25 indicate a significant mean difference in accessibility, accountability, availability, and affordability of technologies for emptying and transportation of sludge/excreta (F (3, 96) = 3.81, p = .013), (F (3, 96) = 9.06, p = .000), (F (3, 96) = 2.75, p = 0.047) respectively. However, emptying and transportation was insignificant (F (3, 96) = 1.598, p = 0.195). The Post Hoc Tests in 4.22 identified the significant differences in mean scores observed in sewers (p=0.000), trucks (p=0.000), handcart (p=0.000), and buckets

(p=0.085). The significant differences conform with Corburn et al. (2017); Mallory et al. (2021a); Mansour et al. (2017); Mutsakatira et al. (2018) & Ofori et al. (2021) who found physical segregation, sabotage, blockage and disjointed service regimes in slums.

Table 26:

Excreta/sludge Treatment or Disposal

		ANOVA				
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Accessibility Sanitation Technologies and Services	Between Groups	35.326	4	8.832	8.980	.000
	Within Groups	93.434	95	.984		
	Total	128.760	99			
Accountability sanitation technologies and services	Between Groups	36.263	4	9.066	8.429	.000
	Within Groups	102.177	95	1.076		
	Total	138.440	99			
Availability Sanitation Technologies and Services	Between Groups	2.737	4	.684	4.692	.002
	Within Groups	13.853	95	.146		
	Total	16.590	99			
Affordability sanitation technologies and services	Between Groups	25.558	4	6.390	4.902	.001
	Within Groups	123.832	95	1.303		
	Total	149.390	99			

Source: Researcher (2023)

Table 26 shows the significant differences in mean scores observed between accessibility, accountability, availability, and affordability and type of excreta/sludge treatment or disposal technologies. The significant differences were observed between accessibility, accountability, availability, and affordability and the type technologies for excreta/sludge treatment or disposal (F (4, 95) = 8.98, p = .000), (F (4, 95) = 8.43, p = .000), (F (4, 95) = 4.69, p = 0.002) and (F (4, 95) = 4.90, p = 0.001) respectively. Table 4.24 show a specific

significance between the accessibility and septic tanks (p=000), landfills (p=0.070), and open grounds, (p=0.000). This is in agreement with Devaraj et al., (2021), and Okoth et al., (2017), who linked the disparities of sanitation services with policies failures, affordability, effectiveness, and practicality of solutions.

Table 27:

Post Hoc Test for Treatment and Disposal of Excreta/Sludge

Dependent Variable	(I) Excreta/sludge Treatment or Disposal	(J) Excreta/sludge Treatment or Disposal	Mean Difference (I-J)	Std. Error	Sig.
Accessibility Sanitation Technologies and Services	Open Ground	Septic Tanks	2.107*	.472	.000
		Landfills	1.357	.513	.070
		Treatment plant	1.951*	.395	.000
		Rivers	.746	.500	.570
	Septic Tanks	Open Ground	-2.107*	.472	.000
		Landfills	-.750	.453	.465
		Treatment plant	-.156	.312	.987
		Rivers	-1.361*	.437	.020
	Landfills	Open Ground	-1.357	.513	.070
		Septic Tanks	.750	.453	.465
		Treatment plant	.594	.372	.503
		Rivers	-.611	.482	.711
	Treatment plant	Open Ground	-1.951*	.395	.000
		Septic Tanks	.156	.312	.987
		Landfills	-.594	.372	.503
		Rivers	-1.205*	.353	.008
	Rivers	Open Ground	-.746	.500	.570
		Septic Tanks	1.361*	.437	.020
		Landfills	.611	.482	.711
		Treatment plant	1.205*	.353	.008

Source: Researcher (2023)

Table 27 shows the post hoc test on the specific accessible sanitation technology for excreta/sludge disposal. The septic tanks, open ground, and rivers were significantly accessible for treatment and disposal of excreta/sludge.

Correlation Analysis

This section details Pearson correlation analysis, which determined the relationships between sanitation technology and sanitation outcomes of affordability, accessibility and availability.

Table 28

Technology/Options and Affordability

		Affordability	Type of toilet	Siting of toilet	Construction/installation process of the toilet	Emptying and transportation of excreta/sludge
Pearson Correlation	Affordability	1.000	.520	-.247	.389	.067
	Type of toilet	.520	1.000	-.302	.329	.044
	Siting of toilet	-.247	-.302	1.000	-.336	.026
	Construction/installation process of the toilet.	.389	.329	-.336	1.000	.091
	Emptying and transportation of excreta/sludge	.067	.044	.026	.091	1.000
Sig. (1-tailed)	Affordability	.	.000	.007	.000	.254
	Type of toilet	.000	.	.001	.000	.334
	Siting of toilet	.007	.001	.	.000	.397
	Construction/installation process of the toilet.	.000	.000	.000	.	.183
	Emptying and transportation of excreta/sludge	.254	.334	.397	.183	.
N		100	100	100	100	100

Source: Researcher (2023)

The table 28 depict moderately strong positive correlation between the affordability of the toilet and type of toilet used ($r = .520$, $p < .05$). There was also a weak positive correlation between type of toilet and construction/installation process of the toilet ($r = .329$, $p < .05$).

However, there was a weak negative correlation between affordability and siting of the toilet ($r = -.247$, $p = .007$). Moreover, there was a weak negative correlation between type of toilet and siting of toilet ($r = -.302$, $p = .001$). The results highlight varying degrees of association between the affordability of the toilet, type of toilet, construction/installation process, siting, and emptying/transportation of excreta/sludge. (Russel et al., 2019a), (Ferguson et al., 2021; Tilmans et al., 2015a) found Container-Based Sanitation (CBS) was an affordable and cost-effective type of toilet technology in informal settlements. In Peru, Haiti, and Ghana, the CBS provider user fees ranged from 3.21 to 12.00 USD per household per month (Russel et al., 2019a).

Table 29:

Technology/Options and Accessibility

		Accessibility	Type of toilet	Siting of toilet	Construction/installation process of the toilet.	Emptying and transportation of excreta/sludge
Pearson Correlation	Accessibility	1.000	.426	-.230	.546	.065
	Type of toilet	.426	1.000	-.302	.329	.044
	Siting of toilet	-.230	-.302	1.000	-.336	.026
	Construction / installation process of the toilet.	.546	.329	-.336	1.000	.091
	Emptying and transportation of excreta/sludge	.065	.044	.026	.091	1.000
Sig. (1-tailed)	Accessibility	.	.000	.011	.000	.261
	Type of toilet	.000	.	.001	.000	.334
	Citing of toilet	.011	.001	.	.000	.397
	Construction /installation process of the toilet.	.000	.000	.000	.	.183
	Emptying and transportation of excreta/sludge	.261	.334	.397	.183	.
N	Accessibility	100	100	100	100	100

Source: Researcher (2023)

The table 29 shows a moderate positive correlation between accessibility and type of toilet (r = .426, p = .0001). Also, there was a moderate positive correlation between accessibility and construction/installation process of the toilet with (r = .546, p < .05). However, accessibility

and siting of toilet, and type of toilet and siting of toilet depict a weak negative correlation respectively ($r = -.230$, $p = .011$) and ($r = -.302$, $p = .001$). There was a weak positive correlation reported between accessibility and emptying and transportation of excreta/sludge ($r = .065$, $p = .261$). The results highlight correlations between accessibility and the type of toilet, as well as ac accessibility and the construction/installation process. The varying accessibility on different types of toilets is in agreement with Ferguson et al., (2021); Tilmans et al., (2015a) who found the coverage, cost and distance influence the use of toilet facilities

Table 30:

Correlations of Availability and Technology/Options

		Availability	**Type of toilet**	**Citing of toilet**	**Construction/installation process of the toilet.**	**Emptying and transportation of excreta/sludge**	**Excreta/sludge treatment/disposal**
Pearson Correlation	Availability	1.000	.383	-.211	.372	-.023	-.018
	Type of toilet	.383	1.000	-.302	.329	.044	.047
	Siting of toilet	-.211	-.302	1.000	-.336	.026	.064
	Construction/ installation process of the toilet.	.372	.329	-.336	1.000	.091	-.048
	Emptying and transportation of excreta/sludge	-.023	.044	.026	.091	1.000	.133
	Excreta/sludge treatment/disposal	-.018	.047	.064	-.048	.133	1.000
Sig. (1-tailed)	Availability	.	.000	.018	.000	.412	.430
	Type of toilet	.000	.	.001	.000	.334	.322
	Siting of toilet	.018	.001	.	.000	.397	.265
	Construction/installation process of the toilet.	.000	.000	.000	.	.183	.319
	Emptying and transportation of excreta/sludge	.412	.334	.397	.183	.	.093
	Excreta/sludge treatment/disposal	.430	.322	.265	.319	.093	.
N		100	100	100	100	100	100

Source: Researcher (2023)

Table 30 presents the correlation matrix for the variables related to availability and different technology/options. The availability and type of toilet was statistically significant and correlated ($r = 0.383$, $p = .0001$). Moreover, the availability and siting of toilet showed a statistically significant negative correlation ($r = -0.211$, $p = 0.018$). There is a significant moderate positive correlation between availability and construction/installation process of the toilet is ($r = 0.3720$, $p = 0.000$). The correlation between availability and emptying and transportation of excreta/sludge was an insignificant weak negative relationship ($r = -0.023$, $p = 0.412$). There is an insignificant weak negative relationship between availability and excreta/sludge treatment/disposal ($r = -0.018$, $p = 0.430$). It is clear that the types of technologies are associated with its availability. However, as per Blackett and Hawkins (2016b); Mallory et al. (2021c); Singh et al. (2017) findings, the availability of sanitation services and infrastructure in informal settlements is a factor of capital cost (CAPEX), priorities, land tenure, competing and vested interests, and power dynamics.

Regression analysis

Test for normality for the data was performed using Shapiro-Wilk Test and Kolmogorov-Smirnov Test. The p-value greater than 0.05 implies that the data did not significantly differ from the normal distribution for all the sanitation technologies. The normality test in table below affirms normality of sanitation technologies across the four categories (accessibility, availability, accountability, and affordability) and which warranted regression analysis.

Table 31:

Tests of Normality

	Sanitation Technology	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Sanitation Accessibility	Open Ground	.504	7	.200	.453	7	.900
	Septic Tanks	.323	12	.150	.780	12	.850
	Landfills	.274	8	.179	.808	8	.950
	Treatment plant	.294	64	.400	.790	64	.975
	Rivers	.245	9	.127	.825	9	.920
Sanitation Availability	Open Ground	.360	7	.017	.664	7	.730
	Septic Tanks	.530	12	.120	.327	12	.780
	Landfills	.325	8	.013	.665	8	.690
	Treatment plant	.521	64	.030	.388	64	.640
	Rivers	.356	9	.020	.655	9	.740
Sanitation Accountability	Open Ground	.504	7	.100	.453	7	.780
	Septic Tanks	.263	12	.022	.807	12	.810
	Landfills	.277	8	.700	.748	8	.760
	Treatment plant	.260	64	.920	.820	64	.680
	Rivers	.402	9	.012	.658	9	.630
Affordability sanitation technologies	Open Ground	.332	7	.019	.710	7	.730
	Septic Tanks	.313	12	.012	.737	12	.800
	Landfills	.250	8	.150	.860	8	.750
	Treatment plant	.318	64	.230	.741	64	.700
	Rivers	.317	9	.029	.767	9	.750

a. Lilliefors Significance Correction

Source: Researcher (2023)

In the table below, all the Variance Inflation Factor (VIF) VIF values in the model were les than the threshold of 5, and ranged from 1.031 to 1.220. Correspondingly, tolerance values were above 0.8. These figures show that multicollinearity was not an issue in the regression model.

Table 32:

Multicollinearity Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	**VIF**
	Sanitation Technology (Toilets)	.845	1.184
	Sanitation Technology (Emptying and Transportation)	.970	1.031
	Sanitation Technology (Excreta/sludge Treatment or Disposal)	.971	1.030
	Siting of Toilet	.839	1.192
	Construction and Installation Process of the Technology	.819	1.220

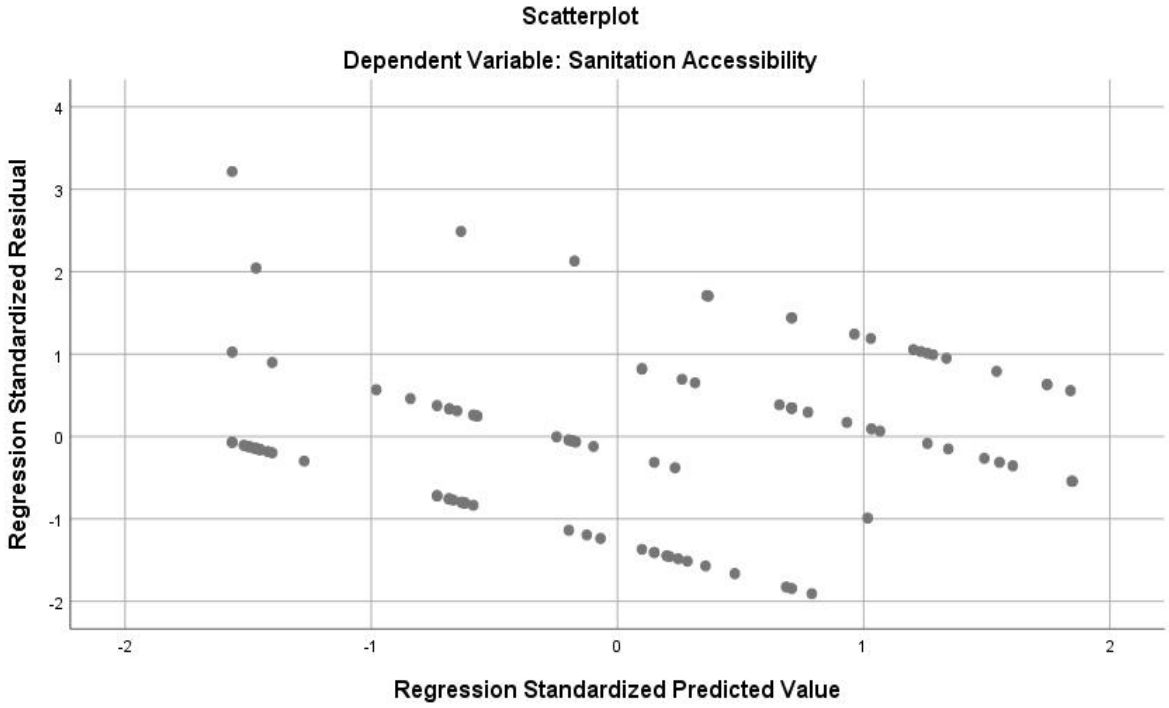
a. Dependent Variable: Sanitation Accessibility

Source: Researcher (2023)

The scatterplot in Figure 3 shows the relationship between the standardized residuals and standardized predicted values for the regression model, which focused on sanitation accessibility. The points were scattered across the graph, showing a general trend where residuals appeared to decrease as the predicted values increased. Most residuals clustered around zero, suggests that the model's predictions were fairly accurate for those values. There were some notable positive residuals, indicating cases where the actual values were higher than predicted. The plot does not show a clear funnel shape, which implies that the model was generally fitted for the data, although the declining trend in residuals with increasing predicted values should be considered for model refinement in future iterations.

Figure 3:

Homoscedasticity



Source: Researcher (2023)

Table 33

Coefficients of Regression Analysis[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	.502	.299		1.678	.097
	Type of toilet	.630	.105	.520	6.022	.000
2	(Constant)	-.039	.350		-.112	.911
	Type of toilet	.532	.107	.439	4.967	.000
	Construction/installation process of the toilet.	.350	.127	.244	2.762	.007

a. Dependent Variable: Affordability

Source: Researcher (2023)

In model 1, for every one-unit increase in the types of toilets, the predicted value of affordability increased by .630. In model 2, for every one-unit increase in type of toilet, the

predicted value of affordability increased by 0.532. one-unit increase in the construction/installation process of the toilet, the predicted value of affordability increased by .350.

The regression equation for the models;

$$\text{Model 1: Affordability} = 0.502 + 0.630(\text{Type of toilet}) \quad (6)$$

$$\text{Model 2: Affordability} = -0.039 + 0.532(\text{Type of toilet}) + 0.350(\text{Construction/installation process of the toilet}) \quad (7)$$

Table 34:

Model Summary of Affordability

					Change Statistics				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**R Square Change**	**F Change**	**df1**	**df2**	**Sig. F Change**
1	.520[a]	.270	.263	1.055	.270	36.267	1	98	.000
2	.569[b]	.323	.309	1.021	.053	7.626	1	97	.007

a. Predictors: (Constant), Type of toilet
b. Predictors: (Constant), Type of toilet, Construction/installation process of the toilet.

Source: Researcher (2023)

The model 1 summary shows approximately 27.2% of the variance in affordability is explained by the type of toilet. In model 2, 32.3% of variance in affordability was explained by the type of toilet used and the construction/installation process of the toilet. There was a variation in the affordability of toilets, and which was brought by toilet type and construction process. The provision of sanitation services and technologies such as sludge emptying and transportation, sewer connection and water supplies in Informal settlements in controlled by cartels (Abeysuriya et al., 2019.; Mallory et al., 2021b).

Table 35:

ANOVA for Two Regression Models on Affordability

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	40.352	1	40.352	36.267	.000[b]
	Residual	109.038	98	1.113		
	Total	149.390	99			
2	Regression	48.300	2	24.150	23.173	.000[c]
	Residual	101.090	97	1.042		
	Total	149.390	99			

a. Dependent Variable: Affordability
b. Predictors: (Constant), Type of toilet
c. Predictors: (Constant), Type of toilet, Construction/installation process of the toilet.
Source: Researcher (2023)

Table 35 shows the significant variation in the two regression models. Model 1 and 2 show a significant overall fit to the data (F (1,98) =36.267, p= 0.000) and (F (2,97) =23.17, p= 0.000) respectively.

Table 36:

Coefficients

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.515	.275		1.870	.065
	Construction/installation process of the toilet.	.727	.113	.546	6.451	.000
2	(Constant)	-.041	.314		-.129	.897
	Construction/installation process of the toilet.	.606	.114	.455	5.315	.000
	Type of toilet	.311	.096	.276	3.227	.002

a. Dependent Variable: Accessibility

Source: Researcher (2023)

Model 1: Accessibility = 0.515 + 0.727 (Construction/installation process of the toilet). (8).

Model 2: Accessibility = -0.041 + 0.606 (Construction/installation process of the toile)t + 0.311 (type toilet) (9)

In model 1, for each unit increase in the construction/installation process of the toilet, the accessibility score increased by 0.546 standard deviations. In model 2, for each unit increase in the construction/installation process of the toilet, the accessibility score increased by 0.455 standard deviations. The models are statistically significant ($p < 0.05$), suggesting they were significant predictors of accessibility. This study correlate with Evans et al. (2017a) and Simiyu et al. (2021) who found some people in settlements could not access the toilets due to the structural and hygienic aspects of the toilets.

Table 37:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	F Change	df1	df2	Sig. F Change
1	.546[a]	.298	.291	.960	.298	41.610	1	98	.000
2	.605[b]	.366	.353	.917	.068	10.413	1	97	.002

a. Predictors: (Constant), Construction/installation process of the toilet.
b. Predictors: (Constant), Construction/installation process of the toilet, Type of toilet
Source: Researcher (2023)

In model 1, 29.8% of variation in accessibility was explained by the construction/installation process of the toilet, while in model 2 construction/installation process of the toilet and the type of toilet explained 36.6% variation in the accessibility.

Table 38:

ANOVA for Two Regression Models on Accessibility[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	38.376	1	38.376	41.610	.000[b]
	Residual	90.384	98	.922		
	Total	128.760	99			
2	Regression	47.138	2	23.569	28.010	.000[c]
	Residual	81.622	97	.841		
	Total	128.760	99			

a. Dependent Variable: Accessibility
b. Predictors: (Constant), Construction/installation process of the toilet.
c. Predictors: (Constant), Construction/installation process of the toilet., Type of toilet
Source: Researcher (2023)

Table 38 presents the results of the ANOVA whereby construction/installation process of the toilet was predictor variable while accessibility was the dependent variable. The regression model was significant with $F(1, 98) = 41.610$, $p < .05$).

Table 39:

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.796	.108		7.376	.000
	Type of toilet	.154	.038	.383	4.099	.000
2	(Constant)	.592	.126		4.713	.000
	Type of toilet	.118	.038	.292	3.061	.003
	Construction/installation process of the toilet.	.132	.046	.276	2.896	.005

a. Dependent Variable: Availability

Source: Researcher (2023)

Model 1: Availability = 0.796 + 0.154 * Type of toilet (10)

Model 2: Availability = 0.592 + 0.118 * Type of toilet + 0.132 * Construction/installation process of the toilet (11)

This equation in model 1 indicates that for each unit increase in the type of toilet, the availability score increased by 0.154 units. For. In model 2, each unit increase in construction/installation process of the toilet corresponded to an increase of 0.132 units in availability. Both models are statistically significant, as indicated by p-values provided of ($p < .05$).The findings affirm the findings by Evans et al. (2017); McFarlane & Silver (2017) and Ofori et al. (2021) who found that the politics of sabotage, patronage and interest derailed the provision of sanitation services and infrastructure.

Table 40:

Model Summary

					Change Statistics				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**R Square Change**	**F Change**	**df1**	**df2**	**Sig. F Change**
1	.383[a]	.146	.138	.380	.146	16.805	1	98	.000
2	.463[b]	.214	.198	.367	.068	8.387	1	97	.005

a. Predictors: (Constant), Type of sanitation Technology
b. Predictors: (Constant), Type sanitation Technology, Construction/installation process of the toilet.
c. Dependent Variable: Availability.

Source: Researcher (2023)

In Table 40, 14.6% variation in accessibility was explained by the type of sanitation technology, while 21.4% was explained by the type of sanitation technology and construction process.

Table 41:

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2.428	1	2.428	16.805	.000[b]
	Residual	14.162	98	.145		
	Total	16.590	99			
2	Regression	3.555	2	1.778	13.230	.000[c]
	Residual	13.035	97	.134		
	Total	16.590	99			

a. Dependent Variable: Availability

b. Predictors: (Constant), Type of sanitation Technology

c. Predictors: (Constant), Type of sanitation Technology, Construction/installation process of the toilet.

Source: Researcher (2023)

In Model 1, the regression model included one predictor variable the type of toilet. The ANOVA table on the type of toilet shows that the regression explains a significant amount of variance in their availability, as indicated by the significant F-value of 16.805 ($p < .05$). In Model 2, the regression model included two predictor variables: construction/installation process of the toilet and type of toilet. The ANOVA table indicates that this expanded model also significantly explains the variance in availability, with an F-value of 13.230 ($p < .05$).

4.5 Role of Formal and Informal Actors in Sanitation Delivery

This section details the findings and discussions on the role of formal and informal actors in sanitation delivery.

4.5.1 Demand and Supply

Table 42:

Main Providers of Emptying

Main providers of emptying	Frequency	Percentage
County Government	9	9.0
Private Companies	63	63.0
Non-governmental Organization	15	15.0
Community Based Organization	12	12.0
No provider	1	1.0
Total	100	100.0

Source: Researcher (2023)

The main providers of emptying and transportation of excreta/sludge were private companies 63%, while the county government accounted for only 9 %. The findings confirm with Scott et al. (2016) who found governments at all levels were not giving sanitation services enough resources and attention, especially when compared to spending on infrastructure services and water delivery in Brazil and Indonesia. However, the findings misalign with the strategies of KESHP (a), (c) and (d).

Table 43:

The Cost of Constructing Toilet

Average cost of constructing a toilet	Frequency	Percentage
Below KSh 4,999	7	7.0
KSh 5,000-9,999	14	14.0
KSh 10,000-19,999	15	15.0
KSh 20,000-29,999	35	35.0
Above KSh 30,000	29	29.0
Total	100	100.0

Source: Researcher (2023)

Table 43 show the cost of constructing and installing toilet in Mukuru Kwa Reuben. The majority of the respondents 35% indicated that the toilet cost between KSh 20,000-29,999, whereas 7% reported it is below KSh 4,999.

Table 44:

Who Pays Costs for Constructing/Installing toilet

Who pays for construction/installing a toilet	Frequency	Percentages
Households	14	14.0
Service provider	23	23.0
Private company	3	3.0
Landlord	58	58.0
Non-governmental organization	2	2.0
Total	100	100.0

Source: Researcher (2023)

Table 44 shows who paid the costs for constructing/installing the toilet. Regarding the responsibility for the costs of constructing/installing the toilet, the respondents identified leading provider the landlords 58.0%, and then non-governmental organization accounted for the least at 2.0%. There is segregation and isolation in provision of public services such as sanitation in informal settlements due to politics of sabotage (McFarlane & Silver, 2017; Ofori et al., 2021).

Table 45:

The Cost of Emptying and Transporting Excreta/Sludge

Average cost of emptying and transporting sludge	Frequency	Percent
Below KSh 999	1	1.0
KSh 1,000- 3,999	3	3.0
KSh 4,000-6,999	11	11.0
KSh 7,000-9,999	16	16.0
KSh 10,000-29,999	39	39.0
More than KSh 30,000	20	20.0
No Payment	10	10.0
Total	100	100.0

Source: Researcher (2023)

In Table 45, the majority of the respondents, 39% indicated they empty and transport the sludge/excreta at a cost range of KSh 10,000-29,999, while only 1% of the respondents reported they less than KSh 999

Table 46:

Toilet Accessibility and Providers

		Accessibility	Providers of emptying and transportation of excreta/sludge	The Main Providers of Toilet	The cost of emptying and transporting excreta/sludge	The cost of constructing/installing the toilet
Pearson Correlation	Accessibility	1.000	-.094	.340	.450	.482
	Providers of emptying and transportation of excreta/sludge	-.094	1.000	.093	-.071	.026
	The Main Providers of Toilet	.340	.093	1.000	.342	.360
	The cost of emptying and transporting excreta/sludge	.450	-.071	.342	1.000	.277
	The cost of constructing/installing the toilet	.482	.026	.360	.277	1.000
Sig. (1-tailed)	Accessibility	.	.176	.000	.000	.000
	Providers of emptying and transportation of excreta/sludge	.176	.	.177	.241	.399
	The Main Providers of Toilet	.000	.177	.	.000	.000
	The cost of emptying and transporting excreta/sludge	.000	.241	.000	.	.003
	The cost of constructing/installing the toilet	.000	.399	.000	.003	.
N		100	100	100	100	100

Source: Researcher (2023)

The Pearson correlation coefficient between accessibility and the cost of constructing/installing the toilet, providers of emptying and transportation of excreta, main

providers of toilets, and cost of emptying and transporting excreta/sludge were (r = -0.482, p =.000), (r = -0.094, p =0.176), (r = 0.340, p =.000), and (r = 0.450, p =.000) respectively.

Table 47:

Correlations between Regulatory framework, Accountability, Availability and Affordability

		Regulatory framework	**Accountability**	**Availability**	**Affordability**
Regulatory framework for fecal sludge management	Pearson Correlation	1	.066	.103	-.017
	Sig. (2-tailed)		.513	.308	.867
Accountability	Pearson Correlation	.066	1	.519**	.491**
	Sig. (2-tailed)	.513		.000	.000
Availability	Pearson Correlation	.103	.519**	1	.201*
	Sig. (2-tailed)	.308	.000		.045
Affordability	Pearson Correlation	-.017	.491**	.201*	1
	Sig. (2-tailed)	.867	.000	.045	
	N	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Source: Researcher (2023)

The Table 47 presents the correlations between regulatory framework, affordability, availability and accountability in fecal sludge management. Regulatory framework for fecal sludge management had an insignificant positive relationship with accountability (r=.066, p=0.513), availability (r=.103, p=.308). The findings confirm Dixon, (2018); Russel et al. (2019b) and Tsinda et al. (2021) with who found fragmented regulatory frameworks for sanitation and impeded service provisions.

Table 48:

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	.664	.289		2.296	.024
	Construction/installation process of the toilet.	.732	.118	.530	6.189	.000
2	(Constant)	.010	.325		.030	.976
	Construction/installation process of the toilet.	.590	.118	.427	4.997	.000
	Type of toilet	.366	.100	.313	3.669	.000

a. Dependent Variable: Accountability
Source: Researcher (2023)

The Table 48 presents the coefficients Model 1 and Model 2 which predicted the accessibility of toilets.

Model 1: Accountability = .664 + 0.732 * (Cost of constructing/installing the toilet) (12)

Model 2: Accountability = 0.010 + 0.590 * (Cost of constructing/installing the toilet) + 0.366 * (Cost of emptying and transporting excreta/sludge) (13)

All coefficients in Model 1 and Model 2 were statistically significant ($p < 0.05$), indicating that the relationships between the predictors and accessibility were unlikely to have occurred by chance. Overall, the coefficients and equations indicate the cost of constructing/installing the toilet and the cost of emptying and transporting excreta/sludge had significant positive effects on the accessibility of toilets.

Table 49:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.530[a]	.281	.274	1.008	.281	38.300	1	98	.000
2	.607[b]	.369	.356	.949	.088	13.462	1	97	.000

a. Predictors: (Constant), Construction/installation process of the toilet.

b. Predictors: (Constant), Construction/installation process of the toilet., Type of toilet

Source: Researcher (2023)

The model 1 summary in table 49, indicate that approximately 28.1% of the variance in accountability was explained by the cost of constructing/installing the toilet. The model 2 summary shows that the construction/installation process of the toilet and type of toilet explained approximately 36.9% of the variance in accessibility.

Table 50:

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	38.901	1	38.901	38.300	.000[b]
	Residual	99.539	98	1.016		
	Total	138.440	99			
2	Regression	51.032	2	25.516	28.316	.000[c]
	Residual	87.408	97	.901		
	Total	138.440	99			

a. Dependent Variable: Accountability
b. Predictors: (Constant), Construction/installation process of the toilet.
c. Predictors: (Constant), Construction/installation process of the toilet., Type of toilet
Source: Researcher (2023)

The ANOVA table for Model 1 express that the regression model is statistically significant (p = 0.000). This explains that the cost of constructing/installing the toilet significantly contributed to the variance in accountability. The ANOVA table for Model 2 indicates that

the regression model is statistically significant (p= 0.000). This implies that both the cost of constructing/installing the toilet and the type of toilet significantly contributed to explaining the variance in accountability.

Capacity Building and Political Advocacy

Fecal Sludge Management Alliance (FSMA) carried out capacity and political advocacy for sanitation workers. The FSMA engaged in knowledge and expertise development to address challenges across the entire sanitation service chain. The Alliance advocated for political support and recognition of the crucial role played by sanitation workers. FSMA empowered these workers and provided a platform for their voices to be heard. The findings aligns with Simiyu et al. (2021a) who found that when fecal sludge operators were motivated by salary increment they were more productive in their workplace. The findings are also in line with the KESHP 2016-2030 strategy (d) which aims to inculcate capacity and KESSF 2016–2020 intervention focus (4) on building leadership and governance capacity for sanitation.

Government Commitment and Investor Engagement

From the findings, government and investors expressed commitment in increasing coverage of sanitation.

> *One of the good things that has happened in the recent time is the question of the investors taking the space to invest in sanitation products. The other thing that will happen is that the government has now been Committed into 40% sewerage coverage by 2030. The rest of 60% will be covered by the non-sewered sanitation systems. By the way, am I speaking into this space. We have done a lot in terms of the sanitation (MoWSI official).*

The commitment is in agreement with Mansour et al. (2017) who found government commitment through public-private-partnership in sanitation services upscale the provision of sanitation services and infrastructure. The findings conform to the KESHP 2016-2030 strategy (a) and (c) on increasing access of urban sanitation and fostering investment and private sector participation respectively.

Table 51:

County Government Commitment to Sanitation

Commitment of County Government	Frequency	Percent
Highly Committed	17	17.0
Moderately Committed	22	22.0
Minimally Committed	28	28.0
Not Committed at all	35	33.0
Total	100	100.0

Source: Researcher (2023)

In Table 51, the majority 35% of the respondents, indicated that the county government was not committed at all to sanitation, and only 17% indicated it was highly committed. The low county government commitment is due to incomplete devolution of sanitation functions and poor adoption of international policies which fail to adhere to local standards (Health, 2016; Mansour & Esseku, 2017; Ren et al., 2020).

Table 52:

Commitment to Sanitation

		The political will from the local leaders	County government commitment
N	Valid	100	100
	Missing	0	0
Mean		3.50	2.77
Std. s		1.159	1.090

Source: Researcher (2023)

Table 52 shows the rated response on the statement of commitment to sanitation, whereby the political will from the local leaders had a mean and a standard deviation of 3.50 and 1.159, respectively, while county government commitment had a mean and a standard deviation of 2.77, and 1.090. Politicization of human waste is linked to urban politics of blockage, sabotage, historical and racialized segregation, and entitlement of sanitation services and infrastructure (McFarlane & Silver, 2017)

Table 53:

County Government Commitment and Technology Availability

		County government commitment	**Availability**
County government commitment	Pearson Correlation	1	.109
	Sig. (2-tailed)		.279
Availability	Pearson Correlation	.109	1
	Sig. (2-tailed)	.279	
	N	100	100

Source: Researcher (2023)

The Pearson correlation coefficient between the availability of sanitation and the County government commitment is 0.109, which depicts a weak positive correlation that is not statistically significant at ($p= 0.279, > 0.05$).

Table 54:

The power relationships between national and county governments

		Availability	The power relationships between national and county governments	Accessibility	Accountability
Availability	Pearson Correlation	1	-.165	.459**	.519**
	Sig. (2-tailed)		.101	.000	.000
The power relationships between national and county governments	Pearson Correlation	-.165	1	-.045	-.090
	Sig. (2-tailed)	.101		.660	.371
Accessibility	Pearson Correlation	.459**	-.045	1	.636**
	Sig. (2-tailed)	.000	.660		.000
Accountability	Pearson Correlation	.519**	-.090	.636**	1
	Sig. (2-tailed)	.000	.371	.000	
	N	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Researcher (2023)

There was a strong positive correlation between accountability and accessibility (r=.636), accountability and availability (r=.519), availability and accessibility (r=.459), and which are statically significant (p=0.000). However, the relationships between availability and power relationships between national and county governments (r=-.165), accountability and power relationships between national and county governments (r=-.090), is a weak negative correlation with a statistically insignificant relationship.

Unscrupulous Cartels Controlling Connection

The Nairobi Water and Sewerage Company provided connections to sanitation systems and water systems. However, one landlord claimed, **"***there are the challenges of water shortages as unscrupulous cartels control or limit water connection and supply in this area, and people use badly this toilet during this time*.**"** The people with vested interest and 'cartels charges more, use violence to prevent or control the connection or installation of a new technology (Mallory et al., 2021a; World Bank, 2016).

Public Obligation and Global Responsibility

The UN Habitat task the member states to provide sanitation as a public obligation, however there were the challenges of politics in the provision of sanitation services:

> *You know we are trying to address this 'complex political plantation'. When we come up with innovations, then try to implement them, some work, while others do not. And, if we walk in silence, meaning that we do work which other people are not aware of. It would mean that even our successes may not be known by those that are implementing* (UN official).

The findings are in agreement with McFarlane & Silver (2017) who found politics of patronage, poo protests and sabotage in the provision of sanitation services in Cape Town's informal settlements in South Africa and which led to inequalities of infrastructure.

4.5.2 Regulation

Adequacy of Regulation

Table 55:

Adequate Regulation of Fecal Sludge Management Services

There's adequate regulation of fecal sludge management	Frequency	Percent
Strongly Agree	8	8.0
Agree	15	15.0
Neutral	19	19.0
Disagree	34	34.0
Strongly Disagree	24	24.0
Total	100	100.0

Source: Researcher (2023)

As captured in table 55, the majority 34% of the respondents disagreed with the adequacy of regulation on fecal sludge management, while only 8% strongly agreed. The findings resonate with Mallory et al. (2021) who found fragmented enforcement and regulatory frameworks for sanitation services. The toilet facilities structural aspects misaligned with the minimum standards of setbacks 1.5m, access width 3m, frontage 6m, height 2.4m, and other sanitary provisions of latrine accommodation and siting as specified under p. 87, 88, and 89, p. 331(1), p.246 (1), p.261(3), (5), and p.258 (1) (8) (Palermo, 2019)

Regulatory Framework and Private Sector Engagement

The Water Services Regulatory Board (WASREB) regulated water and sanitation from the service providers

> *So, what is the mandate of the WASREB regulation in terms of sustainable fecal sludge management? One of them is to ensure the enforcement of regulations by Water Service Providers, including the private sector. There is also needed to monitor progress on sanitation that we have a fecal sludge management system but we lack guidelines on the sanitation plan. The providers need to properly implement*

their community development plan. We still have the Act that is in our Water Act 2016 that has yet to be fully implemented in this country (MoWSI employee).

The NEMA ensured self-regulation, as well as the need for compliance assistance to ensure that sanitation facilities comply with regulations.

We have the Environment Management and Coordination Act and if you look at a section like Section 42, it provides for the protection of riparian areas, and our water bodies. The Act has really clear provisions on permissible limits of discharges and as a result of that, we have also developed the Water Quality Regulation with clear prohibitions (NEMA official).

Despite the clear role of the WASREB and NEMA as per the Water Act 2016 and EMCA 2012, there were still institutional duplication of roles and responsibilities with the other states department and the two levels of government (Mallory et al., 2021a; Mansour et al., 2017).

4.5.3 Coordination

Adequacy of Coordination

Table 56:

Adequate Coordination among stakeholders and institutions

There is adequate stakeholder coordination	Frequency	Percent
Strongly Agree	22	22.0
Agree	21	29.0
Neutral	23	23.0
Disagree	29	21.0
Strongly Disagree	5	5.0
Total	100	100.0

Source: Researcher (2023)

According to table 56, the majority 29% of the respondents disagreed with the statement that Mukuru Kwa Reuben's sanitation provision was adequately coordinated by institutions and stakeholders.

4.5.3.2 Inter-Ministerial Coordination

The Ministry of Health and the Ministry of Water, Sanitation, and Irrigation are the leading ministries responsible for sanitation service delivery.

> *The Ministry of Health (MOH) and the Ministry of Water, Sanitation, and Irrigation nowadays have shown synergy and corporation where you find our technical working group committees, WASH coordinators, and emergency WASH staff working together. However, there are no direct linkages with the Ministry of Environment regarding its role in regulating discharges. Even though we have made progress to link MOH and MoWSI, there is an overlap of functions between these two ministries. Everyone is the lead coordinator in sanitation* (MoWSI employee).

However, the Ministry of Water, Sanitation, And Irrigation (MoWSI), Ministry of Health, and Ministry of Environment and Forestry had conflicting roles concerning the management and coordination of sanitation services. This is in agreement with Mallory et al., (2021b) who found inadequate coordination of sanitation functions and duplication of roles between the Ministry of Health and the Ministry of Water, Sanitation and Irrigation. The Water Services Regulatory Board (WASREB) is the mandated to ensure the enforcement of regulations by the water service providers, including the private sector (Mallory et al., 2021b).

Poor Local Governance and Fiscal Decentralization

There was the problem of partial decentralization of resources and decision-making power between the two levels of government.

> *After devolution and promulgation of Kenya's 2010 constitution, the revenue currently is channeled to the county-level kitty and there is a lack of understanding on the importance of investing in sanitation. It is clear now how the challenges we are facing are about finances at the national level and also at the county level. Most of our leaders at the county level may not understand and they do not think that investing in sanitation is important. They will tell you that they have no financial support to implement some of the sanitation and hygiene interventions that have occurred after devolution* (health official).

Tsinda et al. (2021) found that the devolution and decentralization of sanitation functions and services provided avenue for decision making and sanitation investment.

Private-Public Partnerships

The health official advocated for private sector engagement in the delivery of sanitation services in Mukuru Kwa Reuben. The private sector provided technical backstopping and ensured that the necessary guidelines were implemented. The better coordination between the public health department and the private sectors to ensured that the necessary technical backstopping and guidelines were implemented. NEMA official highlighted the need for (PPPs) to promote the use of wastewater treatment technologies, as well as the need for economic incentives to promote the use of technologies. The private and public sector partnership not only catalyzes accountability but are trusted and reliable actors in the provision of sanitation and water services (Criqui, 2020).

Government Overlapping Mandates

In Kenya, the provision of sanitation service operates under multiple institutional and legal frameworks, which have led to a lack of clear accountability and fragmented responsibilities. Prior to devolution, sanitation function was under the Ministry of Public Health and Sanitation, but after the promulgation of the 2010 Constitution, the responsibility shifted to the Ministry of Water, Sanitation and Irrigation, this raises the concerns about whether sanitation is adequately prioritized. A recurring concern among the stakeholders is that sanitation "has no home," highlighting the confusion regarding which ministry should take primary responsibility.

> *You know very well sanitation would be under the Ministry of Public Health back then. But now, it is under Ministry of Water and this one of the reasons that probably may have contributed to not so much focus on the sanitation but now it's is clear that sanitation has no home. Is it under the ministry of water, public health or environment?* (Health official)

Section 48 of the County Government Act (2012), mandates the devolution of sanitation services and functions. It ensures that county governments take responsibility for managing and providing sanitation infrastructure. However, the findings suggest that duplication of roles, overlapping mandates, and lack of coordination among agencies and which continue to prevent service provision. While Mansour et al. (2017) found that devolution improved sanitation service delivery and infrastructure, the current situation indicates a lack of cohesion between government agencies. Mallory et al.(2021b) observed that conflicting policies, duplication of roles and governance challenges contribute to inefficiencies in sanitation management.

The National Environment Management Authority (NEMA) is among the key stakeholders charged with sanitation delivery. However, according to a NEMA official, the lack of structured coordination between institutions has led to confusion, slowing down investment and limiting accountability in sanitation service provision. This contravenes the County Government Act (2012), Section 48, which mandates distinct roles and responsibilities for different institutions to decentralize services efficiently. Similarly, Criqui,(2020) found that the fragmented governance structure prevents accountability in sanitation service delivery.

> *The challenge that we face is uncoordinated efforts and our mandates look like overlapping. Who would have to say is a challenge, but I know it has also sometimes slowed down our activities? Whereby you find we have two, or three institutions trying to do the same thing, and sometimes this causes a bit of confusion to investors. Then you find that we are not even able to account* (NEMA official).

The accountability and governance of sanitation service provision remain critical challenges due to unclear institutional responsibilities, lack of coordination and overlapping mandates. Despite the legal frameworks in place, the fragmentation of roles among county governments, National Environment Management Authority (NEMA), the Ministry of Water, and other agencies has led to reduced accountability and inefficiencies.

4.5.4 Financing

Financing options

Table 57:

Financing options

Financial options	Frequency	Percent
Loans	31	31.0
Taxes/public funding	4	4.0
Subsidies	13	13.0
Donor funding	16	16.0
No financial option	19	19.0
Public Private Partnership	11	11.0
Rental Income	6	6.0
Total	100	100.0

Source: Researcher (2023)

As per table 57 on the financing options of fecal sludge management, the majority of the respondents 31.0% mentioned loans, and only 4.0% indicated taxes/public funding.

Financial Inclusion

The banks developed urban sanitation investment fund as the traditional sources of funding were not enough.

> *There is a specific fund that the African Development Bank is developing and is at an advanced stage. Africa urban sanitation investment fund is awaiting board clearance so that it can be operationalized and will play a leading and catalytic role in sanitation development. It would provide financial and practical support in programs and will move in finance new sanitation technologies and business models. This fund in terms of objective will be to realize scalable, climate resilient, and inclusive sanitation solutions across Africa* (sanitation enterprise employee).

The findings are line with Mallory et al. (2021b) who found that sanitation investment is a factor of political economy which encompassed development partner support and sector champions who created incentives for institutional reforms and long-term in- vestments.

The monthly salary for manual operators was relatively low, and had to look for other work to sustain their daily living expenses.

> *I cannot fully depend on this salary as it cannot buy food, pay bills, rent or allow me to build. This is why we have formed our groups as operators where we go for merry go round or enter into SACCO where per month, they deduct Ksh 2000, and the company adds Ksh 500 on top of the subscriptions we pay to the SACCOs* (Manual operator).

The findings are in agreement with Mallory et al. (2021b) who found that pit emptiers were physically and institutionally outside the sanitation service delivery paradigm in Mukuru and Kibera settlements.

Sustainable Financing Products

Sustainable financing products for sanitation infrastructure and services were growing. Sanitation enterprise employee stated, "*the bank now gives financial products and services through various instruments which include concessional loan guarantees, grants and trust funds to sanitation enterprise. The bank also promotes knowledge sharing, which underpins the bank financing.*" The findings conform with KESHP and KESSF strategy 3 which seeks to foster investment in sanitation.

Budget Allocation

In the fiscal year 2023/2024, the Nairobi County Government unveiled a budget totaling KSh 42.3 billion, with a significant emphasis on development, allocating 33% of the total

budget to various sectors. The Environment, Water, and Sanitation sector received an allocation of KSh 3.4 billion in the proposed budget. To enhance waste management, the county assembly approved KSh 604 million for the purchase of waste collection trucks and an additional KSh 50 million for the installation of litter bins within the Central Business District (CBD). However, specific budgetary allocations to the Nairobi City Water and Sewerage Company (NCWSC) for the fiscal year 2023/2024 were not detailed in the available sources. The budgetary allocation underscores the county's commitment to enhancing sanitation services.

The employees further stated the vital role of budgeting in sanitation delivery.

> *There is a need to have a budget allocation to improve things like feasibility studies, design and infrastructure. We also require an actual budget activity level to be deployed for one of the finalities of the sanitation infrastructure that has already been developed* (NWSC official).

Structured User Fees and Targeted Subsidies

Targeted subsidies and user fees played a key role in the operation and maintenance of sanitation infrastructures.

> *We need to have recovery. And then it will be a partial or full recovery and this should be done through well-structured user fees and targeted subsidies which user contribution. We need innovative models that provide an incentive for improved performance and receptiveness* (Sanitation enterprise employees).

The installation cost and the monthly payment affected the provision of water and sewer connection.

I use pour flush due to the terms of payment; you find that the Nairobi Metropolitan Service is paid 5,000 Ksh for the connection to sewer line, and which is cheaper when compared to the fresh life toilets which you pay 850 Ksh monthly (landlord).

The findings misalign with Mallory et al. (2021b) who found that the water and sewer connection fees was controlled by cartels who inflated the charges in Mukuru and Kibera slums.

4.6 The Gaps between Policy and Practice in Sanitation Delivery

This section presents the findings and discussions on the gaps between policy and practice in sanitation delivery.

4.6.1 Introduction

This section presents an extensive review analysis of the gap between the policies and the sanitation practices in Mukuru Kwa Reuben, Kenya. It presents an interim assessment of the 8-year implementation of the Kenya Environmental Sanitation and Hygiene Policy (KESHP) 2016–2030. The findings were based on midterm data and should be interpreted as preliminary observations. While the discrepancies between policy objectives and current practices was noted at 8-year period, it was acknowledged that the policy implementation period remains ongoing until 2030. Therefore, any identified gaps were preliminary and highlighted areas for strengthened focus rather than definitive evidence of policy failure. The assessment aimed to generate evidence which will inform adaptive measures that may support the achievement of KESHP goals within the remaining policy timeframe

It carefully examined whether the Kenyan government's policies were in line with the needs and practices. It looked at how the practices align with the Kenya Environmental Sanitation and Hygiene Policy (2016–2030) and Kenya Environmental Sanitation and Hygiene

Strategic Framework (KESSF) 2016-2020 fits into the country's new governance framework, with a focus on the goal of achieving universal access to better sanitation and the devolution of power to counties.

4.6.3 Policy Implementation and Gaps

The analysis of sanitation practices shows a discrepancy between the current sanitation practices and the aspirations of the Kenya Environmental Sanitation and Hygiene Policy (KESHP) 2016–2030. This study showed that in Mukuru Kwa Reuben, 40% of respondents utilized pit latrines, while only 2% used composting toilets (Table 4.7). Similarly, Table 4.8 depicts that county governments contributed only 5% to toilet provision, and landlords accounted for 47%. As for maintenance and operation practices, it was also found inadequate by 32% of respondents (Table 4.9), and 68% reported that landlords primarily decided the siting of toilets (Table 4.10). These findings show the challenges in realizing the aspiration of the provision of the KESHP policy strategy 1 targeting to raise access to improved sanitation coverage from 32% to 65% by 2030. The findings highlight challenges in realizing KESHP's strategies aiming for sustainable waste management practices (Strategy 2).It is clear there was inefficient interim implementation of sanitation policy despite it being implemented for 8 years, and which Evans et al. (2017) and van Welie et al. (2018a) asserts poor governance.

The study findings reveal persistent challenges in the construction, accessibility, affordability, and accountability of sanitation services, which impede the full realization of Kenya's Environmental Sanitation and Hygiene Policy (KESHP) 2016–2030 objectives. Table 4.11 shows that 37.0% of respondents found the toilet construction and installation process to be not easy, while Table 4.12 reveals that 34.0% of respondents still rely on

manual methods such as buckets to transport and empty fecal sludge, with only 12.0% utilizing sewer systems. Furthermore, accessibility concerns are highlighted in Table 4.14, where 39.0% of respondents rated toilet facilities as only slightly accessible, and 18.0% rated them as not accessible. Relatedly, Table 4.15 shows that 79.0% of respondents reported the unavailability of sanitation facilities. In terms of accountability, Table 4.16 indicates that 34.0% of respondents rated sanitation providers as not accountable, and Table 4.17 shows that 44.0% found the cost of fecal sludge emptying and transportation unaffordable. Correlation analyses in Table 4.20 and Table 4.21 further demonstrate that the type of toilet and construction processes moderately influence affordability and accessibility, respectively, while toilet siting shows a weak negative correlation with accessibility.

These findings demonstrate multiple barriers to effective sanitation service delivery. Difficulties in construction and installation suggest gaps in designing accessible and user-friendly facilities, and conflicts with KESHP's focus on inclusive and universal access (Strategies 1 and 6). The continued reliance on buckets for transporting fecal sludge depicts a lag in the adoption of improved technologies advocated under KESHP Strategies 1 and 2, which seek sustainable, safe waste management systems. Disparities in accessibility and facility availability underscore the ongoing challenges to achieving the policy's goal of equitable sanitation services for all by 2030. Meanwhile, affordability constraints and weak accountability mechanisms highlight areas where KESHP Guiding Principle 4.4(k) — ownership with responsibility — and Strategy 5 — strengthening leadership and governance — were not yet fully operationalized. It is important to recognize that KESHP envisions a gradual, phased achievement of its targets within the 2016–2030 timeline. As such, the

study's findings should be interpreted as indicative of early-stage implementation discrepancies rather than definitive failures.

Leveraging Local Resources for Sustainable Sanitation Solutions

The maintenance, operation and supply of sanitation services such as pour-flush toilets and pit latrines in Mukuru Kwa Reuben were majorly managed by landlords. The initial support was provided by sanitation service providers, such as Sanergy, during installation. However, subsequent operations, including the sourcing of materials like sawdust, were often left to private arrangements among landlords and local suppliers. One landlord indicated.

> *There is a delivery first by operators working with Sanergy when the toilet is being installed and which will last you 2-3 days. After that, we search for the sawdust under our arrangement. We then have deals with the ones connected with the company to supply the sawdust, hereby we are given the number of manual operators for the delivery of the sawdust* **(**landlord**).**

The findings show the potential for leveraging local resources to support sanitation services. Nevertheless, it also points to challenges in ensuring standardized service delivery and maintenance practices and which are the key aims of KESHP Strategy 2 on sustainable sanitation. As noted by Mallory et al. (2021b), overlapping interests among NGOs, landlords, and land claimant's complicate infrastructure projects. These findings suggest the need for stronger stakeholder coordination to align with KESHP's broader objectives.

Partial Devolution of Sanitation Functions

While sanitation functions have been officially devolved to county governments following Kenya's 2010 Constitution, certain critical aspects remain under the purview of the national

government, particularly policy formulation and standard-setting. The partial devolution influenced service delivery on the ground.

> *Since devolution, you know most of these policies that came up after 2010 after the promulgation of the Constitution. So now the sanitation function has been devolved. However, the national government maintains the policy formulation framework and training standards. Yes, nowadays sanitation function is devolved, and most of the waterworks have had loans from international partners but the county government does not want to service this. But now, after all, the government did not want to take that; they want us to water on the same floor. Yeah, they do not want to repay the loan so the national government took back some of the functions or did not fully devolve some of the functions due to this loan* (NWSC official).

The current study's findings show financial and operational conflicts between national and county governments, especially around the management of international loans. The conflicts and tensions have resulted to partial retention of functions by the national government, impacting the realization of fully devolved sanitation services envisioned under KESHP.

NEMA enforced Environment Management and Coordination Act and Water Quality Regulation, however, the lack of alternatives proved futile while enforcing the regulations.

> *What is happening to the more than 60% population that are not able to access now sanitation facilities that we have in Mukuru. That is where we face our biggest challenge because you find that we coordinate with other institutions like with the active water services for the level of the city water that we are trying to provide these services to them. But what happens to the informal sector is still a big challenge for us because it comes to these areas, they are not even able to enforce because what*

would be the alternative? Therefore, as an institution we are trying to embrace more of a multi-agency approach whereby we look at solutions (NEMA official).

In Malawi, legislative antagonism exists in the implementation of policies on FSM whereby Part 1, clause 37 section 1 and 2 of the Environmental Management Act (EMA) outlines the council is tasked with regulation of collection, transportation and disposal of fecal sludge (Nyirenda & Holm, 2015). These findings imply that developing context-appropriate enforcement mechanisms and strengthening inter-governmental coordination are critical for realizing KESHP's goals by 2030.

Sanitation Workers and Policy Guidelines

Protecting and recognizing sanitation workers is essential for sustainable fecal management, as stressed by the African Development Bank and aligned with the aspirations of the KESHP Strategy 5 on human resource capacity development.

There is no way we are going to have sustainable fecal sludge management without bringing sanitation workers on board. We need to take the sanitation worker to the table. So, it needs to be part of the agenda as we talked about it. But, you know, the kind of name we call them. We stigmatize them (Sanitation enterprise employee).

However, sanitation workers in Mukuru Kwa Reuben reported weak policy enforcement, low wages, stigmatization, and hazardous working conditions, despite receiving vaccinations and protective training. These efforts are crucial for advancing Kenya's commitments under the KESHP and the Constitution's Bill of Rights, particularly the right to health and dignity (Article 43).

The representative from the FSM alliance further stressed the role capacity building in line within Agenda 2030 and KESSP policy strategy 5 on building leadership capacity and governance and for sanitation.

> *Within the Agenda 2030, fsm workers need capacity building which can be built politically. In terms of the entire value chain. It is important also to identify who does what at what point is inside. I was to focus on two very important aspects. One of them is the importance of capacity building in sanitation and the other one is the importance of moving fast. We have a room, a large shortage of experts in the field* (FSM Alliance Official).

Despite the great work the sanitation workers were doing, their job was not being recognized.

> *The sanitation workers are not empowered enough and that their work is not valid enough. Their voices are not heard enough, and they are always treated as their job is not worthy. They do not do a placement job, but they're doing such an important job and they require the recognition in the national and international level* (Sanergy Employee).

The fecal sludge operators working with Sanergy reported weak enforcement of policies as they report the challenge of water cartels who inflate the price. The operators also reported that the monthly salary from their employer Sanergy was relatively low, and had to look for other work to sustain their daily living expenses. They reported that the work was not relatively good due to the infectious nature even though they had been vaccinated. The operators asserted they wake up early in the morning to avoid shame, as residents do not want to see them. The operators also reported that the work is not relatively good due to the infectious nature even though they had been vaccinated. The preventive maintenance plan

for the Eco bag washing machines and the hand cart was not available during the survey. The operators reported that lack of water for pour flush was the challenge presented by fresh operators and attributed to water cartels who inflate the price. The findings misalign with the aspirations of the KESHP strategy 2 on healthy and clean environment, human the Bill of Rights, KESHP Strategy 5 on human resource capacity development and the Kenya's 2010 Constitution article 43, and Water Act 2016.

The health official noted that there was a need for better policies and regulations in order to ensure that the necessary sanitation services are provided in Mukuru Kwa Reuben. The official also noted that there was a need to ensure that the communities understand the importance of sanitation and take responsibility for their own sanitation needs. As per Mallory et al. (2021b), the enactment of sanitation policies was spearheaded effectively and efficiently by the Chief Administrative Secretary. However, the reshuffle of the cabinet by the president led to eminent challenges in sanitation division of the ministry.

Powers and Limitations

While regulatory frameworks exist to manage sanitation, enforcement limitations hindered full realization of safe fecal sludge management. Public Health Officer is empowered by the Public Health Act Chapter 242 to abate nuisances and hold individuals accountable. However, the fines imposed by the Act was too low to effectively deter violations. The perpetrators continued to engage in disposing excreta/sludge to open ground. Although the regulations on faecal sludge management have been provided, a study by Gitonga et al. (2021a) established that illegal "night soil men" indiscriminately dumped fecal sludge indiscriminately in rivers or in shallow hand-dug pits posing health risk.

CHAPTER FIVE: CONCLUSION, RECOMMENDATIONS AND PUBLICATION

This chapter captures conclusion, recommendations and publication of the research findings. The findings are presented chronologically as per the objectives.

5.1 Summary of the Study

The study investigated the political economy analysis of sanitation delivery in Mukuru Kwa Reuben. It examined through political economy lens the sanitation technologies and service provision and the how it affected the availability, accessibility, accountability, and affordability of sanitation services. It also explored the roles of formal and informal actors in sanitation delivery, and the gaps between policy and practices. The study established that the type of toilet, and the construction and installation process of the toilet significantly influenced accessibility, availability, affordability and accessibility. There was a significant correlation between accessibility and the cost of constructing/installing the toilet, the providers of toilets, and cost of emptying and transporting excreta/sludge.

However, stepwise criteria of regression analysis only entered type of toilets and construction and installation process as significant predictors of accessibility, availability, affordability and accountability. Although landlords were willing to provide safe sanitation options, a cost of 5000 Ksh for sewer connections was expensive. Manual operators, although reliable for the transportation of fecal sludge, reported poor payment which demoralized them from offering services. It was observed that operation of sanitation systems was constrained by the presence of cartels who controlled water provision. Despite the devolution of sanitation functions, the County Government was perceived as unwilling to service loans for sanitation infrastructure. The policy implementation gaps were noted with the low accessibility of sanitation services, informality of services, partial devolution of

sanitation functions, limited enforcement of regulations, and lack of public private partnership in service provision

5.2 Conclusion

To assess how the type of sanitation technology affects availability, accessibility, accountability, and affordability, the study concludes that the type of sanitation technology significantly influences service outcomes.The study concludes that the type of sanitation technology, providers, operation and maintenance, installation/construction process, emptying and transportation, and excreta/sludge treatment and disposal significantly influenced the availability, accessibility, accountability and affordability. There was a strong relationship between the construction/installation process of the toilet and accessibility. The construction/installation process were linked to improved affordability and availability, depicts the importance of proper technical execution in sanitation projects to ensure effective service delivery. For each unit increase in the type of toilet, the availability score increased by 0.154 units. For each unit increase in the construction/installation process of the toilet, the accessibility score increased by 0.546 standard deviations. The type of toilet and the construction/installation process of the toilet are important factors in predicting affordability, accessibility and availability. This indicates that sanitation technology availability, accessibility and affordability is a key factor in delivering effective and accessible sanitation services.

To examine the role of sanitation service providers (formal and informal actors), both the formal and informal actors' role significantly influenced the availability, accountability, affordability and accessibility of sanitation technologies and services. Regulatory framework for fecal sludge management had an insignificant positive relationship with accountability.

The national government and investors expressed commitment in increasing coverage of sanitation. Sanitation cartels controlled the provision of sanitation services and technologies. Fecal Sludge Management Alliance (FSMA) carried out capacity building and political advocacy for sanitation workers.

The findings highlight there were gaps between the sanitation practices and the implementation of the provisions of the KESSF and KESHP strategic objectives. The study reveals persistent challenges in the construction, accessibility, affordability, and accountability of sanitation services, which impeded the full realization of Kenya's Environmental Sanitation and Hygiene Policy (KESHP) 2016–2030 objectives. The study identified key gaps such as low service accessibility, incomplete devolution, informal dominance, weak enforcement, limited budgets, and minimal public-private partnerships, which hindered full realization of strategic sanitation goals. Difficulties in construction and installation suggest gaps in designing accessible and user-friendly facilities, and conflicts with KESHP's focus on inclusive and universal access (Strategies 1 and 6). The continued reliance on buckets for transporting fecal sludge depicts a lag in the adoption of improved technologies advocated under KESHP Strategies 1 and 2, which seek sustainable, safe waste management systems.

5.3 Recommendations

Sanitation stakeholders should develop and promote innovative, context-appropriate sanitation technologies for containment, emptying, transportation, treatment, and disposal. Technologies must prioritize affordability, accessibility, availability, and sustainability to suit the needs of informal settlements. Pilot programs should test new technologies in real-life settings to ensure they align with community needs and environmental conditions. The

National and County governments should strengthen construction standards and guidelines for sanitation facilities to improve accessibility and affordability. Capacity-building programs for local artisans and contractors should be enhanced to ensure quality construction and installation practices. Develop monitoring and evaluation mechanisms to assess the effectiveness of construction processes in improving sanitation outcomes.

The National and County governments should strategize to formalize and regulate informal and formal sanitation services. The two levels of government should develop frameworks for effective collaboration, coordination, financing, and regulation of sanitation services. The National and County governments should support the capacity-building of informal actors (such as sanitation cartels) to transition into regulated, recognized service providers.

MoWSI, MoH, and relevant agencies should review and harmonize sanitation policies and acts to close gaps and address inconsistencies. The actors should develop clear implementation mechanisms for policies, including timelines, responsible parties, and measurable outcomes. Moreover, they should ensure regular audits, strengthen enforcement and accountability systems, performance evaluations, and reporting mechanisms are in place. Also, the need to increase budgetary allocations for sanitation service improvements and infrastructure in informal settlements.

They should also promote public-private partnerships (PPPs) to leverage additional financing, innovation, and technical expertise. Enhance community engagement strategies, ensuring residents participate in the design, implementation, and monitoring of sanitation services to improve alignment with actual needs. The actors should conduct regular policy reviews and evaluations to ensure progress towards achieving the KESSF and KESHP objectives by 2030.

There is a need for further studies to examine the long-term impact of innovative sanitation technologies on health, environment, and socio-economic outcomes. Moreover, the need to evaluate the effectiveness of harmonized regulatory frameworks on accountability and service delivery. Also, assess the outcomes of capacity-building interventions on service quality, worker safety, and compliance

5.4 Publication

Kiprono, E., Riungu, J. N., & Mukiri, L. (2025). The Technologies used in sanitation delivery in Mukuru Kwa Reuben, Kenya. *African Journal of Science, Technology and Social Sciences,* 4(2), TE 9–17. https://doi.org/10.58506/ajstss.v4i2.278

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APPENDICES

Appendix A: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **379954**

Date of Issue: **03/November/2023**

RESEARCH LICENSE

This is to Certify that Mr.. Erick Cheruiyot Kiprono of Meru University of Science and Technology, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nairobi on the topic: POLITICAL ECONOMY ANALYSIS FOR SANITATION DELIVERY IN INFORMAL SETTLEMENTS: A CASE STUDY OF MUKURU KWA REUBEN, KENYA for the period ending : 03/November/2024.

License No: **NACOSTI/P/23/31138**

379954

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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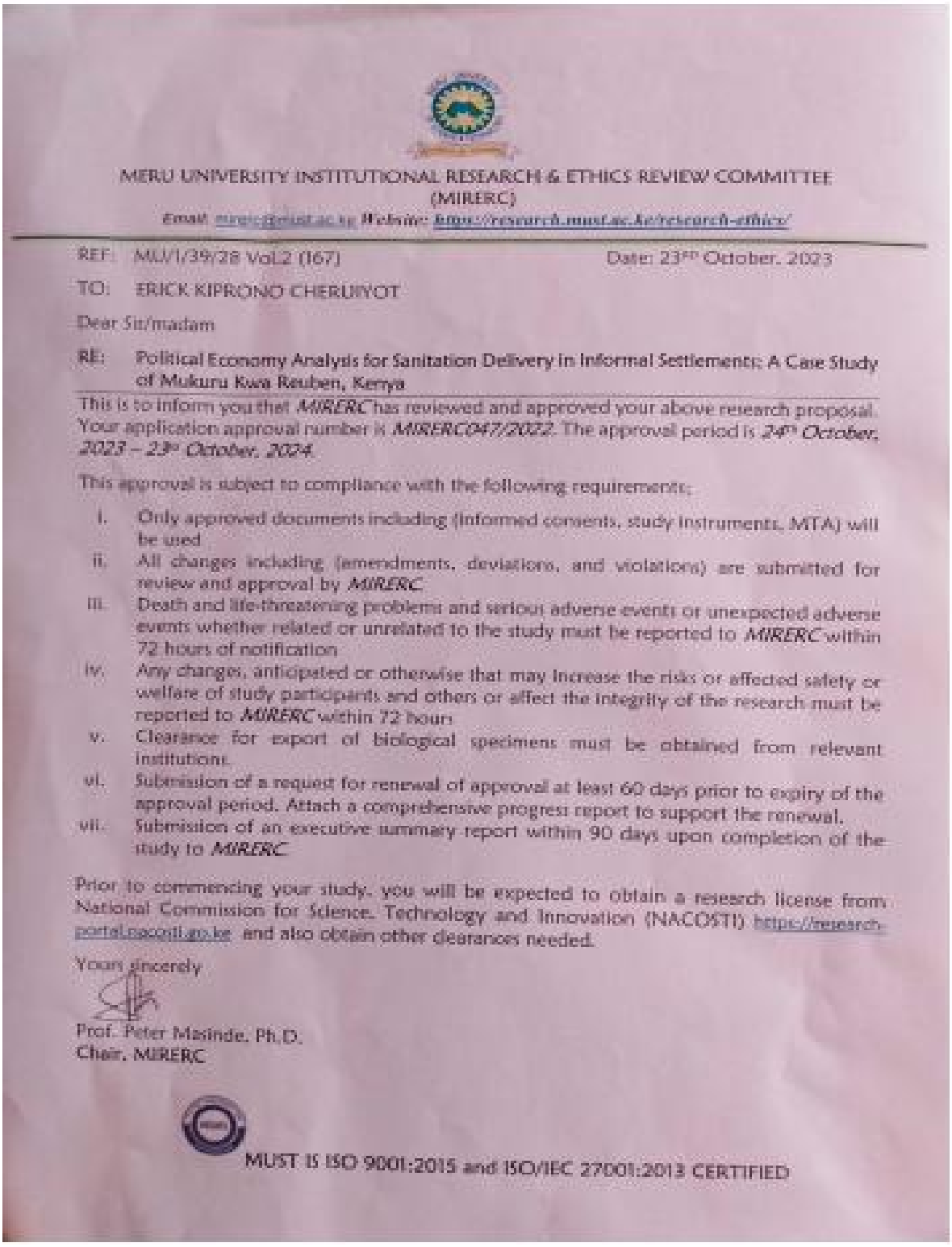
See overleaf for conditions

Appendix B: Ethics Letter



MERU UNIVERSITY INSTITUTIONAL RESEARCH & ETHICS REVIEW COMMITTEE
(MIRERC)
Email: mirerc@must.ac.ke Website: https://research.must.ac.ke/research-ethics/

REF: MU/1/39/28 Vol2 (167) Date: 23RD October, 2023

TO: ERICK KIPRONO CHERUIYOT

Dear Sir/madam

RE: Political Economy Analysis for Sanitation Delivery in Informal Settlements: A Case Study of Mukuru Kwa Reuben, Kenya

This is to inform you that *MIRERC* has reviewed and approved your above research proposal. Your application approval number is *MIRERC047/2022*. The approval period is *24th October, 2023 – 23rd October, 2024*.

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by *MIRERC*
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to *MIRERC* within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to *MIRERC* within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to *MIRERC*

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely

Prof. Peter Masinde, Ph.D.
Chair, MIRERC

MUST IS ISO 9001:2015 and ISO/IEC 27001:2013 CERTIFIED

Appendix C:Introductory Letter

MERU UNIVERSITY
OF SCIENCE & TECHNOLOGY

P.O Box, 972-60200 Meru-Kenya
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Email: info@must.ac.ke *Website:*www.must.ac.ke

SANITATION RESEARCH INSTITUTE (SRI)

OUR REF: 03(46)-23

Date: 3rd/11/2023

To: National Commission for Science Technology and Innovation (NACOSTI),
Off Waiyaki Way, Upper Kabete,
P. O. Box 30623, 00100 Nairobi, KENYA.
Dear Sir/Madam,

Dear Sir/ Madam,
RE: INTRODUCTORY LETTER FOR MR. ERICK KIPRONO, REG NO: EG407/201058/20

Mr. Erick Kiprono is a student enrolled in the Master of Science in Sanitation program at Meru University of Science and Technology. The student has been approved to conduct research on "**Political Economy Analysis for Sanitation Delivery in Informal Settlements: A Case Study of Mukuru Kwa Reuben, Kenya**."

As part of our institution's commitment to academic excellence and practical impact in the field of sanitation, the proposal holds a significant promise in providing insights and potential solutions to the sanitation challenges prevalent in the informal settlements. The study has the potential to contribute substantially to the development of innovative approaches and policies for improving sanitation practices in these settings.

We kindly request your office's support in granting the student the research permit. The research adheres to ethical considerations and was approved under

MIRERC047/2022 and will be conducted in compliance with your regulatory requirements and University guidelines.

Should you require any additional information or clarification, please do not hesitate to contact us. Your support in this matter is deeply appreciated.

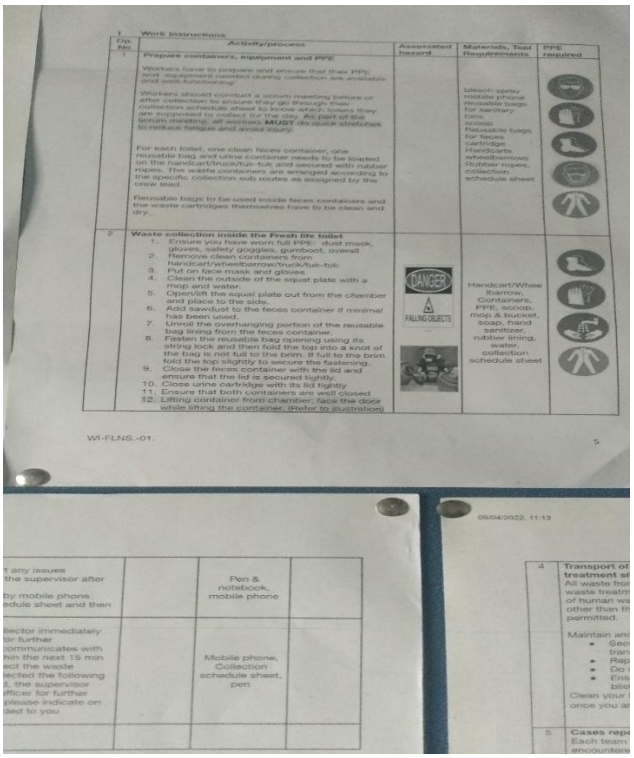
Yours faithfully,

Dr. Joy Riungu,
Director, Sanitation Research Institute

Appendix D:Technologies for Containment and Storage

Appendix E:Technologies for Emptying and Transportation

Appendix F:Technologies, Operation and Maintenance



1 Work Instructions

Op No	Activity/process	Associated hazard	Materials, Tool Requirements	PPE required
1	**Prepare containers, equipment and PPE** Workers have to prepare and ensure that their PPE and equipment needed during collection are available and well functioning Workers should conduct a scrum meeting before or after collection to ensure they go through their collection schedule sheet to know which toilets they are supposed to collect for the day. As part of this scrum meeting, all workers **MUST** do quick stretches to reduce fatigue and avoid injury. For each toilet, one clean feces container, one reusable bag and urine container needs to be loaded on the handcart/truck/tuk-tuk and secured with rubber ropes. The waste containers are arranged according to the specific collection sub routes as assigned by the crew lead. Reusable bags to be used inside feces containers and the waste cartridges themselves have to be clean and dry.		bleach spray rubber phone reusable bags for sanitary bins scoop Reusable bags for feces cartridge Handcarts wheelbarrows Rubber ropes, collection schedule sheet	
2	**Waste collection inside the Fresh life toilet** 1. Ensure you have worn full PPE: dust mask, gloves, safety goggles, gumboot, overall 2. Remove clean containers from handcart/w'heelbarrow/truck/tuk-tuk 3. Put on face mask and gloves 4. Clean the outside of the squat plate with a mop and water. 5. Open/lift the squat plate out from the chamber and place to the side. 6. Add sawdust to the feces container if minimal has been used. 7. Unroll the overhanging portion of the reusable bag lining from the feces container. 8. Fasten the reusable bag opening using its string lock and then fold the top into a knot of the bag is not full to the brim. If full to the brim fold the top slightly to secure the fastening. 9. Close the feces container with the lid and ensure that the lid is secured tightly. 10. Close urine cartridge with its lid tightly 11. Ensure that both containers are well closed 12. Lifting container from chamber: face the door while lifting the container. (Refer to illustration)	DANGER FALLING OBJECTS	Handcart/Wheelbarrow, Containers, PPE, scoop, mop & bucket, soap, hand sanitizer, rubber lining, water, collection schedule sheet	

WI-FLNS.-01. 5

09/04/2022, 11:13

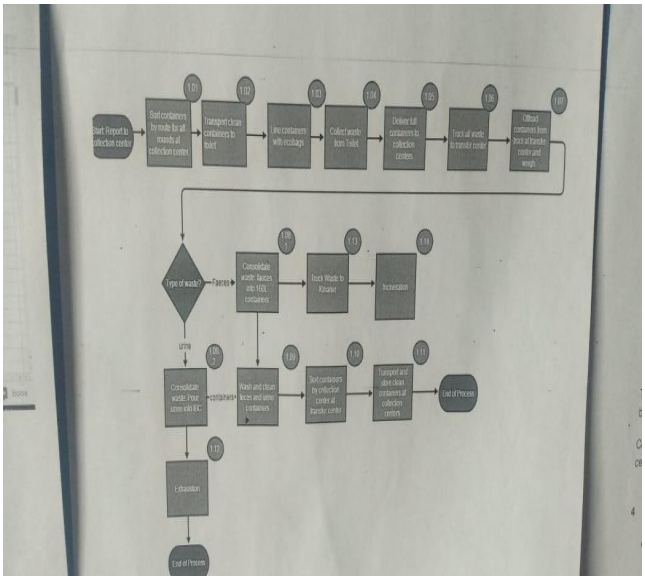
t any issues the supervisor after by mobile phone edule sheet and then		Pen & notebook, mobile phone	
llector immediately or further ommunicates with nin the next 15 min ect the waste lected the following l, the supervisor fficer for further please indicate on ded to you		Mobile phone, Collection schedule sheet, pen	

4 **Transport of treatment s** All waste fro waste treatm of human wa other than th permitted.

Maintain an
- See tran
- Reg
- Do
- Ens bla

Clean your once you a

5 **Cases rep** Each team encounter


Start: Report to collection center
Sort containers by route to all rounds at collection center
Transport clean containers to toilet
Line containers with ecobags
Collect waste from Toilet
Deliver full containers to collection centers
Truck all waste to transfer center
Offload containers from truck at transfer center and weigh
Type of waste?
Faeces
Consolidate waste: faeces into 1 KGL containers
Truck Waste to Kisumu
Incineration
urine
Consolidate waste: Pour urine into IEC
container
Wash and clean faces and urine containers
Sort containers by collection centre at transfer center
Transport and store clean containers at collection centers
End of Process
Evaporation
End of Process

Appendix G:Originality Report

DrillBit

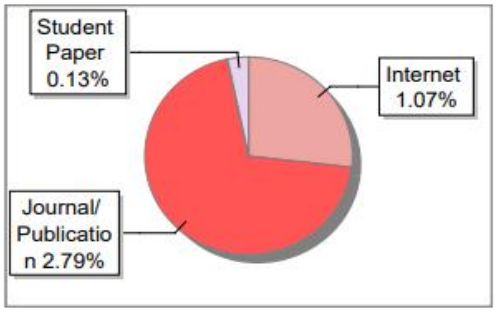
The Report is Generated by DrillBit Plagiarism Detection Software

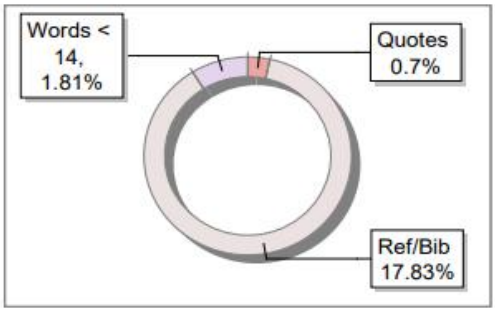
Submission Information

Author Name	ERICK KIPRONO CHERUIYOT
Title	POLITICAL ECONOMY ANALYSIS FOR SANITATION DELIVERY IN INFORMAL SETTLEMENTS: A CASE STUDY OF MUKURU KWA REUBEN, KENYA
Paper/Submission ID	1710213
Submitted by	mmusungu@must.ac.ke
Submission Date	2024-04-28 16:43:27
Total Pages	146
Document type	Thesis

Result Information

Similarity **4 %**





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Quotes	Not Excluded
References/Bibliography	Excluded
Sources: Less than 14 Words %	Not Excluded
Excluded Source	**1 %**
Excluded Phrases	Not Excluded

Database Selection

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

A Unique QR Code use to View/Download/Share Pdf File

Appendix H: Publication

AFRICAN JOURNAL OF SCIENCE, TECHNOLOGY AND SOCIAL SCIENCES, 4 (2) 2025, TE 10-18

OPEN ACCESS

AFRICAN JOURNAL OF SCIENCE, TECNOLOGY AND SOCIAL SCIENCES

Journal website: https://journals.must.ac.ke

A publication of Meru University of Science and Technology

The technologies used in sanitation delivery in Mukuru kwa Reuben, Kenya.

Erick Kiprono[1], Joy Nyawira Riungu[1], Kirimi Lillian Mukiri[1]*

[1]*Meru University of Science and Technology, Meru, Kenya*

ARTICLE INFO

KeyWords:

Sanitation

Technology

Treatment plants,

Pit latrines

Septic tanks

ABSTRACT

The Sustainable Development Goals agenda 6.2 aims to improve access to safely managed sanitation by 2030. However, the sewer system serves only 17 % of the Sub-Saharan African population in informal settlements. Possible interventions and options to address sanitation issues in informal settlements have been advanced through research. However, upscaling and improving sanitation in informal settlements has been a challenge. The study investigated the technologies used in sanitation delivery in Mukuru Kwa Reuben. The study employed a descriptive survey design. The unit of analysis was the household level. The target population comprised the household heads involved in sanitation service provisions. Cluster and simple random sampling technique enrolled 100 household heads from 10 clustered administrative units. Data from the questionnaires and structured observations were analyzed using SPSS version 25, applying both descriptive and inferential statistics at the 5% significance level. The sanitation technologies for containment and storage of excreta/sludge included pit latrine, fresh life toilet, pour flush, cistern flush, and composting toilet. In emptying and transportation, eco bags, washing machines, transfer stations, buckets, urine containers, hand carts, trucks, and sewers were used. The excreta/sludge treatment/disposal options encompass treatment plants, septic tanks, open grounds, rivers, and landfills. There was a moderate positive correlation between accessibility and the construction/installation process of the toilet ($r = .546$, $p < .001$). There was statistically significant variation in the provision of sanitation technologies for emptying and transportation of sludge/excreta concerning accessibility ($p = 0.013$), availability ($p = 0.047$), and accountability ($p < 0.001$). The study concludes there was significant variation in the type of sanitation technology used and its construction/installation process which influenced the affordability, accessibility, and availability of sanitation technologies. The study recommends upscaling of compositing toilets, sewers, and treatment plants.

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https://doi.org/10.58506/ajstss.v4i2.278

AFRICAN JOURNAL OF SCIENCE, TECHNOLOGY AND SOCIAL SCIENCES, ISSN:2958-0560