

Challenges and Opportunities in Fecal Sludge Management: A Case Study of Kampala Capital City

Authority (KCCA)

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Abstract

This study investigated the challenges and opportunities in fecal sludge management (FSM) within Kampala, focusing on the role of Kampala Capital City Authority (KCCA) in managing the city's sanitation system. A mixed-methods approach, combining surveys and key informant interviews, was employed to gather data from various stakeholders, including KCCA officials, sanitation service providers, and local community members. The study found that inadequate infrastructure, financial constraints, and poor stakeholder coordination were the primary barriers to effective FSM. Infrastructure deficits, such as the lack of adequate treatment facilities and transportation networks, were identified as the most significant challenges. Financial limitations were also found to impede the development of sustainable FSM systems, and poor coordination between stakeholders contributed to inefficiencies in FSM management. A logistic regression model revealed that factors such as infrastructure adequacy, stakeholder coordination, and financial resources were statistically significant predictors of FSM success, with improvements in these areas correlating to higher success rates. Despite these challenges, the study identified promising opportunities for FSM improvement, particularly through the adoption of decentralized treatment systems, community-based management approaches, and increased public-private partnerships. The study concluded that addressing the infrastructure gap, improving stakeholder coordination, and investing in decentralized solutions and capacity building were essential to improving FSM practices in Kampala. Based on these findings, the study recommended enhancing infrastructure development, strengthening coordination among stakeholders, and promoting decentralized systems as key strategies for improving FSM in the city. These recommendations aim to provide practical solutions for overcoming the challenges in Kampala's FSM system and contribute to the city's efforts to ensure more sustainable and effective sanitation services.

Key Words: Fecal Sludge, Management. KCCA, Challenges and Opportunities

Background of the Study

Fecal sludge management (FSM) is an essential element of urban sanitation systems, particularly in rapidly urbanizing cities like Kampala, Uganda. As the population grows and urbanization accelerates, the demand for comprehensive sanitation services has intensified. In Kampala, where a large percentage of households rely on onsite sanitation systems, such as pit latrines and septic tanks, managing the disposal and treatment of fecal sludge has become a significant challenge (Jothinathan & Singh, 2023). The urban population of Kampala is estimated to exceed 2 million people, many of whom live in informal settlements where sanitation infrastructure is often inadequate or poorly maintained. As a result, fecal sludge accumulation in these areas, if not properly managed, poses significant environmental and public health risks (Rath et al., 2020). The direct impact of inadequate fecal sludge management includes the contamination of groundwater, the spread of waterborne diseases, and increased exposure to harmful pathogens, leading to outbreaks of diseases like cholera, typhoid,

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and dysentery (Maqbool et al., 2023). Additionally, poorly managed fecal sludge contributes to the degradation of the urban environment, with overflowing pit latrines and septic tanks causing unpleasant odors, air pollution, and unsightly public spaces, further undermining the quality of life for residents (Devaraj et al., 2021).

Kampala Capital City Authority (KCCA), the governing body responsible for the city's urban planning and sanitation management, has made strides in addressing the sanitation challenges posed by fecal sludge. However, KCCA faces several systemic issues that hinder the effective management of fecal sludge. One of the primary challenges is the lack of comprehensive waste treatment infrastructure (Harper et al., 2020). While the city has established a few treatment facilities, these are often insufficient to handle the growing volumes of fecal sludge generated, particularly in densely populated and rapidly expanding informal settlements. The collection and transportation systems are often inadequate, with limited coverage and insufficient fleet capacity to meet demand. Furthermore, the personnel and technical expertise required to manage fecal sludge systems effectively remain limited, contributing to inefficient and unsafe handling practices (Peletz et al., 2020). In many instances, the existing systems are overburdened, and fecal sludge may be left untreated or improperly disposed of, exacerbating pollution and the risk of disease outbreaks. The scarcity of resources allocated to FSM by local authorities, combined with the city's inability to prioritize the issue due to competing urban development needs, complicates the implementation of more sustainable FSM solutions (Andriessen et al., 2023).

In recent years, there has been a growing recognition of the need to address the gaps in FSM in Kampala. Opportunities exist to improve FSM systems through innovative technologies, community-based solutions, and policy reforms. For instance, decentralized treatment systems like bio-digesters and small-scale treatment plants have shown potential in effectively managing fecal sludge, particularly in informal settlements (Schrecongost et al., 2020). These technologies are often more affordable and adaptable to the urban context of Kampala, where centralized treatment plants may not be feasible due to space constraints and high costs. Furthermore, initiatives such as public-private partnerships and community-driven sanitation programs have demonstrated success in empowering local communities to take ownership of their sanitation practices (Dickson-Gomez et al., 2023). These community-based approaches can ensure that FSM solutions are culturally appropriate, affordable, and sustainable. Additionally, the use of data and technology, such as geographic information systems (GIS) and mobile applications, could enhance the planning, monitoring, and evaluation of FSM systems, leading to more efficient service delivery (Dickin & Gabrielsson, 2023).

Fecal sludge management (FSM) is a critical issue in urban sanitation, particularly in rapidly growing cities in the Global South. Several studies highlight the challenges faced by cities like Kampala in managing fecal sludge. A key challenge is the inadequacy of sanitation infrastructure, which is often unable to cope with the growing urban population. According to (Werkneh & Gebru, 2023), inadequate waste treatment and collection systems contribute to widespread environmental pollution and health risks, particularly in informal settlements where sanitation coverage is low. The use of traditional onsite sanitation systems, such as pit latrines and septic tanks, is common in many developing countries, but these systems are prone to overflows, leakage, and improper disposal of untreated sludge. In Kampala, similar challenges have been reported, with studies indicating that the city's fecal sludge collection and disposal mechanisms are insufficient to meet the increasing

demand (Alexander, 2023). Furthermore, a lack of technical expertise and underfunded local authorities exacerbate the problem, leaving the city unable to effectively address the growing sanitation crisis.

However, there are opportunities to improve FSM systems through innovative approaches. According to a study by (Conaway et al., 2023), decentralized treatment systems, such as bio-digesters and small-scale treatment plants, can be effective in managing fecal sludge in urban areas with high population density. These systems are more affordable, sustainable, and adaptable to the unique challenges faced by cities like Kampala. In addition, community-driven approaches to FSM have proven to be beneficial in encouraging local ownership and participation in sanitation management. A study by (Oyoo et al., 2023) emphasizes the importance of public-private partnerships and community engagement in creating scalable FSM solutions. These approaches not only improve waste management but also enhance public awareness about the health risks of improper sanitation. Thus, while Kampala faces significant FSM challenges, there is potential for sustainable solutions through a combination of technology, community involvement, and policy reforms that can significantly improve the city's sanitation landscape.

Problem Statement

Kampala, like many other rapidly urbanizing cities in the Global South, faces significant challenges in managing fecal sludge due to inadequate infrastructure and limited technical expertise. The city's sanitation system, which heavily relies on onsite sanitation technologies like pit latrines and septic tanks, struggles to effectively manage the large volumes of fecal sludge generated, particularly in informal settlements. As a result, improper sludge disposal leads to the contamination of water sources, the spread of waterborne diseases, and environmental degradation. Despite the existence of sanitation interventions, such as limited treatment plants and waste collection services, the infrastructure in place is often overburdened and insufficient to meet the growing demand. The lack of coordinated efforts between stakeholders, coupled with a lack of investment in FSM, has resulted in persistent public health risks and environmental hazards (Li et al., 2017). This problem is compounded by the rapid population growth and urban expansion in Kampala, further exacerbating the existing sanitation challenges.

Although Kampala Capital City Authority (KCCA) has recognized the importance of fecal sludge management, the city's ability to address these challenges remains hindered by financial constraints, lack of capacity, and underdeveloped policies and regulations. There are limited data on the extent of fecal sludge generation and management, which complicates effective planning and decision-making (Majeed et al., 2022). Furthermore, while there is potential for introducing innovative FSM solutions, such as decentralized treatment systems and community-based management approaches, their implementation has been slow and fragmented. Consequently, fecal sludge continues to be poorly managed in Kampala, negatively affecting public health, urban environments, and overall quality of life (Tembo & Abdullahi, 2023). This study aims to explore the challenges and opportunities in fecal sludge management within Kampala, focusing on KCCA's role, in order to propose actionable recommendations for improving FSM practices and ensuring more sustainable sanitation solutions in the city.

Objectives of the study

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1. To assess the current fecal sludge management practices and infrastructure within Kampala, focusing on the roles and responsibilities of KCCA.
2. To identify the key challenges and barriers to effective fecal sludge management in Kampala.
3. To evaluate potential opportunities and innovative solutions for enhancing fecal sludge management in Kampala.

Study Hypotheses

1. H1: Inadequate infrastructure and limited technical capacity significantly hinder the effectiveness of fecal sludge management (FSM) in Kampala.
2. H2: The implementation of decentralized treatment systems and community-based approaches will improve the efficiency and sustainability of FSM in Kampala.
3. H3: Financial constraints and the lack of coordinated stakeholder involvement are key barriers to improving fecal sludge management practices in Kampala.

Methods

The study employed a mixed-methods approach to investigate the challenges and opportunities in fecal sludge management (FSM) in Kampala, focusing on the role of Kampala Capital City Authority (KCCA). The primary data were collected through a combination of quantitative and qualitative techniques. The sample size for the quantitative survey consisted of 200 respondents, including KCCA officials, sanitation service providers, and local community representatives. These individuals were selected using a stratified random sampling technique to ensure a representative distribution across different sectors of the city, including informal settlements, formal neighborhoods, and service providers. In addition, 30 key informant interviews were conducted with stakeholders involved in FSM, including experts, policymakers, and community leaders, to gain deeper insights into the qualitative aspects of the challenges and opportunities associated with FSM. Secondary data were gathered from online sources, such as reports from KCCA, the Ministry of Water and Environment, and other international sanitation organizations, to supplement the primary data and provide contextual background.

To analyze the data, the study employed several statistical methods. Descriptive statistics were first used to summarize the survey data, including the distribution of responses on FSM practices, infrastructure, and challenges. This was followed by inferential statistical analysis using regression modeling to examine the relationships between different factors affecting FSM in Kampala. Specifically, logistic regression was applied to explore the likelihood of successful FSM practices based on variables such as infrastructure adequacy, stakeholder coordination, and financial investment. The logistic regression model was formulated as follows:

$$\text{logit}(P) = \beta_0 + \beta_1 \text{Infrastructure} + \beta_2 \text{Coordination} + \beta_3 \text{Financial Resources} + \epsilon$$

Where P is the probability of successful FSM implementation. The logistic regression model was chosen due to the binary nature of the dependent variable (successful or unsuccessful FSM), and it allowed for an examination of the factors that increased the likelihood of FSM success (Nelson et al., 2023). In addition to logistic

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regression, a thematic analysis was conducted on the qualitative interview data to identify recurring themes and patterns related to the challenges and opportunities in FSM. This analysis was crucial in understanding the deeper, context-specific factors that affect FSM practices, such as local governance structures, cultural attitudes toward sanitation, and the role of community engagement. All the analysis was done STATA (Nelson et al., 2022). The findings from both the quantitative and qualitative analyses were triangulated to provide a comprehensive understanding of the FSM situation in Kampala and to validate the results of the statistical tests. This mixed-methods approach enabled the study to address the research objectives thoroughly, linking the statistical models to the study’s primary focus on identifying key barriers and opportunities for improving fecal sludge management practices in the city.

Results.

Table 1: Descriptive Statistics of Survey Respondents

Category	Frequency	Percentage (%)
Respondent Type		
KCCA Officials	50	25%
Sanitation Service Providers	70	35%
Local Community Members	80	40%
Location of Respondents		
Informal Settlements	90	45%
Formal Neighborhoods	60	30%
Service Providers Areas	50	25%
FSM Practices		
Pit Latrines	100	50%
Septic Tanks	80	40%
Decentralized Treatment Systems	20	10%

The sample comprised a balanced distribution of respondents from KCCA officials (25%), sanitation service providers (35%), and local community members (40%). The majority of respondents (50%) were from informal settlements, highlighting the significant sanitation challenges faced in these areas. The data revealed that pit latrines (50%) were the most common sanitation system used, followed by septic tanks (40%). Only 10% of respondents indicated the use of decentralized treatment systems, pointing to the limited adoption of innovative FSM solutions in the city.

Table 2: Logistic Regression Model of FSM Success Factors

Variable	Coefficient (β)	Standard Error	Z-Value	P-Value
Intercept	-1.23	0.45	-2.73	0.006
Infrastructure Adequacy	0.82	0.32	2.56	0.011
Coordination Among Stakeholders	0.75	0.28	2.68	0.007

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Financial Resources | 0.55 0.25 2.20 0.028

The logistic regression results indicated that all three independent variables—*infrastructure adequacy*, *coordination among stakeholders*, and *financial resources*—were statistically significant predictors of successful FSM practices in Kampala. Specifically, an improvement in infrastructure adequacy ($\beta = 0.82$, $p = 0.011$), better coordination among stakeholders ($\beta = 0.75$, $p = 0.007$), and increased financial resources ($\beta = 0.55$, $p = 0.028$) were all associated with a higher likelihood of successful FSM implementation. These results suggested that addressing these factors could enhance FSM outcomes in the city.

Table 3: Challenges to FSM Management in Kampala (Survey Responses)

Challenge	Frequency	Percentage (%)
Inadequate Infrastructure	120	60%
Lack of Financial Resources	110	55%
Poor Stakeholder Coordination	90	45%
Limited Technical Expertise	80	40%
Insufficient Public Awareness	70	35%

The survey results indicated that *inadequate infrastructure* was the most commonly cited challenge to FSM management, with 60% of respondents highlighting this issue. This was closely followed by *lack of financial resources* (55%) and *poor stakeholder coordination* (45%). These findings confirmed that infrastructure deficits, limited funding, and coordination failures were the primary barriers to effective FSM in Kampala. *Limited technical expertise* (40%) and *insufficient public awareness* (35%) were also significant but less prevalent concerns.

Table 4: Opportunities for FSM Improvement in Kampala (Survey Responses)

Opportunity	Frequency	Percentage (%)
Decentralized Treatment Systems	150	75%
Community-based Management	140	70%
Public-Private Partnerships	120	60%
Capacity Building and Training	110	55%
Increased Financial Investment	100	50%

The survey revealed that respondents saw *decentralized treatment systems* (75%) and *community-based management* (70%) as the most promising opportunities for improving FSM in Kampala. Public-private partnerships (60%) and *capacity building and training* (55%) were also identified as key strategies for enhancing FSM practices. Financial investment (50%) was perceived as essential, but less emphasized compared to other factors. These opportunities highlighted the need for innovative and locally adapted solutions to address FSM challenges effectively.

Table 5: Correlation Matrix for FSM Variables

Variable	Infrastructure Adequacy	Coordination	Financial Resources	FSM Success
Infrastructure Adequacy	1.00	0.65	0.59	0.73

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<i>Coordination</i>	0.65	1.00	0.62	0.74
<i>Financial Resources</i>	0.59	0.62	1.00	0.69
<i>FSM Success</i>	0.73	0.74	0.69	1.00

The correlation matrix revealed strong positive relationships between the key variables. *Infrastructure adequacy*, *coordination among stakeholders*, and *financial resources* all showed strong correlations with FSM success, with values ranging from 0.65 to 0.74. The highest correlation was between *coordination* and *FSM success* ($r = 0.74$), indicating that effective stakeholder coordination was particularly crucial for the success of FSM practices in Kampala. These correlations supported the findings from the logistic regression analysis, reinforcing the importance of these factors in achieving successful FSM outcomes.

Table 6: Thematic Analysis of Key Informant Interviews

<i>Theme</i>	<i>Frequency</i>	<i>Percentage (%)</i>
<i>Lack of Infrastructure</i>	25	83%
<i>Stakeholder Engagement Issues</i>	20	67%
<i>Financial Constraints</i>	15	50%
<i>Limited Awareness of FSM Benefits</i>	10	33%

The thematic analysis of key informant interviews reinforced many of the survey findings, with *lack of infrastructure* (83%) and *stakeholder engagement issues* (67%) being the most frequently mentioned barriers to FSM. *Financial constraints* (50%) and *limited awareness of FSM benefits* (33%) were also frequently discussed, though to a lesser extent. These qualitative insights provided additional context for understanding the structural and social challenges affecting FSM management, highlighting the need for more focused efforts on infrastructure development, stakeholder collaboration, and public education.

Discussion of Results

The results of the study highlighted several key challenges and opportunities in fecal sludge management (FSM) in Kampala, which were closely aligned with the findings from the literature review. The study found that *inadequate infrastructure* (60%) was the most significant barrier to effective FSM, a finding that corroborated the observations of several scholars (e.g., McConville et al., 2019) who emphasized that poor infrastructure, particularly the lack of treatment facilities and transportation networks, was a central challenge in urban sanitation systems in developing countries. The shortage of proper infrastructure often leads to the overburdening of existing systems, resulting in improper waste disposal and the contamination of water sources (Kleemann et al., 2021), a challenge that Kampala’s FSM system continues to face, as evidenced by the high percentage of respondents identifying infrastructure issues.

The *lack of financial resources* was another critical challenge identified, with 55% of respondents pointing to this as a significant obstacle. This finding was consistent with the literature, which has highlighted that financial constraints are a pervasive issue in FSM, particularly in rapidly urbanizing cities in sub-Saharan Africa (Kabwe et al., 2017). The limited allocation of funds for sanitation infrastructure and management in developing cities has resulted in underdeveloped or poorly maintained systems, leading to inefficient FSM practices. This lack of investment has been compounded by weak institutional frameworks and insufficient technical expertise, as was

highlighted by Zubairu et al. (2020), who pointed out the need for increased financial commitment to improve FSM infrastructure and services.

Coordination among stakeholders emerged as a key factor influencing FSM success, with 45% of respondents identifying poor coordination as a challenge. This finding supported the literature, which suggested that the fragmentation of roles and responsibilities among different stakeholders—such as government agencies, private sector actors, and local communities—has hindered effective FSM

Conclusion

This study examined the challenges and opportunities in fecal sludge management (FSM) in Kampala, with a focus on the role of Kampala Capital City Authority (KCCA). The findings revealed several significant barriers to effective FSM, including inadequate infrastructure, financial constraints, and poor stakeholder coordination, which were identified as the primary obstacles to FSM success in the city. These results aligned with existing literature, which consistently highlighted infrastructure deficits and financial limitations as key challenges in the sanitation sector across many developing urban areas. The study also emphasized the importance of coordination between various stakeholders, which has been shown in previous research to be crucial for the success of FSM programs.

Despite these challenges, the study also identified several promising opportunities for improving FSM in Kampala. These included the potential for *decentralized treatment systems* and *community-based management* approaches, both of which were viewed favorably by the respondents. Previous studies have also suggested that decentralized systems can enhance FSM efficiency, particularly in areas where centralized systems are not feasible due to financial or logistical constraints (McConville et al., 2019; Kabwe et al., 2017). Furthermore, the study found that increasing *financial investment* and enhancing *public-private partnerships* were vital strategies that could help address the financial gaps in FSM infrastructure and service delivery. The findings from the thematic analysis underscored the need for greater public awareness of FSM benefits and the importance of building local capacity to ensure sustainable and community-driven solutions.

The study's results contribute to a better understanding of FSM challenges and opportunities in Kampala and offer valuable insights for policymakers, KCCA, and other stakeholders. By addressing the identified challenges—particularly those related to infrastructure, financial resources, and stakeholder coordination—and capitalizing on the opportunities for decentralized systems and community engagement, Kampala

Recommendations

Enhance Infrastructure Development and Maintenance. Given that inadequate infrastructure was identified as a significant barrier to effective fecal sludge management (FSM) in Kampala, it is crucial for Kampala Capital City Authority (KCCA) and other relevant stakeholders to prioritize the development and maintenance of sanitation infrastructure. This includes the expansion of treatment facilities, improvement of waste transportation networks, and investment in more resilient waste disposal systems. Additionally, regular maintenance of existing infrastructure should be ensured to prevent system failures and avoid further deterioration of sanitation services. Public-private partnerships (PPPs) should also be explored to help finance

the development of FSM infrastructure, which can significantly alleviate the financial burden on local authorities.

Strengthen Stakeholder Coordination and Community Engagement. The study found that poor coordination among stakeholders was a major obstacle to FSM success. To address this, KCCA should establish a robust framework for coordinating the roles and responsibilities of all relevant parties involved in FSM, including government agencies, private sector actors, non-governmental organizations (NGOs), and local communities. Regular meetings and workshops should be organized to facilitate communication and collaboration among stakeholders. Furthermore, community-based management approaches should be integrated into FSM programs, ensuring that local communities are actively involved in the planning, decision-making, and implementation processes. This could enhance ownership, improve service delivery, and ensure the sustainability of FSM practices.

Promote Decentralized Treatment Systems and Capacity Building. As highlighted by the study, decentralized treatment systems and community-based management approaches hold significant potential for improving FSM in Kampala. Therefore, KCCA should explore and invest in decentralized sanitation solutions, especially in informal settlements and densely populated areas where centralized systems may be impractical. Additionally, it is essential to invest in capacity building and training for both technical staff and community members to equip them with the necessary skills to manage and maintain these systems effectively. This could include training in the operation of decentralized treatment plants, waste management techniques, and awareness campaigns to educate the public on the benefits and proper use of sanitation services.

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