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Original Article

Factors Determining the Actual Emptying Fees for Fecal Sludge in Unplanned Residential Areas of Lusaka District, Zambia

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Factors, Emptying Fees, Fecal Sludge, Unplanned Residential Areas.

ABSTRACT

In Sub-Saharan Africa, and specifically in Zambia, managing fecal sludge presents significant challenges, particularly in the unplanned residential areas of Lusaka where the majority of the population relies on pit latrines. Despite these challenges, the Lusaka Water Supply and Sanitation Company (LWSC) has intensified its efforts to improve sanitation by establishing a dedicated Faecal Sludge Management Unit. This unit not only provides essential services such as the emptying and transportation of fecal sludge but also coordinates with various service providers to ensure that these services are regulated and systematically implemented. The current study used a case study design and explored the factors influencing the determination of emptying fees in these areas, employing a mixed-methods approach that includes both quantitative and qualitative analyses, guided by the Theory of Environmentally Responsible Behavior. The findings from the study reveal that several factors significantly influence the pricing of fecal sludge emptying services. The volume of the pit or septic tank, known as the level of sludge, is the primary factor, accounting for 45.5% of the decision on pricing according to service providers. Other important factors include the distance to the disposal site and the speed of response, each playing a critical role in fee determination. In response to these findings, the study makes several recommendations aimed at improving fecal sludge management in Lusaka. These include promoting flexible regulatory frameworks that accommodate both small-scale and large-scale service providers, establishing standards for pit latrine construction that facilitate easier emptying, and enforcing licensing for service providers to ensure environmental and personal safety. Additionally, the study advocates for educational initiatives on latrine maintenance and the potential reuse of fecal sludge, thereby enhancing the sustainability and effectiveness of sanitation services in the region.

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INTRODUCTION

Fecal sludge management (FSM) is a vital component of sanitation, particularly in densely populated urban areas where poor practices can lead to disease outbreaks. FSM involves the proper containment, emptying, collection, transport, treatment, disposal, or safe reuse of sludge from sanitation systems, with the potential for the recovery of energy and nutrients, creating a circular sanitation value chain (Strande et al. 2014). In this context, sludge is often emptied from pits by either professional service providers using safe technologies or informal emptiers who manually remove the sludge. Despite the availability of these services, the reality is that some providers may irresponsibly dispose the sludge into the environment, such as nearby rivers. Ideally, collected sludge should be transported to treatment plants where it can be safely processed into useful products like compost (Peal et al. 2014).

Sludge is emptied from pits by either professional emptying service providers who use safe technologies or informal emptiers who remove the sludge manually (Peal et al. 2014). Although some corporations or emptiers may dispose of the sludge into adjacent surroundings such as rivers, the sludge is collected in drums or tanks and transferred by trucks to treatment plants (Strande et al. 2014; Peal et al. 2014). Local governments or utilities typically run treatment sites, and a dumping fee may be charged to release sludge for treatment. Pit emptying services must be available and affordable to collect fecal sludge from onsite sanitation technologies and transport it to a treatment facility where it can be safely disposed of after treatment or processed into sludge-based products like compost (Strande et al. 2014).

The majority of pit emptying services are performed by private companies that determine their own fees (Burt et al. 2019; Yesaya and Tilley 2020; Peletz et al. 2020b). Where pit emptying services are available, cost remains an issue, especially for low-income families (Tsinda et al. 2013; Cummings et al. 2016). Many houses that require pit emptying cannot afford it since residents of unplanned peri-urban regions are typically low-income, and prices set by pit emptying service providers are susceptible to pricing signals resulting from changes in the supply and demand for products and services. Subsidies, on the other hand, may give additional charges to help offset the financial burden of pit emptying. Some study has been conducted to determine the willingness to pay (WTP) for toilet usage services such pit emptying (Burt et al. 2019). Subsidies for pit emptying have been implemented to see if safer emptying services can be adopted over unsafe emptying methods or services (Lipscomb and Schechter 2018). In Rwanda, for example, a study determined WTP for enhanced pit emptying services over the use of informal manual pit emptying (Burt et al. 2019).

the study aims to address critical gaps in fecal sludge management (FSM) by identifying the factors influencing emptying fees and

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understanding the socio-economic dynamics affecting service accessibility. The objectives include evaluating the pricing determinants of emptying services, which is vital for crafting effective policies and interventions. This topic holds significant interest for the scientific community as it intersects public health, environmental sustainability, and urban planning, highlighting the urgent need for accurate data and innovative solutions to improve FSM in underserved communities. Ultimately, this research seeks to inform strategies that can lead to more equitable and sustainable sanitation practices.

In such areas of focus the challenges of FSM are exacerbated by infrastructural deficiencies, economic constraints, and a lack of precise data to guide interventions. Yesaya and Tilley 2020; Peletz et al. 2020b). Research shows that even with subsidies intended to reduce the cost burden, FSM services remain costly for the poorest populations (Peletz et al. 2017, 2020b; Burt et al. 2019). Thus, there is a pressing need for a holistic approach that not only enhances infrastructure and reduces financial burdens but also strengthens regulatory frameworks to support sustainable FSM practices. This paper examines the management of fecal sludge in Lusaka's unplanned residential areas, with a focus on identifying effective strategies to tackle the challenges posed by FSM in these communities.

MATERIALS AND METHODS

Study Area

Chazanga Compound, located approximately ten kilometres north of Lusaka City and bordering Chisamba district, is a bustling community with a significant population challenge that has direct implications for faecal sludge management (FSM). The compound, which also borders Chipata compound to the south, Old Kabanana and Chipwalu village to the east, and Lilanda compound of Chisamba district to the west, is home to 38,601 people distributed across 8,000 households. This demographic profile is predominantly youthful, underscoring the need for robust public health and sanitation initiatives. The majority of the residents are engaged in diverse economic activities. About sixty percent own small businesses such as shops, groceries, bars, clubs, and market stalls, while thirty-five percent are employed either by the government or private companies. The remaining five percent are subsistence farmers. This mix of economic activities highlights the community's entrepreneurial spirit but also indicates varied income levels that might affect access to essential services, including sanitation.

Water for domestic uses is primarily sourced from the Chazanga Water Trust, which provides both communal and individual taps. However, the sanitation infrastructure is likely under strain due to the high population density and the informal nature of many of its economic activities. The presence of one government health center (Chazanga Clinic) and a private facility, Bwafwano Integrated Health Services, along with several unregistered clinics, points to a responsive but potentially overwhelmed health infrastructure. This setup underscores the urgency of implementing effective FSM practices to prevent sanitation-related diseases and promote public health in a rapidly growing and economically diverse community like Chazanga.

Chazanga Compound in Lusaka, Zambia, is a typical example of an unplanned residential area facing significant challenges with fecal sludge management (FSM). Like many similar communities, Chazanga is characterized by high population density, inadequate sanitation infrastructure, and limited access to formal sewerage systems. Most residents rely on pit latrines or makeshift sanitation facilities, which necessitates periodic emptying and management of fecal sludge to prevent environmental contamination and health hazards.

The FSM challenges in Chazanga are compounded by economic barriers that limit residents' ability to pay for regular and safe sludge removal services. The infrastructure for transporting and treating fecal sludge is also often inadequate, leading to improper disposal practices that can exacerbate public health risks.

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Furthermore, the lack of detailed, community-specific data hampers the ability to implement targeted and effective FSM solutions tailored to the needs of Chazanga residents.

Research Design

A case study design was used in this research. A case study is a research method for gaining a comprehensive, multi-faceted understanding of a complicated subject in its real-world setting. It is a well-established research strategy that is widely employed across many fields, especially in the social sciences (Stake, 1995). The researcher adopted a case study approach because it is especially effective when an in-depth understanding of an issue, event, or phenomenon of interest is required in its natural real-life setting.

Sample Size

In this study, the sample size of 510 people was determined using a combination of statistical sampling methods to ensure a representative and comprehensive understanding of the fecal sludge management (FSM) challenges in the Chazanga compound. The criteria for selecting this sample size involved several key considerations. Firstly, the population size and diversity of the Chazanga compound necessitated a broad cross-section of the population to be included in the sample, ensuring the findings would reflect the entire community's experiences and needs. Simple random sampling was employed to select the 495 Chazanga residents, ensuring that every member of the population had an equal chance of being included, thus eliminating selection bias. Purposive sampling was used to select the 10 emptiers and 5 community leaders, chosen for their specific characteristics or knowledge relevant to the study. This method ensured that key stakeholders directly involved in FSM practices provided crucial insights into operational and managerial aspects.

The sample size also considered the need for adequate representation of all relevant stakeholders in FSM, including service recipients (residents), service providers (emptiers), and community leaders. The size of 510 was calculated to provide sufficient statistical power for reliable quantitative analysis while remaining manageable for qualitative interviews and observations. Practical considerations such as time, budget, and manpower influenced the sample size, balancing the need for comprehensive data collection with available resources. By using these criteria, the study ensured the sample was both representative of the broader population and capable of providing detailed, actionable insights into the factors affecting FSM in the Chazanga compound.

Sampling Techniques

The researcher selected the inhabitants using simple random sampling in this case. This method of sampling was utilized since it ensures that every member of the population has an equal chance of being chosen as a study sample (White, 2003). Purposive sampling, on the other hand, was used to select community leaders. Purposive sampling, also known as judgmental, selective, or subjective sampling, is a non-probability sampling method in which researchers choose people of the public to participate in their study based on their own judgment. This sampling method necessitates previous understanding of the study's goal in order for researchers to appropriately choose and approach eligible participants. Purposive sampling is used by researchers when they want to reach a certain subset of people, as all study participants are chosen because they fit a specific profile (Alchemer, 2018). This technique was chosen because it assisted the researcher in selecting respondents who provided information relevant to the study.

Research Instruments

This study utilized both interviews and questionnaires as the primary instruments for data collection, aimed at understanding the phenomena under investigation through a comprehensive methodological approach. Interviews were conducted with community leaders using structured interview guides. Kvale (2004) emphasizes that interviews are crucial for

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obtaining detailed descriptions of the participants' lived experiences, which help in providing interpretations of the phenomena under study. Seidman (2012) supports this by noting that interviews are particularly effective for gaining deep insights into significant social issues, especially when exploring the experiences of individuals directly impacted by the research topic. In this study, interviews were instrumental in uncovering nuanced understandings and essential meanings from the community leaders, providing qualitative depth to the research findings.

In addition to interviews, the researcher utilized questionnaires to collect data from a broader respondent base. Saul (2018) describes questionnaires as a series of questions designed to elicit specific information from respondents, functioning similarly to written interviews. This instrument was chosen for its efficiency in gathering data on behaviors, attitudes, preferences, opinions, and intentions from a large number of people. Questionnaires were administered in various modes including in-person, over the phone, on the computer, or by mail, allowing for flexibility in data collection and enhancing the quantitative breadth of the study.

The combination of interviews and questionnaires enabled a mixed-methods approach, providing both qualitative insights and quantitative data. This methodology was selected to maximize the comprehensiveness of the study, ensuring that both in-depth personal experiences and broader behavioral patterns were captured. The use of questionnaires complemented the interviews by quantifying trends and preferences across a larger sample, thereby facilitating an efficient and economical approach to data collection.

The strategic use of interviews and questionnaires in this study effectively gathered a rich array of data, which supported a detailed analysis of the social phenomena being investigated. This dual approach not only enhanced the depth and breadth of the findings but also ensured that the research objectives were met comprehensively. The insights gained from the community leaders through interviews, coupled with the broad data collected via questionnaires, provided a robust foundation for the study's conclusions and recommendations

Data Analysis

The researcher analyzed qualitative data using thematic analysis. Thematic analysis is a method for studying qualitative data that comprises examining a data set for repeating patterns, understanding them, and reporting them (Braun and Clarke 2006). It is a way for describing data, but it also involves interpretation in the selection of codes and the creation of themes. The ability to be employed within a wide range of theoretical and epistemological frameworks, as well as to be applied to a wide range of study questions, designs, and sample sizes, is a defining property of thematic analysis. The quantitative data acquired in this study, on the other hand, was subjected to descriptive analysis. Descriptive analysis is a sort of data analysis that helps to explain, show, or summarize data points in a constructive way so that patterns can develop that satisfies all the data's conditions (Rawat, 2021).

RESULTS

Demographic Characteristics and General Views of Respondents

In Table 4.1 the age range of the respondents in this study was 14-77 years of age with the majority being between 14 and 55 years old. This was seconded by respondents between the age of 35 – 55 years (87) and 55 – 76 years (38). A smaller fraction of respondents was over the age of 77. Age is crucial as it influences behaviors, needs, and perspectives, allowing for the tailoring of interventions and policies to specific age groups.

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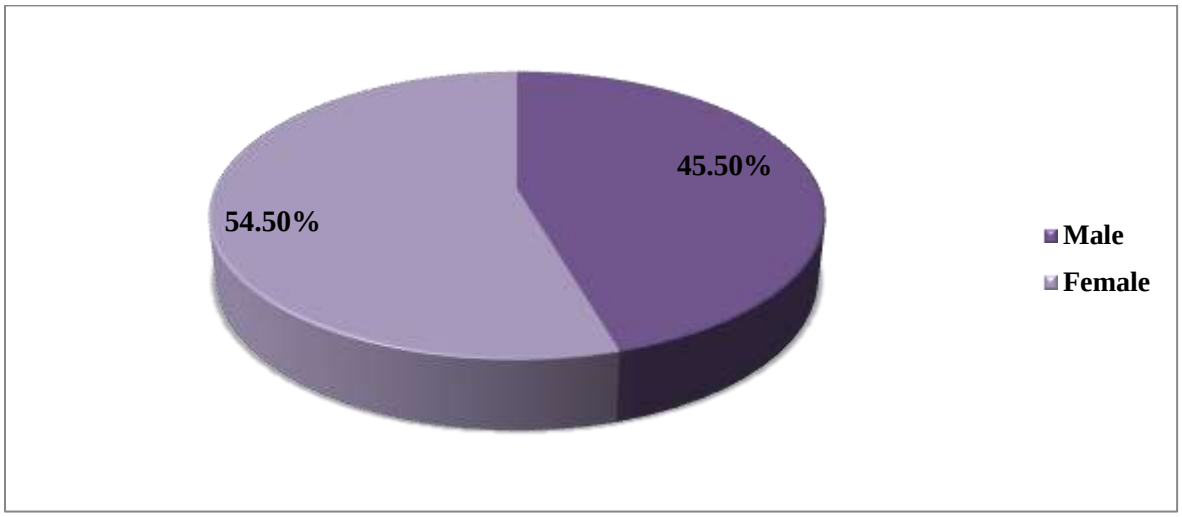
Table 4.1. Age of the respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
14-35 years	309	62.4	62.4	62.4
35 -55 years	87	17.6	17.6	80.0
55 -76 years	61	12.3	12.3	92.3
77 years and above	38	7.7	7.7	100.0
Total	495	100.0	100.0	

Figure 4.1. Gender of respondents.

The results in Figure 4.1. indicate a gender distribution among the respondents with males constituting 54.4% and females comprising 45.5%. This suggests a slightly higher participation rate among males compared to females in the study. Understanding the gender distribution of participants in a study about fecal sludge emptying fees is important because gender can influence perspectives on sanitation, financial decision-making, and household priorities. Men and women may have different experiences and views regarding the importance of sanitation services, which can affect their willingness to pay and how they prioritize these services in their households. Knowing the gender helps in tailoring outreach and educational programs to effectively address and engage all members of the community.

Table 4.2. Educational Level



Under the level of education data, majority of respondents (54.5%) have attained tertiary education. 27.3% (135) of the respondents indicated that their highest level of education is secondary education. 9.1% (45) of the respondents indicated that their highest level of education is primary education. Lastly, 45 respondents indicated that they did not have access to any form of education. Knowing the education levels of participants in a study about the actual emptying fees for fecal sludge was crucial as it can directly influence individuals' understanding and valuation of sanitation services. Higher education levels often correlate with a greater awareness of health and environmental implications, potentially affecting willingness to pay and prioritize such services in household budgets. This understanding allows researchers to better interpret variations in fee acceptance and payment behaviors across different educational backgrounds

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Table 4.3: Education levels of the respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
Not educated	45	9.1	9.1	9.1
Primary	45	9.1	9.1	18.2
Secondary	135	27.3	27.3	45.5
Tertiary	270	54.5	54.5	100.0
Total	495	100.0	100.0	

Figure 4.2. Type of on-site sanitation

With reference to the figure 4.2 below, 63.6% of the respondents indicated that they use pit latrines. Conversely, 36.4% of the respondents indicated that they use septic tanks. This data on the types of sanitation facilities used by respondents is crucial for understanding the infrastructure diversity within the community and informs the design and targeting of emptying services. Knowing the proportion of pit latrines versus septic tanks helps in tailoring specific service requirements and operational strategies for each type of system, ensuring effective and efficient fecal sludge management.

Figure 4.2. Type of onsite sanitation

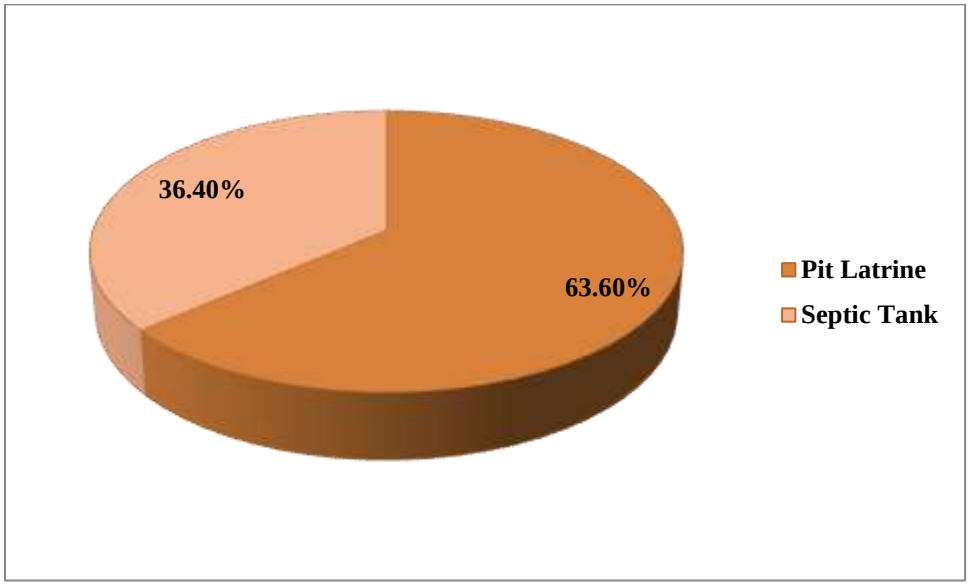

Figure 4.3. Type of service accessed.

As regards types of services accessed, mechanical emptying was cited as the commonest mode of emptying by the respective respondents. 77.6% (384) of the respondents indicated that they access mechanical emptying services. 22.4% (111) indicated that they access manual emptying because it's cheaper and affordable. As regards the types of services offered by the service providers, the findings from the interviews equally indicated that mechanical and manual emptying are the services offered to the residents when emptying pit latrines. In view of the foregoing one of the respondents highlighted that;

> *A traditional mechanized approach is used, and this involves the use of vacuum trucks that are equipped with a vacuum pump designed to remove liquids, sludge's, and slurries from the pits and septic tanks, into the tank of the truck for transport to another location for disposal. However, the manual emptiers mainly use buckets and drums when emptying pit latrines and septic tanks.*

Similarly, another respondent indicated that:

> *Emptying the on-site facilities is done both manually and mechanically; some of the households use manual services. Some*

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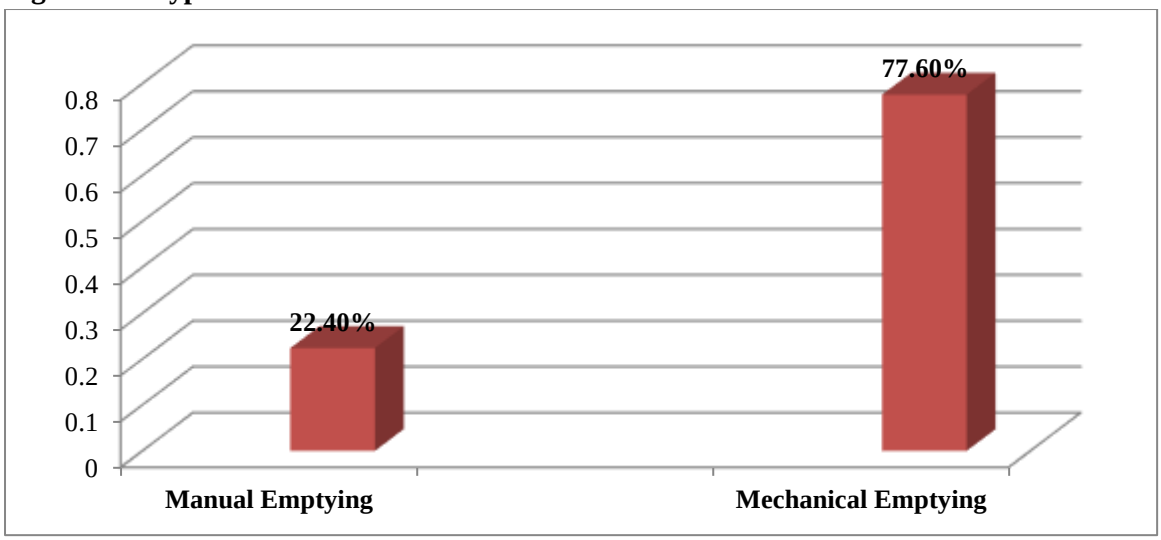
households rely on manual emptying for sludge management. The remaining households use mechanical emptying services that are provided, for the most part, by private operators in the city.

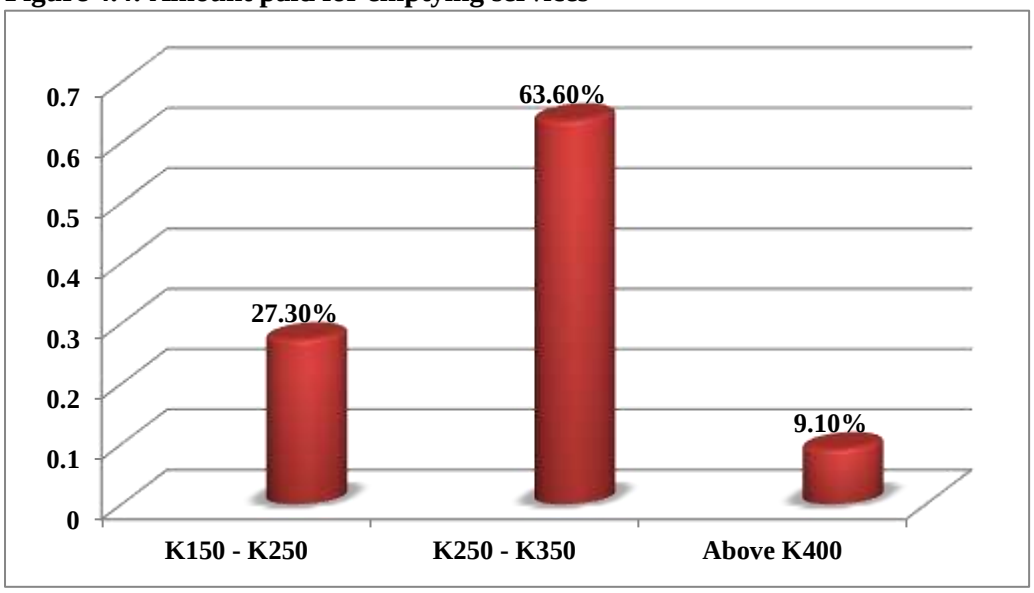
Figure 4.3: Type of service accessed



Amount paid for emptying services

The figure below shows the amount paid for emptying services. According to the figure, majority of the respondents (63.6%) pay K 250 – K 350 for empting services. 27.3% of the respondents indicated that they pay K150 – K250 to access emptying services. Conversely, 9.1% of the respondents indicated that they pay more than K400 to access emptying services. This payment data was crucial as it revealed the prevailing market rates for emptying services within unplanned residential areas of Lusaka district, helping to identify the economic accessibility and affordability of such services. Understanding these cost ranges assisted in evaluating the financial burden on households and the feasibility of current pricing structures in meeting community needs.

Figure 4.4: Amount paid for emptying services



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Further, a Pearson's correlation was done to establish if there is a significant correlation between the amount paid for emptying services and willingness to pay for the service. This was guided by both the null and alternative hypotheses which was stated as follows:

H_0 *– There is a significant correlation between the amount paid for emptying services and willingness to pay for the service.*

H_1 *– There is no significant correlation between the amount paid for emptying services and willingness to pay for the service.*

Table 4.4: correlation table between the amount paid and willingness to pay

Correlations

		Willingness to pay for the service	Amount paid for emptying services
Willingness to pay for the service	Pearson Correlation	1	.390**
	Sig. (2-tailed)		.000
	N	495	495
Amount paid for emptying services	Pearson Correlation	.390**	1
	Sig. (2-tailed)	.000	
	N	495	495

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

Interpretation of results: Since the calculated r value of 0.39 is less than the critical value of 0.495 at the chosen level of significance, the null hypothesis will be accepted while the alternative hypothesis will be rejected.

Decision: This is a moderate correlation and positive correlation which means that there is a significant correlation between the amount paid for emptying services and willingness to pay for the service. It was therefore concluded that there is a significant correlation between the amount paid for emptying services and willingness to pay for the service.

The results of the Pearson's correlation were supported by the receiver operating characteristic curve (ROC curve). The test result variable(s): Amount paid for emptying services has at least one tie between the positive actual state group and the negative actual state group. The smallest cutoff value is the minimum observed test value minus 1, and the largest cutoff value is the maximum observed test value plus 1. All the other cutoff values are the averages of two consecutive ordered observed test values. The P-P plot is tabularised in the figure below:

Area Under the Curve

Table 4.5 Test Result Variable(s)

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.714	.024	.000	.667	.761

The test result variable(s): Amount paid for emptying services has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

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Table 4.6: Test Result Variable(s): Amount paid for emptying services

Positive if Greater Than or Equal To[a]	Sensitivity	1 – Specificity
.00	1.000	1.000
1.50	.857	.500
3.00	.143	.000
5.00	.000	.000

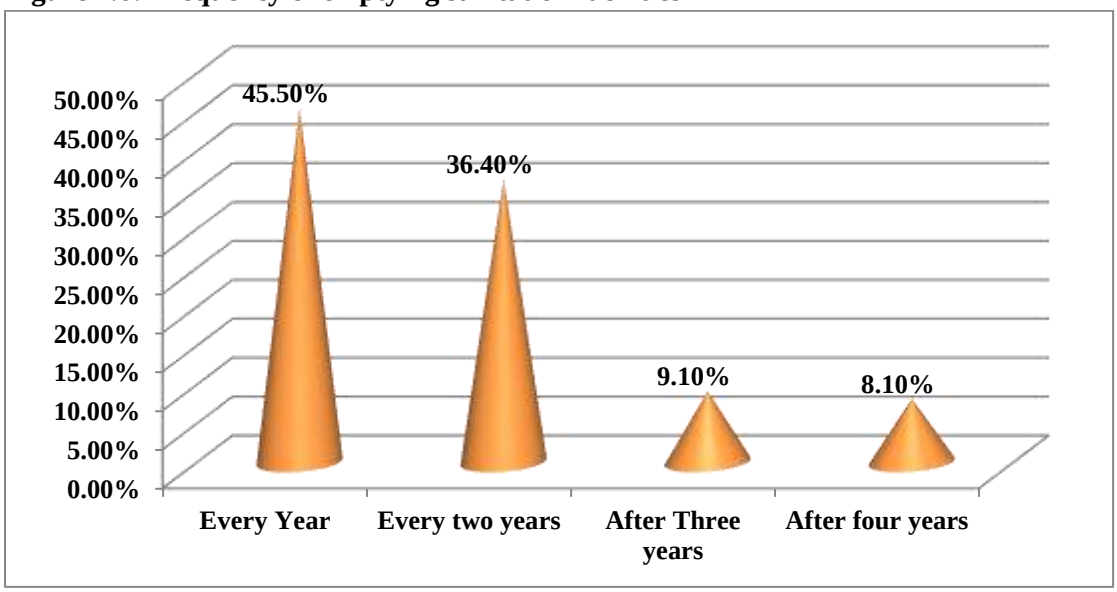
The test result variable(s): Amount paid for emptying services has at least one tie between the positive actual state group and the negative actual state group. The smallest cutoff value is the minimum observed test value minus 1, and the largest cutoff value is the maximum observed test value plus 1. All the other cutoff values are the averages of two consecutive ordered observed test values.

Frequency of emptying sanitation facilities

The respondents were asked to indicate how often they empty their sanitation facilities. The table below illustrates that emptying is done at different intervals. Majority of respondents (45.5%) indicated that they empty their sanitation facility at least once a year. 36.4% of the respondents indicated that they empty their sanitation facilities every after two years. 9.1% of the respondents indicated that they empty their sanitation facilities every after three years. Similarly, the last cohort of respondents (8.1%) indicated that they empty their sanitation facilities every after four years.

This information on the frequency of emptying sanitation facilities was essential as it highlighted the maintenance patterns and periodic demand for emptying services in the community. Analyzing these intervals helped in understanding the operational needs and planning for resource allocation and scheduling of services to meet community expectations effectively.

Figure 4.6: Frequency of emptying sanitation facilities



Factors considered in determining emptying fees

The study also endeavored to establish the factors considered in determining emptying fees of fecal sludge from septic tanks and pit latrines. According to the findings, several factors are taken into consideration when determining the emptying fees. Pit/Septic volume (Level of Sludge) was cited as the major determining factor in determining the emptying fees by service providers. 36.4% of the respondents indicated that distance of disposal also determines the emptying

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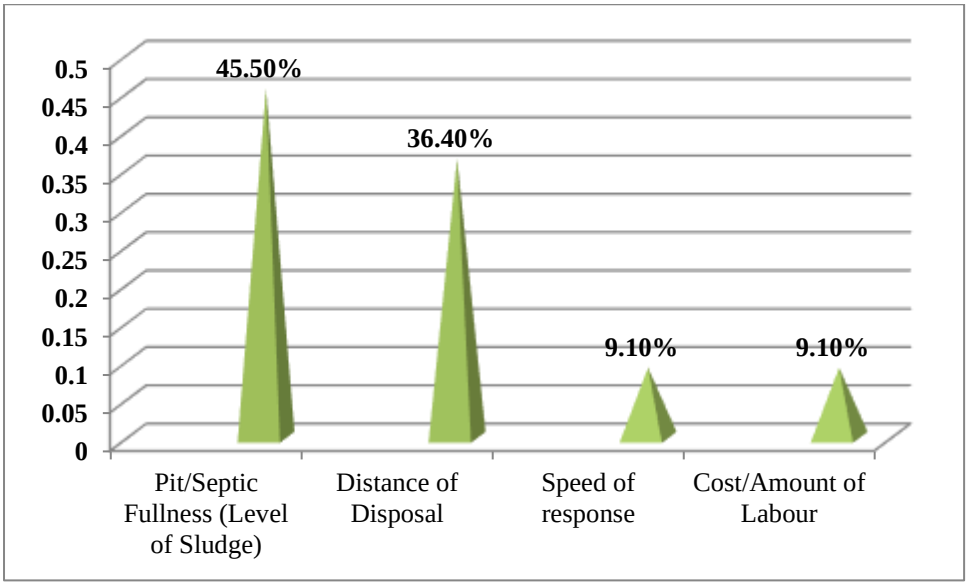
fees by service providers. 9.1% of the respondents correspondingly indicated that speed of response and cost/amount of Labor are equally taken into consideration when determining the emptying fees by service providers. This information is illustrated in the figure 4.8 below.

Figure 4.8: Factors considered in determining emptying fees



4.4.1 Pit/Septic Volume (Level of Sludge)

The findings from the interviews from the interviews carried out also revealed that Pit/Septic tank volume (Level of Sludge) is one of the factors considered when determining the emptying fees of fecal sludge in most residential areas in Lusaka district.

4.4.2 Distance to the Disposal Site

The findings from the interviews carried out with the key informants revealed that the distance to the disposal site is taken into consideration when determining the faecal sludge emptying fees. To validate this, one of the respondents indicated that.

> *The distance to the disposal site also determines the faecal sludge emptying fees in Lusaka district. We usually incur some expenses when disposing of the faecal sludge especially when using a large vacuum tanker.*

4.4.2 Transportation Costs

Collaboratively, the findings also revealed that the cost of transportation is relatively high. Four key informants highlighted that high transport costs are one of the challenges that they have been grappling with. In view of this, one of the key informants stressed that.

> *The cost of transportation is relatively high because of high fuel prices, poor road networks and the distance where the sludge is disposed of. Some residential areas do not have good road networks this makes it very hard to get to the destinations where our services are needed.*

DISCUSSION

Factors determining faecal sludge emptying fees

The first objective sought to determine the actual emptying fees for fecal sludge by manual and mechanical service providers in Lusaka district. The study established that the major factors that determine the actual emptying fees for fecal sludge by manual and mechanical service providers include the volume of the sludge in the pit or tank, distance to the disposal site which also determines the cost of transportation, speed of response by the service provider, and cost of labor.

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Affordability

Affordability does not necessarily translate into willingness to pay. Many potential customers are not accustomed to thinking about sanitation as a service and are unlikely to factor it into their household budgeting. Affordable pricing is therefore only one of a set of measures that may be required to stimulate demand, including effective marketing and improved regulation and enforcement. While it is good business practice to develop fixed rates to ensure profitability, FSM businesses will need to bear in mind the unique challenges of the sanitation sector and will in practice respond to the environment in which they operate.

Price of emptying

According to the findings, the price to empty a septic tank varies according to the tank size and how long it will take to empty and clean it. For instance, 16 barrels (1000 liters), cost k300, and the highest price of k2700 for 144 barrels (9000 liters) The size of the septic tank is another thing the emptiers consider. Depending on how the business runs, the size will determine how long it takes to empty, which impacts on the cost. The results of this investigation show that some emptiers charge by the liter while others have established fees for specific tank sizes. The needs of the property and the volume of solids generated mostly dictate the tank size.

The study also established that a larger property will naturally house a larger septic tank to cope with the amount of waste, which means the cost will be at the higher end of the scale. The type of septic tank a property has matters too because of the number of chambers concealed within the tank. Bottle shaped, onion shaped, or round septic tanks only house two chambers which makes them easier to clean. However older septic tanks, such as those that are brick built or are made with masonry usually have three chambers and can be trickier to access and clean. The emptiers therefore take this into consideration when determining the emptying fees.

Accessibility

According to the study findings, unobstructed access must be created for the tanker to be able to approach closely enough for the hoover hose to reach the bottom of the tank to empty a septic tank and pit latrines. Because of this, it is advised that septic tanks be situated 30 meters or less from an access point to make emptying easier. Increased fees may result from failing to make necessary preparations for the emptying tanker, such as failing to notify of low, narrow, or difficult access. The location of your property will affect the price one pays to empty a latrine or a septic tank, as is frequently the case in the real estate market. Locations in Lusaka where shanty compounds are located yet where there are no main drains are very remote and may result in significant costs. Extra expenses are considered in other cases were getting to the property is difficult or tough, such as when there are weight restrictions or small roadways, since emptiers are compelled to pay higher charges.

According to the Delphi study, the ability of emptiers to provide safe services to everyone is greatly impacted by the availability and condition of roads and the accessibility to informal settlements. In fact, bad roads not only damage the service cars but also restrict the ability of regulators to keep an eye on emptiers and involve communities. Mechanical emptiers can't get inside some homes. Furthermore, as previously mentioned, bad roads and/or heavy traffic may deter emptiers from delivering sludge to disposal or treatment facilities. Mobile transfer stations are frequently set up for emptying events in Kampala, while new treatment facilities are being strategically placed in Lusaka to address the transportation issue. The transfer station project, however, was a failure in Freetown (WHO, 2019). To facilitate the implementation of the regulation of sanitary services, the transportation infrastructure needs to be generally improved.The study also revealed that another element that is considered when calculating the real fecal sludge emptying costs is the work required. The cost of manpower is always included in any charges

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associated with emptying of latrines and septic tanks. In case of mechanical emptying, a tank operator oversees running the vehicle's machinery, driving the vehicle, emptying and sanitizing the tank, and transporting the waste to a sewage treatment plant after removing the particles and sludge from the tank. As a result, the amount of labor costs will entirely depend on the size of the tank, the size of the property, the convenience of access, and the amount of effort required to empty the tank.

The researcher believes that homeowners should always do routine maintenance on septic tanks and pit latrines to reduce the cost of emptying fecal sludge. The first place to start is to check what is entering via the drains. Significant food waste, for example, should not be disposed of down the drain of your washbasin since it could quickly accumulate sediments, increase manpower costs, and increase the cost of emptying the tanks.

The expense of emptying septic tanks can be decreased with good maintenance practices. Checking the detergents and the potency of the antibacterial components before to purchasing cleaning supplies is a good idea. The anaerobic bacteria found inside a septic tank oversee breaking down as much solid waste as they can (Tyre, 2012). The tank will not function properly if you introduce new chemicals or disruptive microbes to the equilibrium. This can take some time, but it will save time and money in the long term by preventing problems inside the tank. There are other actions homeowners can take if the prices to empty their septic tank are proving to be too costly, in addition to performing appropriate maintenance.

In view of the foregoing, Strande (2014) avows that for a septic tank to function correctly, it must be able to break down the waste entering it, and to do that it needs to have the correct bacterial balance. Retaining the bacterial balance means not putting harsh chemicals into the tank, such as bleaches, antibacterial soaps, or any other antibacterial household cleaners. Often the chemicals in these products will destroy the anaerobic bacteria and damage the environment in the tank, leading to a plethora of problems. To maintain the anaerobic bacterial balance in the septic tank, homeowners must use detergents with low levels of phosphate. Items such as dishwasher tablets are high in harmful phosphates which can damage the good bacteria in the septic tank.

According to Gaze (2017) using detergents with low, or no phosphate levels helps the bacteria in the tank to decompose the solid matter, preventing drainage fields being overloaded with solids and leading to blockages. Gaze further contends that an optimum bacterial environment will also prevent sludge from building up quickly, which will make the process of emptying the tank both quicker and easier, lessening the costs of labor involved.

To reduce the cost of emptying, individuals should also make sure there is adequate access to the septic tanks or pit latrines. Restrictions or difficulties of septic tank access can lead to incurred additional labor costs, or even being charged for a failed visit if the tanker is unable to properly access the tank. Things to be aware of include narrow lanes, difficult terrain, or bridges with weight levels. These elements can all have an impact on which vehicle is suitable for the job, and the wrong vehicle can be a costly mistake. It is conceivable that the customer will be charged for both the unsuccessful visit and for another, different vehicle to visit the property if an incorrect or unprepared vehicle shows up and is unable to acquire sufficient admission to the location. To prevent this, clients seeking tank emptying services should accurately describe the property's location, any special topography needs to be aware of, and, if practical, the access to the tank to the contractor.

Factors that affect the management of faecal sludge

The third objective sought to establish the factors that affect the management of fecal sludge from pit latrines and septic tanks in unplanned residential areas in Lusaka district. The study findings presented in chapter four illustrate that the respondents indicated that high transportation

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cost is the biggest challenge hampering fecal sludge management. The other set of respondents indicated that lack of safe emptying is another challenge that has been affecting fecal sludge management. Some of the respondents indicated that limited treatment plants is another challenge that has been affecting fecal sludge management. Illegal dumping directly into the environment was cited as one of the factors that affects fecal sludge management. Lastly, some of the respondents indicated that pit emptiers face stigmatization from the community.

The emptiers indicated that the costs of transporting waste depend on moisture content of the sludge, nature of the terrain, distance to transport, types of equipment used and the method by which waste is transferred from smaller units to larger units within the area over which it is to be transported. The cost of transport is determined by the distance of disposal, fuel cost, state of the roads as well as the maintenance costs of fecal sludge transportation vehicles. A major barrier to the success of road-based FSM systems is the operational and maintenance costs of fecal sludge transportation vehicles (Chowdhry and Koné, 2012; O'Riordan, 2009; Thye et al., 2009). Due to their speed and capacity limitations, this is particularly true when employing motorized vehicles like vacutugs (O'Riordan, 2009).

Field Trials and Vacutug Limitations

In field trials using Vacutugs in Mozambique and Ghana, it was found that latrine emptying time was relatively quick, but long Vacutugs journey times and their associated costs were the biggest limitation of the system (O'Riordan, 2009). One method to reduce costs, which has successfully been employed in the aforementioned field trials, is to use an intermediate transfer station for waste; this reduces Vacutug transport time (O'Riordan, 2009). A transfer station is a holding tank sited at the edge of the settlement from where larger tanker trucks collect and transport faecal sludge the remaining distance to the treatment plant over the main road network (O'Riordan, 2009; Tilley et al., 2008). Using spatial network variables, the placement of the transfer stations can be optimized in terms of the amount of time faecal sludge needs to be transported. Although they do not lend themselves to inclusion in the spatial modeling step, other factors that would also affect the siting of transfer stations, such as local planning restrictions, residents' influence on decision-making, and the cost of land, would be considered along with transportation costs**.**

Social Stigma and Labor Conditions

The study also showed that members of the community stigmatize people who empty pits. The act of manually emptying has a negative social connotation. People who are eager to do this kind of employment are frequently the underprivileged and destitute, who need extra money. Manual emptying is tiring and unpleasant task that, if not handled appropriately, carries major health and safety dangers. Simple tools, generally just a bucket, a shovel, and a rope, are used for manual emptying. To avoid coming into contact with the faecal sludge directly, workers frequently wear little to no personal protection, such as gloves or boots. They consequently report illnesses, rashes, and other ailments (Chowdhry & Kone, 2012; Opel, 2012). Emptying on-site sanitation systems and handling faecal sludge involve risks that workers or homeowners performing the operation must be aware of.

Professionalization of Emptying Services

The social stigma around sanitation workers was previously identified by researchers around manual emptying (Nkansah et al., 2012; Mazars and Earwaker, 2013; Mikhael and Drabble, 2014). This research shows that this is also the case for mechanical emptiers in several cities. Almost half the emptiers who participated in the Delphi study reported this issue. Therefore, the emptying market may not be attractive to entrepreneurs, and it is difficult for emptying companies to recruit qualified staff. Many respondents to the three studies suggested regulating emptying services as a method to enhance the perception of emptying businesses as formal and secure service providers, complete with PPE and business cards, looking

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more professional and less embarrassing to their communities.

Challenges and Solutions for Pit Emptiers

Despite the critical role played by informal pit emptiers in the sanitation value chain, their work, especially the manual ones, is often ignored by government policymakers and donors (Bongi & Morel 2005; Hawkins et al. 2014). They usually have no access to government financing or donor funding and thrive by providing services that residents are willing to pay for (Bongi & Morel 2005). Pit emptying is often regarded as a non-lucrative business due to limited business models that guarantee return on investment and limited funding (Murungi & van Dijk 2014). Pit emptiers are also often threatened and associated with a social stigma (Eales 2005).

Manual Emptying Techniques and Challenges

Often pit emptiers conduct their work without personal protective equipment due to its discomfort or a lack of awareness of the benefits (Nkansah et al. 2012). In a study in Bangladesh, it was found that manual pit emptiers did not meet the criteria for 'decent' work and were often deprived of basic rights and faced social and financial insecurities. The support of government and NGOs was able to improve the status of emptiers in certain cases and identified a need to study the role and livelihoods of pit emptiers in different contexts (Zaqout et al. 2020).

Most of the manual pit emptiers stated that increased safe discharge of faecal waste would be improved by the provision of transfer stations or disposal points. Hence, they all advocated for multiple placements of transfer stations near the residents to reduce travel distances to alternative disposal sites. Manual pit emptiers push their heavy carts on often narrow and challenging roads over long distances up to 3 km. Inaccessibility of some desludging sites during the rainy season was also highlighted as a significant challenge. They also stated that once the additional discharge points are constructed, the time saving would enable them to service additional households. This makes the case of Sanergy's transfer station interesting. Combined with the formalization, PPE and washing, it has enabled pit emptiers to dispose waste safely and conduct their work in the day with more dignity and less violence. The provision of such infrastructure is unlikely to be a total solution, however, as some of the pit emptiers still complained about the disposal fee and discharged into unsafe places anyway. These informal emptiers often operate on low margins and without safe disposal options resort to illegal disposal that has many associated health risks. A recent study found that none of the pit emptiers in different cases in Bangladesh met the ILO criteria of 'decent' work (Zaqout et al. 2020). More focus is needed to ensure that achieving universal sanitation is not at the expense of decent fair livelihoods for pit emptiers. Attempts to provide infrastructure or to change the behavior of pit emptiers are fraught with risk due to vested interests and the potential of violence within informal settlements.

Urban Challenges and Sanitation Services

Sanitation services operate in a wider urban context and are thus affected by urban issues. Most cities in sub-Saharan Africa are home to many residents living in poor-quality housing and are experiencing high urbanization rates and population growth (Mitlin and Satterthwaite, 2012; Satterthwaite et al., 2015; Satterthwaite, 2017). As a result, cities' planners and service providers are faced with the challenge of providing safe services to a growing population in a competitive environment**.**

Technical Limitations of Manual and Mechanical Emptying

Manual emptying technologies have experienced various technical and implementation challenges. For instance, some pumps clog with sludge that contains household solid waste, which is commonly found in pit latrines. As well, some are not designed with locally available pumps or spare parts, andparts and rely on importation. Of all the manual emptying technologies, the Gulper has reached the widest number of pit emptying service providers in Asia and Africa. This is mainly due

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to strong interventions from external organizations, like nongovernmental organizations (NGOs) that provided funding, training and technical support (Strande, Ronteltap & Brdjanovic, 2014). Manually emptying sludge (with buckets and a shovel) from pits deeper than 1.5 metres is impossible, unless the emptier climbs inside the pit, which is a serious health and safety risk. A compromise must be made between the pit depth and the frequency and difficulty of emptying. Shallow pits (less than 1.5 meters deep) are easier to empty and have less health risks to emptiers than deeper pits, but they need to be emptied more often.

However, there are some technical limitations for using vacuum trucks. Conventional vacuum trucks can usually only suck down to a depth of 2 to 3 meters. They also must be parked within 25 meters of the on-site sanitation technology, depending on the strength of the pump (Strande, Ronteltap & Brdjanovic, 2014). As well, large vehicles are often unable to access narrow streets and poor roads, especially in unplanned and informal communities. Vacuum trucks are also designed for emptying water-based technologies, such as pour flush latrines, septic tanks, and aqua privies. The sludge may thicken beyond what can be easily pushed, depending on the technology. In order for the faecal sludge to flow more easily in this situation, water must be added to it. Though possibly expensive, this is ineffective. The technology may only be able to be emptied manually if water is not readily available (Tilley et al., 2014**).**

CONCLUSION

The study on faecal sludge management in Lusaka district primarily aimed to identify the factors influencing the fees charged for emptying septic tanks and pit latrines. Key findings indicated that the volume of the pit or septic tank, namely the level of sludge, was the primary determinant of the fees set by service providers. Other significant factors included the distance to the disposal site, the speed of response, and the cost and amount of labor required. These variables collectively inform the pricing strategy for faecal sludge emptying services, underscoring the complexity and multifaceted nature of setting these fees in a manner that is economically viable for service providers while remaining affordable for households.

The study further explored the broader challenges associated with the management of faecal sludge in unplanned residential areas, highlighting several critical issues such as high transportation costs, the absence of designated safe emptying spaces, limited availability of treatment facilities, illegal dumping practices, and community stigma associated with waste handling. These challenges are compounded in informal settlements and rapidly urbanizing areas, which are often marked by dense populations and insufficient infrastructure. In response to these findings, the study proposed several recommendations aimed at improving the overall management of faecal sludge, including the development of more accommodating management rules, the establishment of construction standards for emptiable latrines, and enhanced regulatory and educational measures to ensure safe and sustainable faecal sludge management practices.

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Ethical Approval

The University of Zambia Natural and Applied Sciences Ethics Committee-IRB of the Directorate of Research and Graduate Studies permitted this study. Permission to collect data from the study site was also obtained from the Board of Graduate Studies and other relevant authorities. Participants who took part in the study completed consent forms and were assured of anonymity.

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