AN ASSESSMENT OF THE HEALTH AND SAFETY PRACTICES IN FAECAL SLUDGE MANAGEMENT IN THE URBAN AND SLUM AREAS OF KAMPALA.

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A DISSERTATION SUBMITTED TO THE FACULTY OF SCIENCE TECHNOLOGY, DEPARTMENT OF ENGINEERING & ENVIRONMENT IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT AT THE INSTITUTE OF PETROLEUM STUDIES KAMPALA IN AFFLIATION TO UCU.

DECLARATION

I, Juliet Nansikombi, hereby declare that this dissertation is my work and it has not been submitted before to any other institution of higher learning for fulfillment of any academic award.

Signed……

Date…….

APPROVAL

This is to certify that, this dissertation entitled “An Assessment of the Health and Safety Practices in Faecal Sludge Management in the Urban and Slum areas of Kampala” has been done under my supervision and now it is ready for submission.

Signature ……

Supervisor’s Name:

Date……

DEDICATION

I dedicate this dissertation to my dear husband, children and my dear mother, who encouraged and supported me throughout the course of this study period.

Special dedication goes to the almighty God for his providence, grace and mercy.

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Glossary of Terms and Acronyms

CBO	Community Based Organizations
COVID-19	Corona Virus Disease of 2019
FS	Faecal Sludge
FSM	Faecal Sludge Management
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ILO	International Labour Organisation
IWMI	International Water Management Institute
KCCA	Kampala Capital City Authority
MoGLSD	Ministry of Gender, Labour, and Social Development
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
NWSC	National Water and Sewerage Corporation
OSH	Occupational Health and Safety
PPE	Personal Protective Equipment
SDG	Sustainable Development Goal
UNDP	United Nations Development Program
UNFPA	United Nations Population Fund
UNICEF	United Nationals International Children's Education Fund.
WASH	Water Sanitation and Hygiene
WHO	World Health Organisation

ABSTRACT

Safe faecal sludge management has increasingly become an issue of public health concern in the development agenda. This study assessed the health and safety practices in faecal sludge management in the urban and slum areas of Kampala.

A mixed research design was employed in this study. Data was collected at both the household level and from the sanitary operators working in the study areas. Both semi-structured and structured interviews were used to collect data using a questionnaire and interview guides as tools. Data was analyzed using descriptive statistics and the Multiple Regression Model. Results showed that somerespondents at household level largely have good knowledge and attitude towards faecal sludge management with 98.4% stating that the activity is necessary, 74.1% own an onsite sanitary facility, 97.2% were aware of the need for emptiers to wearappropriate PPE when emptying toilets/latrines and 77.3% perceived theimportance of latrine/toilet emptying. Ensuring good mechanical condition ofvehicles (32%) and tightening barrel valves/covers (17.30%) were common sanitation practices amongst sanitary operators at the transportation stage although unsanitary practices such as leakage of horse pipes (30.3%) and entering the pit latrines or septic tanks during emptying (12%) also existed.

The socio-economic factors were found to have a statistically significant influence on the safe feacal sludge management practices amongst the households in the study area. Human and or non- development and knowledge dissemination should be undertaken by relevant authorities such as National Environmental Management Authority (NEMA) and Kampala Capital Authority (KCCA) to increase awareness on safe faecal sludge management amongst sludge emptiers and households respectively.

CHAPTER ONE - INTRODUCTION

1.1 Background to the study

Proper management and disposal of human excreta is important for prevention of health risks such as water pollution and spread of diseases (Nakyagaba *et al.*, 2021). This calls for ensuring access and utilization of globally accepted feacal sludge management practices including ownership of on-site pit-latrines and toilets, lined pit-latrines, septic and pit-latrine emptying services, lined pit-latrines. However,only 2 billion and 3 billion people worldwide have on-site toilets or pit-latrines and lined pit-latrines respectively (UNICEF & WHO, 2019). In Sub-Sahara Africa (SSA),over 20 per cent of the population lacks access to improved sanitation services and latrine/toilet (Roche et al., 2017). Over 1.8 billion persons in the urban areas of SSA do not use safely managed sanitation services (Schertenleib et al., 2021).

Equally, there are challenges of low access to and utilization of basic and safe sanitation services including pit-latrine emptying, lack lined pit latrine and lack of sufficient treatment plants and illegal dumping of the sludge directly into the environment (Velkushanova et al., 2021; Mkude et al., 2019; Harada & Strande, 2016). According to MWE (2018), 8% of Uganda's rural population and 12.6% of the urban population still practice open defecation. Over 50% of the population across different areas of Kampala such as Nakawa, Kawampe and Makindye Division still use a shared sanitation facility, of which 39% of these facilities are unlined pit latrines (KCCA/NWSC/MWE, 2020). Only 10% of the households in Kampala have their sanitation facilities connected to the national sewer system (KCCA/NWSC/MWE,2020).

Consequently, some rigorous efforts including sensitization, infrastructural development and a shift from inefficient state owned sludge collection trucks to private cesspool trucks have been undertaken by relevant bodies like Kampala Capital City Authority (KCCA, 2016; KCCA/NWSC/MWE, 2020). New technologies like the gulpers for emptying sludge from sanitation facilities in slums (Nakyagaba et al., 2021), transportation and treatment have been established (KCCA/NWSC/MWE, 2020). However, regardless of the recent efforts that have been made to improve feacal sludge management, there is still limited information on the health and safetypractices in feacal sludge management such as on-site toilet ownership and emptyingin the urban and slum areas of Kampala like Nakawa and Kawempe Divisions. There isalso limited information on the health and safety practices undertaken by cesspool emptiers and gulper operators during their operations in the faecal sludge management value chain. This study therefore explored the health and safety practices administered by households, as well as the gulper and cesspool operators inNakawa Division of Kampala along the faecal sludge management value chain.

1.2 Problem Statement

In the past 5 years, efforts have been underway to improve the feacal sludge management value chain in Uganda by relevant authorities and development partners such as KCCA and German Federal Ministry for Economic Cooperation and Development (BMZ) (GIZ, 2018; KCCA, 2016). Some observed efforts have included rehabilitation of Lubigi and Bugolobi sludge treatment plants (KCCA/NWSC/MWE, 2020; MWE, 2018), encouraging on site-toilet ownership amongst households, promoting toilet emptying and training emptiers to put in place safe management practices along the key stages of feacal sludge management value including

collection, transportation, treatment and disposal (GIZ, 2018). One of the areas where the strongest emphasis has been observed is Kampala City. This has partly been due to the fact that 20-25% of the toilets in slum and urban areas like Nakawa, Kawampe and Makindye Division are reported to have never been emptied by a service provider, with the rest abandoned or emptied directly into the environment (GIZ, 2018).

However, there is has not been much empirical evidence documented to indicate the health and safety practices in place amongst households in the urban and slum areas of Kampala such as Bukoto I, Naguru II, Old Kira Road and Mulimira following the initiatives put in place by the relevant bodies. More so, there is a dearth of knowledge on the practices implemented by sludge emptiers such as the gulper and cesspool operators along the feacal sludge management value chain including collection, transportation, treatment and disposal. In light of the above-mentioned challenges, this study was undertaken to explore the health and safety practices at household level and by sludge emptiers in Bukoto I and Naguru II Wards of Nakawa Division to ensure safe faecal sludge management.

1.3 Study objectives

The main objective of the study was to assess the health and safety practices in faecal sludge management in the urban households of Naguru II Ward (Naguru Bank Village) and Bukoto I Ward (Old Kira Road Village) and households in Naguru Go- down and Mulimira slums in Kampala District.

The specific objectives of the study were:

i. To assess the knowledge, attitudes and practices related to faecal sludge management among slum and urban households of Naguru II and Bukoto I Wards in Nakawa Division of Kampala.

ii. To identify the health and safety practices among sludge emptiers (cesspool and gulper operators) operating among slum and urban households of Naguru IIand Bukoto I Wards in Nakawa Division of Kampala.

iii. To examine the driving factors influencing safe faecal sludge management among the slum and urban households of Naguru II and Bukoto I Wards in Nakawa Division of Kampala.

1.4 Research questions

i. What is the knowledge, attitudes and practices related to faecal sludge management among urban and slum households of Naguru II and Bukoto IWards in Nakawa Division of Kampala?

ii. What are the health and safety practices applied by sludge emptiers (cesspool and gulper operators) along the faecal sludge management chain in the study areas?

iii. What are the factors influencing safe faecal sludge management among the urban and slum households of Naguru II and Bukoto I Wards in Nakawa Division of Kampala?

1.5 Justification of the study

Although there have been growing efforts aimed at improving the state of sanitation among populations in the different towns of Uganda such as Kampala, there is still limited information on the sanitation measures undertaken by key stakeholders such as the faecal sludge emptiers and individuals at household level. The lack of such crucial information is most likely to derail important decision making and planning for improved sanitation. Therefore, this study aimed at generating information important for informing policy and decision making required for implementing safe

faecal sludge management amongst various stakeholders while carrying out their day-to-day work.

1.6 Significance of the study

This study will contribute to the existing body of knowledge in health and safety management in the faecal service chain. The study established new insights to the growing literature on safe faecal sludge management, within the urban and slums context.

Information generated in this study is important for informing decision makers on the implementation and enforcement of national and internationally recognized health and safety management practices for proper faecal and sewage management in Uganda. Results of the study give initial insights to scholars or students aiming to undertake further research in the field of sanitation, and specifically in the area of faecal sludge management.

1.7 Conceptual framework

The conceptual framework (Figure 1) shows the interactions between theindependent variables, dependent variables and the intervening variables (Imenda, 2014).

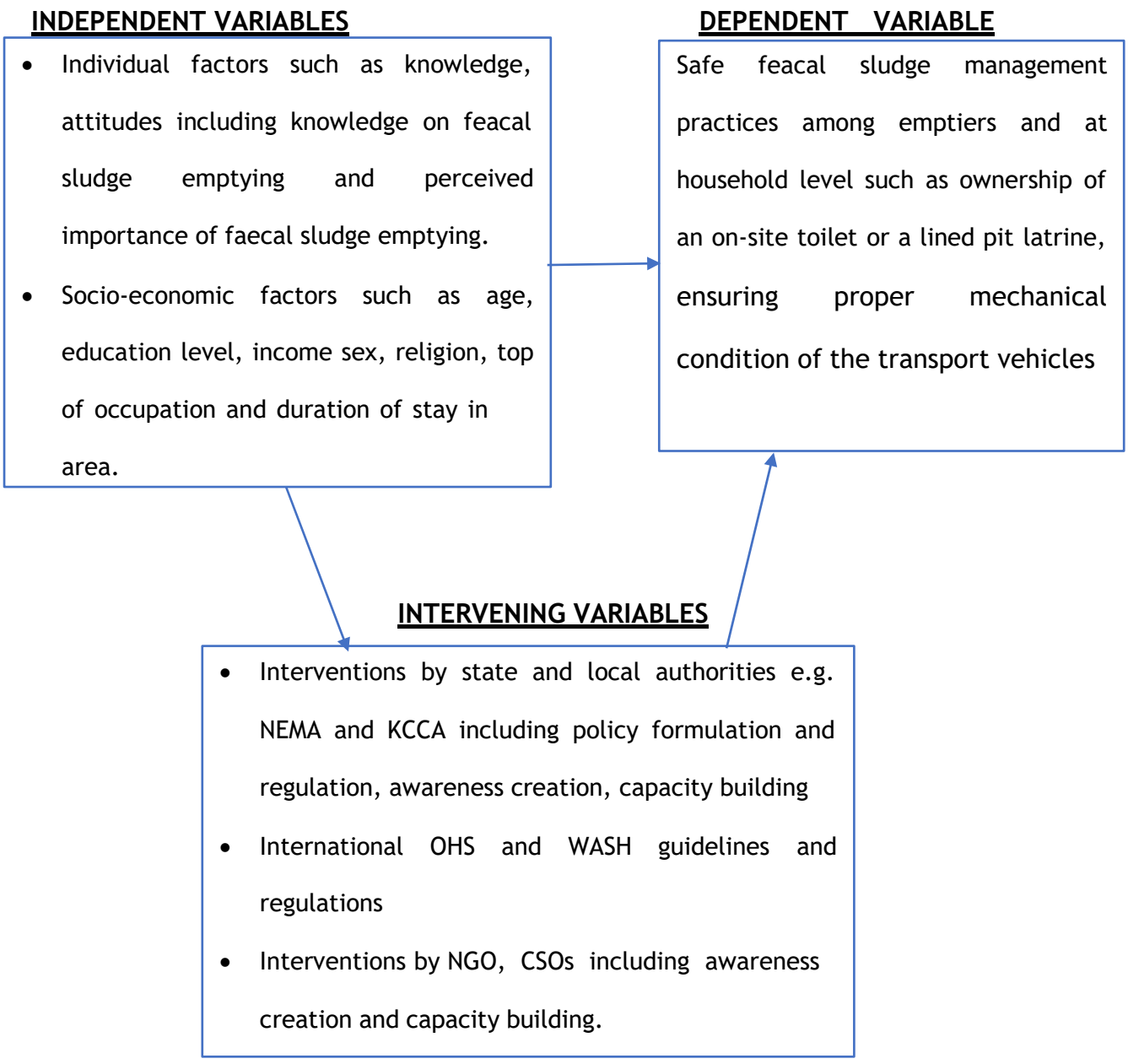

Figure 1 Conceptual framework for examining health and safety practices in fecal sludge management

The independent variables of the study were considered as the various factors that both directly and indirectly influence the sustainable faecal sludge management amongst individual households and faecal sludge emptiers including cesspool and gulper operators (Kabir and Salahuddin, 2014). Based on existing studies (Mougoue et al., 2012; Bäuerl et al., 2015; Nzouebet et al., 2019), the factors for sustainable faecal sludge management include individual factors such as knowledge, attitudes and socio-economic characteristics. The knowledge and attitudes of individuals towards sustainable faecal sludge management include their perceived importance ofemptying their sanitary facilities and the knowledge on the process and safetyprocedures during the faecal sludge management value chain (Kabir and Salahuddin, 2014). Sludge management among individuals can also be influenced by their socio- economic characteristic such as age, income status, gender and education level among others (Jenkins et al., 2015).

Ownership of an on-site toilet or a lined pit latrine and its subsequent emptying for sustainable faecal sludge management is considered as a dependent variable amongst households in this study.

The Intervening variables were considered to be those factors that mediate the relationship between the independent and dependent variable and with the individuals and households having no significant control against them (Saragih, 2015). Intervening variables indirectly influence individuals' and households' choices and means of sustainably managing the faecal sludge. Intervening variables in this study included international guidelines on water sanitation and hygiene and, the occupational health and safety guidelines and regulations. National and local government mandates such as formulation of proper faecal sludge management

policy and regulations and capacity building of faecal sludge emptiers through lead agencies such as NEMA and KCCA were also considered as intervening variables. Ensuring compliance with regulations and guidelines of proper feacal sludge management through monitoring and evaluation and penalties for law offenders is also considered as a preserve of the national and local government. Awareness creation and capacity building on proper and safe faecal sludge management coming from non-governmental organizations (NGOs) and civil society organizations (CSOs) also forms another set of intervening variables. Another intervention by NGOs includes donations of faecal sludge emptying equipment to the cesspool and gulper operators.

1.8 Scope of the study

The study focused on assessing the health and safety practices on faecal sludge management among households and emptiers such as cesspool and gulper operators in the urban households of Naguru II (in Naguru Bank Village) and Bukoto I (in Old Kira Road Village) Wards of Nakawa Division and slums of Naguru Go-down and Mulimira slums in Kampala. The study explored the factors influencing safe faecal sludge management amongst emptiers in the urban households of Naguru II and Bukoto I, and Naguru Go-down and Mulimira slums in Kampala.

CHAPTER TWO - LITERATURE REVIEW

2.1 Introduction

Africa has got the largest number of people in the whole world with poor sanitation facilities, and of the 2 billion people lacking basic sanitation facilities across the world, the majority are found on the Africa continent (Joint Monitoring Programme, 2019). Also, globally, a vast number of people rely on non-sewered systems for their sanitation, which generate a mix of solid and liquid waste generally termed 'faecal sludge (Water and Sanitation Program, 2014).

The sludge generated has to be well managed in order to control the negative effects which may come up as a result of poor management. Therefore, we define faecal sludge management as "the storage, collection, transportation, treatment and safe end use or disposal of faecal sludge" (UNDP, 2020). Accordingly, this requires infrastructure and planning, which are lacking in many countries of Africa. Where available, existing treatment facilities are often underutilized or overloaded, and release untreated or partially treated effluent into the environment (UNDP, 2020).

Universally, only 7 per cent of the population is connected to sewers, and only 1 per cent of the waste is treated. Nineteen per cent, practice open defecation, while the remaining use on-site sanitation systems (WHO, 2017). Particularly in poor andrapidly expanding cities, this faecal sludge represents a growing challenge, generating significant negative public health and environmental risks. Without proper management faecal sludge is often allowed to accumulate in poorly designed pits, or is discharged into storm drains and open water, or is dumped into waterways, wasteland and insanitary landfill sites.

Poor sanitation has differential impacts on the health of men, women, boys and girls as well as broad economic and environmental implications. Access to sanitation facilities remains a challenge for urban populations in many sub-Saharan African cities, particularly for people living in poor peri urban areas. Socio-economic status and settlement characteristics are the main indicators of access to reliable sanitationin peri-urban settlements (Angoua et al., 2018).

While a lack of sanitation facilities reflects the lack of services in urban and peri- urban spaces, community members bear some responsibility for their environment and health. For example, unauthorized temporary structures, discharging wastewaterand excreta into public spaces, dumping garbage near households, and open defecation all contribute to environmental and health risks (Angoua et al., 2018).

2.2 Faecal sludge management and the sustainable development agenda

Achieving Sustainable Development Goal (SDG) number 6 and ensuring safe and health sanitation in low-income countries, to "ensure availability and sustainable management of water and sanitation for all" remains a major hurdle for 61% of the global population (United Nations, 2021). Low-income countries are often served by onsite technologies, such as pit latrines, with 5 billion people expected to be served by onsite sanitation by 2030. In addition, faecal sludge (FS) treatment plants often fail after construction due to lack of ongoing finances for operations (Mallory, Holm and Parker, 2020).

Since the United Nations introduced the Sustainable Development Goals (SDGs) in 2015, the global community has focused on ensuring "access to water and sanitation for all" (SDG 6), a crucial cross-cutting issue to drive progress across several other

goals in the 2030 Agenda for Sustainable Development. However, the challenges to achieving this goal include weak policy implementation and reforms, lack of financing by governments and other institutions in the sanitation sector, and an over-reliance on shared toilet facilities (World Bank, ILO, WaterAid, and WHO 2019). Population increase and growth in Africa is reported to have led to increase in the production of wastewater and faecal sludge, and this has been attributed to urbanization, rapid industrialization and changes in consumption (UNDP, 2020). Over the past four decades, the urban population in sub-Saharan Africa has nearly quadrupled (UNDP, 2020).

Therefore, because of the sustainable development agenda, improving the working conditions of sanitation workers would contribute to four of the 17 Sustainable Development Goals (SDGs), to name a few; end poverty in all its forms everywhere (SDG 1) by promoting access of the poor to basic services; ensure healthy lives and promote well-being for all at all ages (SDG 3) by reducing exposure to unsafe chemicals on the job; ensure availability and sustainable management of water and sanitation for all (SDG 6); and focus on decent work (SDG 8). The SDG framework offers an opportunity to revert and improve the situation of sanitation workers including those, handling faecal sludge at the on-site sanitation systems (World Bank,ILO, WaterAid, and WHO 2019).

2.2 Faecal Sludge Management Value Chain

Fecal sludge management is the storage, collection, transport, treatment, and safe end use or disposal of fecal sludge. Jointly, the collection, transport, treatment and reuse of excreta comprise the "value chain" of fecal sludge management (NWASCO, 2018; Sarkar & Banerjee, 2021). All the stages of the feacal sludge management

value chain ought to be respected to ensure community safety (Nanyonjo, et al., 2020). This calls for holistic practices that ensure safe feacal sludge management.

2.2.1 Faecal Sludge Management (FSM) practices

Without proper management, faecal sludge is often allowed to accumulate in poorly designed pits, is discharged into storm drains and open water, or is dumped into waterways, wasteland, and unsanitary dumping sites.

Faecal Sludge Management (FSM) deals with on-site sanitation systems including the storage, collection, transportation, treatment and safe end use or disposal of faecal sludge" (UNEP, 2020). There are a number of FSM practices implemented within the communities along the faecal sludge value chain as discussed in the subsequent write up.

2.2.2 Emptying, collection and transportation

Removal from on-site systems and transportation to a treatment or disposal facility are the second and third steps in the sanitation service chain for faecal sludge after containment. Sludge can be removed by mechanical means or manually: the specific method depends on the type of containment system, the local climate, access to the site, the type of equipment used by the service provider, and their level of expertise (Mikhael et al., 2014).

Manual collection methods are used most often in low-income communities and in informal settlements. By manual emptying, faecal sludge is removed using basic tools such as buckets, shovels and ropes. Other collection methods are direct lifting, cartridge containment, and manually operated mechanical collection (sludge Gulper, manually operated diaphragm pumps, Nibbler and MAPET2; Mikhael et al., 2014).

Manual collection methods have not been formally regulated in Africa. Although there are some informal associations that regulate the practice, standards for

occupational health and safety are seldom enforced. The high demand for these services by low-income urban dwellers continues to sustain the status quo (African Water Association, 2017). Fully mechanized emptying equipment can be mounted on a frame or trolley or directly onto the transport vehicle. Examples of mechanized methods are the motorized diaphragm pump, trash pump, pit screw auger, Gobbler, Vacu-Tug and the conventional vacuum tanker (Mikhael et al., 2014).

Mechanical emptying is a faster and more efficient process. It is, however, restricted to middle and high-income households with septic tanks and watertight tanks. Vacuum trucks often transport sludge to illegal dumping sites outside the city limits rather than authorized treatment stations (Peal *et al.*, 2014; Nanyonjo et al., 2020)

.

A study carried out in Burkina Faso, Nigeria and Senegal showed that about 60 per cent of households in cities used mechanical emptying, 34 per cent used manual emptying services, and less than 2 per cent a combination of the two (Chowdhry and Koné, 2012). The frequency of emptying is, on average, once every two years, mostlyby small private operators or self-financed entrepreneurs (Strande et al., 2014; Chowdhry and Koné, 2012). It was reported that the desludging rate of most septic tanks in Vietnam ranged between 7 and 8 years (Harada, Dong and Matsui, 2008). This shows the irregularity in the emptying of pit-latrines and septic tanks that mightexist in the community, thus leading to poor feacal sludge management.

According to GIZ (2018), the charges of using gulpers for emptying in Uganda range from 7 to 11 United States dollars per 200 litres barrel. On the other hand, the charges for a cesspool truck range from 20 United States dollars for 2.5m^3 to 50 United States dollars for 10m^3 of faecal sludge (GIZ, 2018). These charges are

reported to heavily influence toilet emptying in the urban and slum areas of Uganda because of the lack of affordability of these charges by poor households (GIZ, 2018). This could also be linked to the poor empting rates that are reported in the urban and slum areas of Kampala.

2.2.2.1 Human powered emptying and transport

Human-powered emptying and transport refers to the different ways by which people can manually empty and/or transport sludge and solid products generated in onsite sanitation facilities.

Human-powered emptying of pits, vaults and tanks can be done in one of two ways:

1) Using buckets and shovels, or

2) Using a portable, manually operated pump specially designed for sludge (e.g., the Gulper, the Rammer, the Manual Desludging Hand Pump (MDHP) or Manual Pit-latrine Emptying Technology (MAPET).

Some sanitation technologies can only be emptied manually, for example, the Fossa Alterna or Dehydration Vaults. These technologies must be emptied with a shovel because the material is solid and cannot be removed with a vacuum or a pump.

When sludge is viscous or watery it should be emptied with a hand pump or a vacuum truck, and not with buckets because of the high risk of collapsing pits, toxic fumes, and exposure to unsanitized sludge.

Manual sludge pumps (Gulpers) are relatively new inventions and have shown promise as being low-cost and effective solutions for sludge emptying techniques. In Uganda, faecal sludge emptying using the gulper technology is reported to have started in 2013 as a pilot project under a partnership between Water for People Organization and GIZ (KCCA, 2016).

The initial purpose was to improve faecal sludge collection and transportation amongst households in informal settlements of some slums of Kampala City such as Kibuye I, Kanyanya, Mutungo, Bwaise II and Nateete (KCCA, 2016). It is indicated thathouseholds in both the urban and slum areas of metropolitan Kampala including Mukono and Wakiso are appreciating the use of gulper technologies (KCCA, 2016). However, there has not been empirical studies to show the extent to which urban and slum areas of the major towns of Uganda where these technologies have been introduced.

Sludge hand pumps, such as the Gulper, work on the same concept as water hand pumps: the bottom of the pipe is lowered into the pit/ tank while the operator remains at the surface. As the operator pushes and pulls the handle, the sludge is pumped up and is then discharged through the discharge spout. The sludge can be collected in barrels, bags or carts, and removed from the site with little danger tothe operator. Hand pumps can be locally made with steel rods and valves in a PVC casing.

Hand pumps can be used for liquid and, to a certain degree, viscous sludge. Domestic refuse in the pit makes emptying much more difficult. The pumping of sludge, which contains coarse solid wastes or grease, can lead to clogging of the device, and chemical additives can corrode pipes, pumps and tanks (World Health Organisation, 2015). The hand pump is a significant improvement over the bucket method andcould prove to be a sustainable business opportunity in some regions. Manually operated sludge pumps are appropriate for areas that are not served or not accessible by vacuum trucks, or where vacuum truck emptying is too costly (World Health Organisation, 2015).

They are well suited to dense, urban and informal settlements, although the type and size of transport vehicle determines the feasible distance to the discharge point. These also have a high potential for job creation, need low capita, are simple to operate and can easily operate where large vehicles may not be able to maneuver. However, the hand-pump technologies are more feasible when there is a Transfer Station nearby, increase environmental pollution due to spill overs and are moretime demanding during emptying.

2.2.3 Treatment

When managing the faecal sludge, it is very important to ensure that it is always treated, as this helps in controlling the negative effects associated with disposal of the faecal sludge. Treatment is always done when the faecal sludge has been takento the faecal sludge treatment plant. Treatment starts with separating the solid fromthe liquid through mechanical or biological means. Biological treatment includes stabilization ponds, drying beds and constructed wetlands, while mechanical treatment involves mechanized processes such as activated sludge, up-flow anaerobic sludge blanket (UASB) reactors, and anaerobic digesters. Many studies (e.g. UNEP, 2020, Tayler, 2018, Scott et al., 2016, water Research Commission, 2015) show that some faecal sludge treatment plants in Africa are not well maintained or managed and treatment performance is questionable. One underlying cause is the constant financial constraints encountered in these facilities. Unlike biological treatment, mechanical treatments are more expensive to operate, hence most African countries opt for biological methods.

Drying beds are also another technology for treating faecal sludge. The two common types of drying beds include the planted and unplanted drying beds (Ingallinella et al., 2002; Mugauri and Inambao, 2018). Constructed drying beds are made in the

form of wetlands with gravel/sand filters at the bottom of the bed and planted with emergent plants such as reeds and papyrus to absorb the nutrients from the sludge matter (Ingallinella et al., 2002). Unplanted drying beds are fitted with sand and gravel but devoid of plants. The moisture in the sludge matter is first removed through percolation of the leachate through sand/gravel and through evaporation to remove the bound water from the sludge matter (Bassan et al., 2013; Singh et al., 2017).

2.2.4 End-use/Disposal methods

2.2.4.1 Reuse/ recycling

When the practice of treating the faecal sludge has been carried out at the treatment plant, the faecal sludge is then left for some time to dry up, and after, it can be recycled and used in several ways (Eawag/Sandec 2008). In some parts of Africa including Uganda, Kenya, Rwanda, Ghana and Senegal, treated dry sludge waste is used as a compost fertilizer in agriculture (Cofie et al., 2016; Adam- Bradford et al., 2018). It can also be converted to biogas and electricity, to briquettes for use as fuel instead of wood charcoal, or to biochar to sequestrate carbon for agriculture (Woldetsadik et al., 2017).

The Compendium of Sanitation Systems is a guidance document that provide information on tried and tested improved sanitation technologies that are safe, hygienic, and accessible (Tilley et al., 2014). Some of the use and/disposal technologies are provided below:

2.2.4.2 Compost fertilizer

Compost is decomposed organic matter that results from a controlled aerobic degradation process. In this biological process, microorganisms (mainly bacteria and

fungi) decompose the biodegradable waste components and produce an earth-like, odourless, brown/ black material. Compost has excellent soil-conditioning properties and a variable nutrient content. Because of leaching and volatilization, some of the nutrients may be lost, but the material is still rich in nutrients and organic matter. Generally, Excreta or Sludge should be composted long enough (2 to 4 months) under thermo-philic conditions (55 to 60 °C) in order to be sanitized sufficiently for safe agricultural use.

A composting chamber is designed to convert excreta and organics into compost. Compost is a stable, inoffensive product that can be safely handled and used as a soil conditioner. This technology usually requires four main parts: (1) a reactor (storage chamber); (2) a ventilation unit to provide oxygen and allow gases (CO_2, water vapour) to escape; (3) a leachate collection system; and (4) an access door to remove the mature product.

A composting chamber can be designed in various configurations and constructed above or below ground, indoors or with a separate superstructure. Since this technology is compact and waterless, it is especially suited in areas where land and water are limited, or when there is a need for compost. It can also be installed in rocky areas, or where the groundwater table is high. This technology cannot be used for the collection of anal cleansing water or greywater; if the reactor becomes too wet, anaerobic conditions will cause odour problems and improper degradation.

2.2.4.3 Biogas system

Biogas is the common name for the mixture of gases released from anaerobic digestion. Biogas is comprised of methane (50 to 75%), carbon dioxide (25 to 50%) and varying quantities of nitrogen, hydrogen sulphide, water vapour and other

components. Biogas can be collected and burned for fuel (like propane) (Tilley et al., 2014).

The Biogas system is based on the use of a Biogas Reactor to collect, store and treat the Excreta. Additionally, the Biogas Reactor produces biogas which can be burned for cooking, lighting or electricity generation. Inputs to the system can include urine, feaces, flush- water, Anal Cleansing Water, Dry Cleansing Materials, Organics (e.g., market or kitchen waste) and, if available, animal waste. The biogas system supports two different user interface technologies: a pour flush toilet or, if there is a demand for the urine to be used in agriculture, a urine-diverting flush toilet. A urinal could additionally be used. The user interface is directly connected to a biogas reactor, also known as an anaerobic digester for collection and storage/ treatment. If a urine-diverting flush toilet is installed (and/or a urinal), it will be connected to a storage tank for urine collection.

The biogas system is best suited for rural and peri-urban areas where there is appropriate space, a regular source of organic substrate for the biogas reactor and a use for the digestate and biogas. The reactor itself can be built underground (e.g., under agricultural land, and in some cases roads) and, therefore, does not require a lot of space.

This study will contribute to the existing body of knowledge in health and safety management in the faecal service chain. The study established new insights to the growing literature on safe faecal sludge management, within the urban and slums context.

Information generated in this study is important for informing decision makers on the implementation and enforcement of national and internationally recognized health and safety management practices for proper faecal and sewage management in

Uganda. Results of the study give initial insights to scholars or students aiming to undertake further research in the field of sanitation, and specifically in the area of faecal sludge management.

2.3 Faecal sludge management in slum and informal settlement areas

The impact associated with Faecal Sludge Management (FSM) in most developing countries, particularly, in Africa is intense and it needs high attention. The latter follows from the fact that most of the faecal sludge generated on a daily basis from onsite sanitation systems is not well managed and handled. The faecal sludge (FS) from unsewered family and public toilets and septic tanks is disposed of untreated indiscriminately into lanes, drainage ditches, onto open urban spaces as well as into inland waters, estuaries and the sea (Montangero & Strauss 2004). This improper practice of FS disposal is a growing environmental and sanitary concern, since many waterborne diseases are transmitted from feaces to humans through water and soil pollution (Kengne et al. 2001).

When the faecal sludge is not managed properly, and disposed indiscriminately into the environment, it can lead to outbreak of waterborne diseases and water pollution, and a lack of access to clean, functioning toilets threatens human dignity thus affecting the health of the communities. And that is the case for 2.4 billion people worldwide without access to sanitary toilets (UNICEF & WHO 2015). It also contributes to the fact that 0.7 billion people worldwide do not have access to safe drinking water, as precious water is polluted with the people's own excreta.

Sustainable management of faecal sludge improves human and environmental health and generates societal and economic benefits. Although the goal of sanitation

agencies is to improve health, households rarely use toilets for health-related reasons alone; their primary concern is a desire for privacy. Most households aspireto some concept of 'modernity' and social acceptance and want to avoid the discomfort and dangers of open defecation (Jenkins and Scott, 2007; Reisch, 2008; Crocker et al., 2016; Asia & Kar, 2005). In general, faecal sludge management has gender implications at different levels in the communities. For example, the construction of latrines reduces the risk of women being attacked and raped when going to the bush or public toilets to defecate (Mara et al., 2010).

Unfortunately, treatment facilities in Sub-Saharan Africa are not well maintained or managed. A lack of sustainability in terms of their operation, maintenance and monitoring affects treatment performance and constitutes a threat to community health and the environment. In Kampala, Uganda, a study assessed health risks from wastewater, faecal sludge management and the reuse chain in agriculture. The findings show that farmers were at greater risk (prevalence of infection 75.9 per cent) than wastewater treatment plant workers (41.9 per cent) and faecal sludge collectors (35.8 per cent). The stream receiving the treated wastewater was contaminated by E. coli and hookworm eggs, with concentrations exceeding WHO standards for reusable wastewater in agriculture (between 3.8 $x10^5$ and 9.9 x 10^4 CUF/100 mL (Fuhrimann et al., 2014). This indicates the rate at which feacal sludge waste is released to the environment probably due to lack of on-site pit-latrines or the limited use of emptiers for the emptying of the pit-latrines and toilets.

2.4 Sanitation value chain and feacal sludge management

Sanitation service chains around the world are designed to cope with regular, predictable amounts of excreta produced by communities. Their design depends on

local circumstances, level of development, and cultural differences. In order to ensure health and safety of the sanitation workers handling faecal sludge, in developed countries, households are connected directly to a central sewerage systemwhere they dispose of the excreta produced from each household directly, thus protecting the sanitation workers from impacts associated with direct contact of faecal sludge.

Globally, the great majority of urban dwellers, especially poor people, rely for their sanitation on non-sewered systems that generate a mix of solid and liquid wastes generally termed “fecal sludge.” In poor and rapidly expanding cities, FSM represents a growing challenge, generating significant negative public health and environmental risks (Peal et al., 2014; Berendes, 2017). Without proper management, fecal sludge is often allowed to accumulate in poorly designed pits, is discharged into storm drains and open water, or is dumped into waterways, wasteland, and unsanitary dumping sites. Faecal sludge management is a long-term solution in the sanitation value chain, however, without an institutionalized emptying system for on-site sanitation, effective faecal sludge management and the elimination of open defecation are difficult to achieve.

2.5 Safe Management of Feacal Sludge

SDG 6.2, “End defection and provide access to sanitation and hygiene”, targets address sanitation beyond access to toilets, to include safe management of excreta. Understanding and implementing options for safe management of excreta is an important step towards fulfilling the ambitions of the SDGs (Water Aid 2018). Eliminating open defecation is just the first step in ensuring everyone has safely managed sanitation services, as outlined in Sustainable Development Goal (SDG) 6. In

South Asia, where most people use on-site toilets and sewerage coverage is limited, FSM, which involves everything from emptying pits of faecal matter and transporting the sludge to treatment and disposal is central to ensuring safely managed services (Water Aid 2018).

Safe FSM entails some aspects such as putting in place on-site sanitation systems that minimize the chances of human contact with faecal matter and pathogens (Strandeet al., 2014). Sustainable FSM also calls for safe handling and disposal of faecal sludge and reducing the discharge of faecal matter directly into the environment (Peal *et al.*, 2014; Harper et al., 2020). This will reduce risk of water pollution and hence disease prevention at household and community level, and will consequently lead to improved working conditions of the sludge emptiers.

2.6 Health and safety along the FSM value chain

The faecal sludge management chain involves process storage, collection, transport, treatment and safe end use or disposal of faecal sludge (Strande et al., 2014). It has been recommended that an integrated systems approach that incorporatestechnology, management and planning should be put in place in order for sustainable faecal sludge management to be achieved in any community or level (Bassan et al., 2013). For instance, when designing treatment plants, the final end use of the sludge needs to be determined in order to obtain the desired treatment level and ensuring its incorporation into the construction design (Strande, Ronteltap and Brdjanovic, 2014). Occupational and environmental health and safety is important as far as faecal sludge is concerned because sanitation workers are exposed to multiple occupational and environmental hazards (World Bank, ILO, Water Aid, and WHO 2019). Workers

engaged in faecal sludge management should be provided with a safe and healthy working environment most especially when collecting, transporting and storing the faecal sludge.

Occupational health and safety (OSH) is a key indicator in the maintenance of labour standards, and most of the labour acts of different countries (OSHA, 2016). Althoughit is the responsibility of government departments and private sector to ensure OHS, the health and safety of workers involved in the FSM is broadly ignored and waterand sanitation campaigns have failed to sufficiently address OHS for workers in the sanitation service chain.

Workers engaged in emptying and transportation of faecal sludge should be made aware of personal safety and health issues. Workers should be encouraged to undertake regular health checks and to always use Personal Protection Equipment (PPE) (Harada, Dong and Matsui, 2008). Workers should be aware of the health impacts of alcohol consumption, and especially the role of alcohol in workplace accidents. Sludge discharge into the local environment should be prohibited and workers made aware of its environmental and health impacts.

2.7 Roles of the faecal sludge emptiers

Faecal sludge needs to be considered as a very dangerous substance and therefore requires careful handling. The health of emptiers can be affected by direct contact with feaces and associated pathogens, as well as by the gas generated in the septic tank or pit. Emptiers are involved in the collection and transporting of the faecal sludge from their clients' premises and, are therefore tasked with ensuring that faecal sludge is not discharged into the environment and thus safely disposed at treatment plants (Bassan, 2014).

With the KCCA framework of faecal sludge management in Kampala city, emptiers such as the cesspool and gulper operators are tasked with mobilizing and creating awareness among their clients on proper sanitation and faecal sludge management (KCCA, 2019). Secondly, the leadership of emptiers' organizations are responsible for organizing and helping in provision of compliance assistance about the KCCA faecal sludge management framework to their respective members (KCCA, 2019).

2.8 Safety and Dignity of Sanitation Service Workers

The term sanitation workers refer to all people—employed or otherwise— responsible for cleaning, maintaining, operating, or emptying a sanitation technology at any step of the sanitation chain. This includes toilet cleaners and caretakers in domestic, public, and institutional settings, those who empty pits and septic tanks once full and other fecal sludge handlers, those who clean sewers and manholes, and those who work at sewage and fecal waste treatment and disposal sites (Dalberg Advisors 2017; WHO 2018). This research was limited sanitation to households and workers involved in emptying pit latrines and septic tanks from the point of collection to the disposal point.

Sanitation workers' rights need to be recognized; workers need freedom and support to organize as a labor force; and their working conditions need to be improved and progressively formalized to safeguard health and labor rights to ensure decent working conditions, as called for by SDG 8. The World Bank, World Health Organization (WHO), International Labour Organization (ILO), and Water Aid have joined forces in the year of "no one left behind" to shed light on this neglected issue. In this report, the most extensive global exploration of the topic to date, we

analyze the problems, explore good practices, and challenge ourselves, countries, and development partners to act so that we can improve the health, safety and dignity of sanitation workers (World Bank, ILO, WaterAid, and WHO 2019).

Beyond operational health and safety risks of working in direct contact with hazardous biological and chemical agents in dangerous environments, sanitationworkers also face stigma and social discrimination resulting from the nature of their work. Their dignity and labor rights may be violated, and few countries have any guidelines that explicitly protect sanitation workers. They remain invisible to many and despite carrying a disproportionate burden of health risks common to many workers of the informal economy, sanitation workers often do not have affordable and proper access to preventive and remedial health care or social protection (WorldBank, ILO, WaterAid, and WHO 2019).

2.9 Institutional and regulatory arrangements for FSM

Different stakeholders play different roles in management of the faecal sludge, from the primary local service delivery to high-level policy formulation. Thus successful implementation of a FSM system needs integration of a comprehensive approach which includes different institutional aspects, and a strong commitment from government in relation to sanitation policies including onsite sanitation (Bassan, 2014). The different stakeholders in the FSM and their possible involvement at different levels of the faecal sludge organization is summarized below:

Households. These usually decide what type of on-site sanitation system they build in their houses, the use of toilet facilities, decide when they want their pits/ tanks to be emptied and call for emptying services, pay for the emptying services. However, participation of the local population in the decision-making process of

faecal sludge management is low, so is awareness of the need for adequate faecal sludge management. The willingness-to pay for FS management is thus lower than for water supply (Bolomey, 2003). In addition, knowledge on the need to empty the septic tanks/pits regularly is often lacking. (Klingel et al., 2001).

2.9.1 Community-Based Organizations (CBOs)/Non-Governmental Organizations (NGOs).

These are central in creating awareness for reuse of FS based products and their marketing; represent the community and express its needs and concerns at hygiene, health and sanitation meetings (with the authorities and private sector etc.), and the promotion of sustainable solutions for the sanitation sector. Notwithstanding the above, in regard to FSM, CBOs and NGOs actively engage in offering financial assistance for acquisition and maintenance collection and transport equipment and build capacity of actors through awareness and training programmes on safe FSM (Eawag/Sandec 2008). CBOs and NGOs also advocate for the health, safety, dignity, and rights of sanitation workers at all levels in order to achieve safely managed sanitation for all (SDG 6.2) (World Bank, ILO, WaterAid, and WHO. 2019).

2.9.2 The private sector.

This responsible for emptying and transportation services and the operation of faecal sludge treatment plants. However, private sector mainly works independently from the public sector where public services are insufficiently ensured (Bolomey, 2003) which is the case in most slum areas. This reveals the level of flexibility of private companies in offering FS services. In Africa, some private collection and transport companies are organized in associations which are legally recognized (Bassan, 2014) for example, the Gulpers Association of Uganda. Associations of this naature have a

potential to provide an interface with the public authorities which can lead to the provision of incentives such as tax exemptions and securing of contracts as an association which could not have been obtained by a single company. Thus these associations enable the recognition of small operators and facilitate sector formalization, transparency and regulation (Bassan, 2014).

2.9.3 Public authorities.

These include national or local departments of governments and municipal utilities. These can be involved in FS management at different levels that is, at the local, city or national. They are also responsible for:

- collection and transport
- the development of a sanitation policy;
- setting up of a legal framework, define measures, sanctions and incentives to assist in meeting the objectives defined in the set policy(s);
- control and enforce the legislation;
- define roles and responsibilities of the different stakeholders;
- assume a coordinating role between the different administrative levels, and different actors (in particular between the public and private sector (Eawag/Sandec 2008).

As aforementioned, most of the responsibilities of the authorities are insufficiently assumed in practice, that is faecal sludge management is often not given adequate priority, and governments as well as municipalities often lack the required institutional and financial capacity (Bassan, 2014).

2.9.4 Donors Entities

In many countries, the sanitation sector is predominantly financed by Environmental Sanitation Approach and supported by international consultancy. The external

financial support is predominantly geared towards the construction of infrastructure to provide better access to sanitation for the population of a given geography. However, sustaining this trend of infrastructure provision, requires strong capacity building programme to provide local expertise for operation, maintenance and upgrading of these established infrastructures. This remains a challenging task for the international sanitation community.

Above all, the neglect, and existence of an unclear and overlapping allocation of responsibilities and the lack of incentives to enable efficient operations, result in failure of the FSM systems. This is common where incomplete institutional arrangements exist, which results in a continual lack of accountability and disparity between stakeholders (Bassan, 2014). It is therefore essential that institutions are functional since the entire service chain are linked.

2.8 Gaps the study sought to address

Considering the reviewed literature, which is limited in regard to practices employed by sanitary operators in thr faecal sludge management value chain, this study sought to explore the health and safety practices in FSM in the urban and slum areas in Nakawa Division, Kampala District. This included the assessment of the KAP ofhouseholds in Naguru 11 and Bukoto 1 urban areas, as well as those in Muramira and Naguru Go-Down Villages. The study also assessed the health and safety practices among the gulper and cesspool operators in the same areas during collection, transportation, treatment and disposal of faecal sludge. The significance of the studyis as provided in section 1.6 above.

CHAPTER THREE - METHODOLOGY

3.1 Introduction

In this chapter, research methods, tools and procedures that were utilized during the research are presented and discussed.

3.2 Research Design

The study utilized a mixed research design method comprised of both quantitative and qualitative approaches. Quantitative methods involved the acquisition of data such as the number of people sharing sanitary facilities and the lifespan of the sanitary facilities. Quantitative approaches are important for studying the trendsand patterns of a phenomenon under investigation (Creswell, 2012).

Qualitative approaches involved acquisition of data from the respondents of the study on the knowledge, attitudes and factors influencing sustainable faecal sludge management in the study area. Qualitative approaches were also used during acquisition of data from the key informant interviews. Yin (2015) indicated that qualitative methods are good for research surveys involving understanding and interpreting descriptions made in words and verbally by respondents about a phenomenon under investigation, and literature reviews that explored the concepts (Maxwell, 2005).

3.2.1 Study Areas

The study was conducted in the urban areas and slums of Nakawa Division in Kampala District. Naguru Bank Village and Naguru Go-down Village of Naguru II Ward; and Old-Kira Road Village and Mulimira Village of Bukoto I Ward were selected for this study. The choice of selecting Nakawa Division for this study based on the fact that the

Gulper operators regularly implement their services in this area because of the high demand for faecal sludge emptying and collecting services. Initial guidance was obtained from the Directorate of Public Health and Environment, Kampala Capital Authority and the Uganda Gulpers Association.

Nakawa Division is one of the five administrative divisions of the City of Kampala, the capital and largest city of Uganda. Nakawa Division lies in the Eastern part of the city, bordering Kira Town to the East, Wakiso District to the North, Kawempe Division to the North-West, Kampala Central Division to the West, Makindye Division across Murchison Bay to the South-West and Lake Victoria to the South.Neighboring towns include Bugolobi, Bukoto I, Butabika, Kiswa, Kiwatule, Kyambogo, Kyanja, Luzira, Mbuya, Mutungo, Nabisunsa, Naguru Go down, Nakawa, and Ntinda.

The 2014 census put the figure of Nakawa Division at 317,023 persons and 83,853 households (UBOS, 2017). Naguru Go-down slum was randomly selected for this study amongst the different areas that cesspool and Gulper operators regularly carry out their services because of the high and regular demand for faecal sludge emptying and collecting services.

3.2.2 Sources of Information

The empirical data used in this study was collected from the households in the urban areas of Naguru II and Bukoto I and households in Naguru Go-down and Mulimira slums. On top of this, another set of data was collected from faecal sludge emptiers (cesspool and gulper operators) that operate in the study area. Secondary data was obtained through desk review of pre-existing published literature such as journal articles, reports, research books and published government reports and statutory instruments.

3.2.3 Population and sampling techniques

3.2.3.1 Population

The target population that was interviewed were the households in the urban areas of and slums of Naguru II and Bukoto I Wards in Nakawa Division. Precisely, the urban areas were Old Kira Road Village and Naguru Bank Village while the slums were Naguru Go-down and Mulimira slums. The study also targeted local council authorities of both the urban and slum areas in Naguru II and Bukoto I, institutions including Kampala Capital City Authority (KCCA), National Environmental Management Authority (NEMA), National Water and Sewerage Corporation (NWSC), and the Gulpers Association that are involved in the processes of faecal sludge management in the study area.

3.2.3.2 Sample Size

The sample size of this study was determined from the method according to Krejcie and Morgan (1970). This method allows for sample size determination at confidence level of 95% and margin error of 5 (Equation 1).

$s = X2\ NP\ (1 - P) \div d2\ (N - 1) + X2\ P\ (1 - P)$…… Equation 1

Where;

s = required sample size

X2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841)

N = the population size.

P = the population proportion (assumed to be .50 that should provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (0.05) Sample size

Using this formular, the sample size of this study was determined to be 322 households from 2095 households. Only 4 household respondents declined to give consent to the researcher during data collection. A total of 36 gulper and cesspool operators were interviewed during the field survey of this study.

3.2.4 Procedure for data collection

Data collection is a stage in the research process that involves collection and measurement of data about a given variable of interest in the study (Fraenkel, et al 2012; Kothan, 2004). Both primary and secondary data was collected for this study. Primary data was collected during the interviews with the respondents of the study while secondary data was collected through desk reviews from pre-existing literature like books and journal articles.

3.2.4.1 Objective One: Knowledge, attitudes and practices related to faecal sludge management among households

To collected data on the knowledge, attitudes and practices related to faecal sludge management among households, semi-structured interviews were conducted with the use of questionnaires (Appendix 1).

A questionnaire is a tool consisting of precise questions in an orderly and logic manner used for data collection from respondents in a consistent manner (Jenn, 2006). Semi-structured interviews are dominated with often open-ended questions that allow respondents to elaborate themselves and comprise less closed-ended questions (Phellas et al, 2012). Respondents were asked questions using a questionnaire (Appendix 1). Questions rotated around the presence of faecal management sanitary facilities in their households, questions about presence of a toilet or latrine in the household were asked, cleaning of the toilet, presence of the

lining in latrines and the use of sludge emptiers, and questions about their knowledge on the sanitary procedures that must be followed by emptiers during faecal sludge collection.

3.2.4.2 Objective two: Sanitary practices among sludge emptiers (cesspool and gulper operators) operating in the study area

Structured interviews were conducted with sludge emptiers including cesspool and gulper operators to inquire from them the sanitary measures they undertake while handling the faecal sludge. Structured interviews are usually conducted using an interview guide (Appendix 2) mainly consisting of closed-ended questions that enable the interviewee to easily provide the desired responses (Phellas, Bloch and Seale, 2011). Questions about the measures undertaken to prevent environmental contamination at stages like sludge collection, sludge transportation, sludge treatment and sludge disposal or reuse were asked (Appendix 2).

3.2.4.3 Objective three: Factors influencing safe faecal sludge management among households

To collect data on the knowledge, attitudes and practices related to faecal sludge management among households, semi-structured interviews were conducted using a questionnaire (Appendix1). Key informant interviews (Appendix 3) were conducted with relevant local stakeholders involved in faecal sludge management in the study area namely; local council and local government officers tasked with sanitation in the area. Key informant interviews are often conducted with individuals based on their experiences and presumed level of knowledge about the subject matter and provide in-depth information (Wilson, 2014).

Questions on the major challenges faced in ensuring sustainable faecal sludge management at household level and on the by-laws that are in place to ensure sustainable faecal sludge management were asked.

3.2.5 Validity and reliability

The research assistants underwent a two-day training to familiarize themselves with the research tools, that is, interview guide and digital voice recorder. The research assistants were trained on how to probe further; in case a question needed further exploration or if a unique point came up. Electronic capturing of data was used to prevent data loss through poor handwriting. For the qualitative study, validity was established through triangulation data using various sources (Bjurulf, et al., 2013).

For the quantitative study, the questionnaire was pre-tested/by administering the questions to households in the planned study areas before the actual field survey started and adjustments needed were made.

3.2.6 Unit of inquiry and Unit of analysis

The unit of inquiry in this research was the household heads in Naguru II and Bukoto I and slums of Naguru Go-down and Mulimira slums in Kampala District. Secondly, sludge emptiers (cesspool and gulper operators) involved in faecal sludgemanagement in the study area were also part of the study.

3.2.7 Variables and indicators

Study variables for this research were categorized into three kinds: the independent, intervening and dependent variables. Independent variables included individual factors such as knowledge and attitudes on sludge management, demographic characteristics: age, sex, religion and marital status. Intervening variables included national and international WASH regulations and local by-laws. The dependent

variables were health and sanitation practices in sludge management. The interaction between the independent and dependent variables influenced the outcomes such as improved health and safety practices within the fecal sludge management and service chain. The absence or presence of sanitary facilities and lack of knowledge on key procedures of faecal handling was used as indicators on safe sludge management.

3.2.8 Strategy for data processing and analysis

The approach used for analyzing data based on all the three specific objectives of the study is presented in the subsequent write up.

3.2.8.1 Objective One: Knowledge, attitudes and practices related to faecalsludge management amongst households

Descriptive statistics and inferential statistics were conducted using the Statistical Package for Social Sciences (SPSS) software (version 23) was utilized to calculate frequencies and percentage of the respondents on the knowledge, attitudes and practices related to faecal sludge management amongst households. A One-Way Analysis of Variance (ANOVA) was conducted to analyze the variations in the awareness knowledge, attitudes and practices related to faecal sludge management amongst households from different areas in Kampala (Appendix 4).

3.2.8.2 Objective two: Sanitary practices among sludge emptiers (cesspool and gulper operators) operating in the study area

Descriptive statistics were conducted using SPSS software Version 23 to calculate frequencies and percentage of the respondents on sanitary practices among sludge emptiers (cesspool and gulper operators) operating in the study area. Qualitative

data obtained during the interviews was analyzed using thematic analysisprocedures. Thematic analysis involves data transcription, coding, interpretation and building themes with similar related patterns of qualitative data (Braun, 2006).

3.2.8.3 Objective three: Factors influencing safe faecal sludge management among households

The Multiple Linear Regression Model was conducted to analyze the factors influencing safe faecal sludge management among households. Multiple linear regression predicts correlated dependent variables such as the factors that might influence safe faecal sludge management among households.

$\gamma i = \beta 0 + \beta 1 Xi1 + \beta 1 Xi2 \ldots. + \beta p Xip + \varepsilon \ldots\ldots\ldots\ldots$

Where,

yi = dependent (response) variable

X1-Xip = independent (predictor/explanatory) variables

β0 = y-intercept (constant term)

βp = slope coefficients for each predictor variable

ϵ = the model's error term (known as residuals as well)

Qualitative data obtained during the key informative interviews was transcribed, coded and triangulated and analyzed using thematic analysis procedures.

Data was first tested to find out whether it met the three main assumptions for running the multiple regression model including normality, non-multicollinearity and homoscedasticity. All these three conditions including normality (Appendix 5 and 6); non- homoscedasticity (Appendix 7) and multicollinearity (Table 4.5) were all observed and deemed the data fit for running the Multiple regression Model.

3.2.9 Ethical considerations

To carry out the research, permission was sought from the University's ethics committee and the local leaders to carry out research in the study areas (Appendix 8). Informed consent was obtained from the respondents before any interviews were conducted (Appendix 9). However, the form was digitized, and only verbal consent was obtained from the respondents after explaining the study to them.

Utmost confidentiality was provided for all information given by the participants and any participant was allowed to leave at any point of the research. No names were captured during data collection to ensure that the data remains anonymous.

After presentation of the dissertation, the digital video recordings were destroyed to avoid information going into the wrong hands.

3.2.10 Anticipated methodological constraints

With a cross sectional study, the phenomena are only assessed at a particular time, and there is no future or retrospective follow-up. Once the subjects are selected, the investigators collect the data and assess the associations between the outcomes and exposures. Also, the data collected mainly shows relationships between variables and how they influence each other (Wang and Cheng, 2020). It was anticipated that some respondents were going to conceal information on their real faecal sludge management practices in fear of being penalized. Therefore, effort was made by the researcher to ensure that the respondents clearly understood that this was anacademic study, and the information given would be used for academic purposesonly, and with utmost confidentiality.

3.2.11 Quality/error controls

During the study, the steps that were taken to ensure quality control include, pretesting the questionnaire, training of research assistants, supervision of data

collection and electronic transmission of data. The questionnaire was pre-tested to ensure validity. Research assistants underwent a training on how to use the data collection tool.

Cross checking of the data-recording forms was done to make sure errors made are corrected in time. Supervision of data collection was done to ensure that theresearch assistants are actually collecting the data and also to make sure they were doing it right. Electronic transmission and capturing of data were used to prevent loss of data and reading from badly written data.

3.2.12 Limitations of the study

The study was undertaken during the period when the world (including Uganda), was significantly being affected by the COVID-19 pandemic which is highly infectious and fatal, and required minimal human interaction, with mandatory social distancing, and other strict standard operating procedures. This therefore somehow delayed the collection of data.

Cesspool and gulper operators were mainly accessed through their companies such as Sanitech Engineering Services Ltd and Tekirigana Sanitation Services Ltd that largely operated in the study areas. The scale of the companies varied in terms of equipment used in transportation, and the size of the workers operating the Gulpers,and the work procedures.

CHAPTER FOUR - RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter contains findings based on the specific objectives of the study. The chapter comprises information on the socio-demographic characteristics, knowledge, attitudes and sanitary practices in faecal sludge management and the factors that influence safe faecal sludge management amongst households in urban areas of Naguru II (Naguru Bank Village) and Bukoto I (Old Kira Road Village) and in Naguru Godown and Mulimira slums.

4.1 Socio-demographic characteristics of the respondents

A total of 322 respondents from the household survey in the study areas were interviewed, while a total of 36 faecal sludge emptiers were also interviewed. Based on the household survey data (Table 4.1), majority of the respondents of this study (58%) were residents of Mulimira Village while the least number of respondents (5%) were from Naguru Go-down Village. Majority of the respondents were female (54.9%) while male respondents accounted for 45.1%. 67.8% of the respondents of this study were married and 48.9% have attained a secondary school education, over 31.9% were unemployed.

Table 4. 1: Socio-demographic characteristics of the respondents of the study

Socio-demographic characteristics		Frequency	Percentage (%)
Residence	Naguru Go down	71	22.4%
	Old-Kira Road	46	14.5%
	Mulimira	184	58%
	Naguru Bank Village	16	5.0%
Sex of the respondent	Male	143	45.1%
	Female	174	54.9%
Marital status	Single	77	24.3%
	Married	215	67.8%
	Widowed	14	4.4%
	Divorced	11	3.5%
Occupation of respondent	Unemployed	101	31.9%
	Formal employee	63	19.9%
	Casual labour	42	13.2%
	Business person	95	30%
	Crop cultivator	2	0.6%
	Livestock keeper	3	0.9%
Highest education level attended	No formal education	19	6%
	Primary education	29	9.1%
	Secondary A level	155	48.9%
	Diploma	51	16.1%
	Bachelor degree	59	18.6%
	Post graduate	4	1.3%
Faecal facility ownership	Yes	235	74.1%
	No	82	25.9%
Type of facility owned	Pit latrine	133	55.4%
	Toilet	107	44.6%

4.2 Knowledge, attitudes and practices related to safe faecal sludge management at household level

Results on the knowledge, attitudes and sanitary practices associated with safe faecal sludge amongst respondents at household level within the study area are presented here.

4.2.1 Knowledge and attitudes about faecal sludge management at household level

An assessment of the knowledge and attitudes towards faecal sludge management among respondents at household level revealed that a large proportion of the respondents from the study area (53.1%) were not aware of the dumping sites of the feacal sludge collected from their households by sanitary operators. Only 46.1% of the respondents stated that they were aware of the location of the dump sites where feacal sludge collected from their households by sanitary operators is disposed of (Table 4.2).

An overwhelming 98.4% of the respondents at household level indicated that faecal sludge management and toilet/latrine emptying was a necessary sanitary exercise. 97.2% reported that they were aware of the need to use personal protective equipment by the emptiers such as gulper and cesspool sanitary operators. Only 0.3% of the respondents perceived and ranked faecal sludge management and toilet/latrine emptying as unnecessary practice while 77.3%, 20.8% and 1.6% perceived and ranked the practice as very important, important and neutral respectively (Table 4.2).

The high response observed on the need for safe feacal sludge management and sanitary services such as toilet/latrine emptying amongst households in the study area can be attributed to the increased recognition and appreciation of the need for safe sanitation services as a right towards everyone within the community (. Evidence from elsewhere has shown that awareness creation enhances the sanitation practices among individuals and households (Seimetz, Kumar and Mosler, 2016). In India, Seimetz et al.,(2016) reported that awareness creation increased hand washing with soap practice amongst homestead visitors after toilet use. This can be linked to

the fact that the households in the study areas might have perceived ownership of an on-site pit-latrine or toilet as an important practice due to the knowledge that has been imparted in them by bodies that have been involved in community sensitization for sustainable feacal sludge management such as KCCA and GIZ. This is in line with the Sustainable Development Goal (SDG) 6 which aims at ensuring access to safely managed sanitation for everyone (UN, 2018).

Conversely, the low level perception on the importance of the sanitary facility emptying and proper feacal sludge management can be attributed to low levels of awareness and sensitization amongst local households on the relevance of safe faecal sludge management (Seimetzet al., 2016).The low awareness among the respondents can also explain the low knowledge on location of the faecal sludge dumping site used by the sanitary operators among the respondents at household level. Elsewhere,Cookey *et al*. (2020) reported that a laissez-faire attitude towards faecal sludge management led to a bad behaviour amongst households and community towards emptying of on-site faecal technologies such as toilets and pit latrines in Bangladesh.Similarly, Mkude, Gabrielsson and Kimwaga (2021) reported that low levels of knowledge and negative attitude towards faecal sludge management technologies such as resource recovery and reuse affected sustainable faecal sludge management in Tanzania.

Table 4.2: Knowledge and attitudes and sanitary practices for faecal sludge management at household level

Knowledge and attitudes on faecal sludge management		**Percent response**
Aware of the faecal sludge dump site used by sanitary operators	No	53.9%
	Yes	46.1%
Faecal sludge management Necessity	No	1.6%
	Yes	98.4%
Aware of need for PPE use	No	2.8%
	Yes	97.2%
Perceived importance of latrine/toilet emptying	Important	20.8%
	Neutral	1.6%
	Unnecessary	0.3%
	Very important	77.3%

4.2.2 Sanitary practices for feacal sludge management at household level

An investigation of the sanitary practices for safe feacal sludge management at household level revealed that the majority of the respondents (74.1%) owned a sanitary facility such as a toilet or pit latrine while 25.9% neither had a pit latrinenor a toilet in their homesteads (Figure 2). Ownership of an on-site lined pit latrine was reported by 61.8% of the respondents, while the remaining 38.2% owned an on- site pit latrine that was not lined (Figure 2).

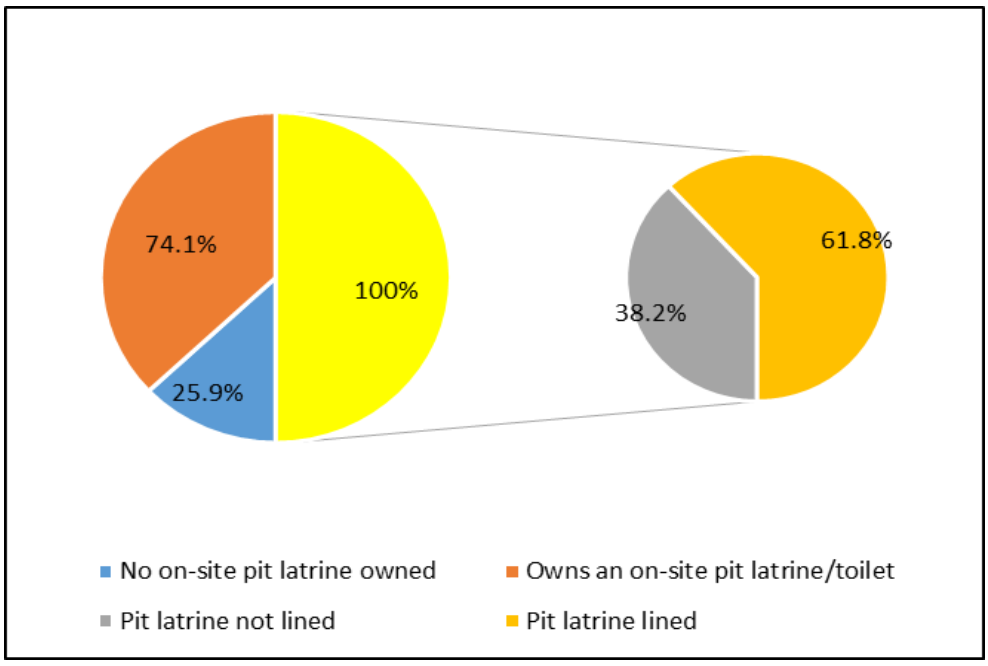

Figure 2: Ownership of an on-site toilet/pit latrine and type of pit-latrine owned amongst respondents

Among the other good sanitary practices of feacal sludge management at household level in the study area was the presence of toilet/latrine pans and clean floors amongst households (97.5%), unblocked toilet/septic tank hose pipes (96.2%), daily cleaning of the toilets/pit latrines (60.3%), stocking toilets/pit latrines with brushes/brooms for cleaning (50.8%) and the presence of properly fitting doors/shuttles on the toilets/pit latrines (50.8%) respectively (Table 4.3).

Table 4.3: Sanitary practices for faecal sludge management amongst respondents

Type of sanitary practices	**Practice Not available**	**Practice Yes/available**
Latrine/toilet shared	22.4%	77.6%
Latrine/toilet doors and walls broken	49.2%	50.8%
Latrine/toilet brush or brooms available	49.2%	50.8%
Water supply in latrine/toilet	8.5%	91.5%

Cleaning latrine/toilet daily basis	39.7%	60.3%
Blockage of toilet/latrine pipes blocked	96.2%	3.8%
Emptying latrine/toilet when full	20.8%	79.2%
Latrine/toilet pan or floor deposited with feaces	97.5%	2.5%
Pit latrine eye covered	86.4%	13.6%
Toilet Water seal present in toilet	59%	41%
latrine/toilet reduce direct contact or direct release to environment	59.3%	40.7%
Houseflies access faecal matter in latrine/toilet	77.6%	22.4%

Although the biggest proportion of households were found owning an on-site faecal facility in their households, the proportion of households without an on-site facility (25.9%) is worrying because lack in local residents' households of these facilities propels them to engage in unsafe practices such as open defecation (Kwesiga et al., 2018; Okello et al., 2019). Previous nationwide reports from Uganda have shown that the continued existence of poor sanitation among urban and slum areas is associated with the increasing urban population that pose challenges to extending proper sanitation services (National Environmental Management Authority, 2012).

The presence of sustainable faecal management practices such as stocking sanitary facilities with cleaning materials like toilet brushes, daily cleaning of the toilets/latrines and the presence of lined septic tanks/latrines among households displays stewardship towards proper sanitation (Kabir and Salahuddin, 2014). Findings at both regional and international scale have shown that local communities are making significant progress towards access and utilization of improved sanitation services at household level (UN, 2015; WHO/UNICEF, 2017). Therefore, households in

the study area were commendable for practicing the observed degree of sanitary practices such as lining and daily cleaning of the toilets/latrines.

Among the unhygienic practices of feacal sludge management reported amongst households in the study area are sharing of the sanitary facility, lack of a latrine (toilet) cover/(pan) (86.4%), houseflies accessing faecal matter in the latrine/toilet (77.6%) and lack of a water seal in the toilet (59.3%) were widely reported respectively (Table 4.3). Under the water and sanitation strategy for 2016-2030, eradication of unhygienic practices such as lack of toilet water seals, access of houseflies due to lack of water seals and toilet pans is top on agenda (UNICEF, 2016a). Therefore, the existence of unhygienic practices such as lack of toilet water seals and toilet pans amongst the households in the study area indicates the need to improve the feacal sludge management practices in this area.

Studies elsewhere have also reported the existence of unhygienic activities such as lack of toilet pans/covers and water seal that prevents access of houseflies to faecal matter in the latrines/toilets (Kabir and Salahuddin, 2014). Earlier studies have shown that unsanitary practices such as lack of water seals and toilet covers promotes the access of houseflies to faecal matter, thereby exposing households to outbreak of disease such as cholera where houseflies play a big role in it spread (Kwesiga et al., 2018; Mamera et al., 2020).

4.3 Health and Safety practices among sludge emptiers (cesspool and gulper operators) operating in the study area

Findings on the health and safety practices in faecal sludge management amongst emptiers including cesspool and gulper operators within the study area along the

faecal sludge management value chain including collection, transportation, treatment and disposal phases are presented in the subsequent subsections.

4.3.1: Health and safety practices among sludge emptiers at the collection phase

Results from the investigation on engagement in both hygienic and unhygienic practices by the cesspool and gulper emptiers during faecal sludge collection from households in the study area are presented in Figure 3.

The health and safety practices undertaken during the collection phase of the faecal sludge were reported as ensuring proper mechanical condition of the transportvehicles (11.20%), reducing distance between the faecal sludge collection van andthe sanitary facility (6.9%) and cleaning the working area with water and detergent after emptying of the faecal facility (14.4%). The unhygienic practice of entering the pit latrines or septic tanks during the emptying of the sanitary facility was recorded amongst 12% of the emptiers, leakage of feacal sludge collection barrels reported by 25% of the emptiers and leakage of horse pipes reported by 30.3% of the emptiers (Figure 4).The collection phase of faecal sludge matter has been observed as one of the important stages in the faecal sludge management cycle with challenges of spill overs and environmental contamination (Chowdry and Kone, 2012). It is therefore of great regard that important sanitary strategies such as avoiding entering of the pit-latrines and cleaning the working area with water and detergent were observed among the emptiers in the study area. Conversely, the few unsanitary practices suchleakage of the collection barrels, leakage of sewer horse pipes and entering pit latrines and septic tanks during emptying have also been reported by earlier studies (Odey et al., 2017). This could be attributed to the low level of professionalism and training amongst the emptiers of the sanitary facilities households in developing countries like Uganda (Harada and Strande, 2016; Odey et al., 2017). This points to

the need for sensitization and capacity building of the emptiers on the safe guidelines to undertake while collecting the faecal sludge from local. Indeed, international development partners such as the World Bank and United Nations have prioritized knowledge dissemination and capacity building as a measure to improve the fecal sludge management value chain in the developing region of the world (Harada and Strande, 2016).

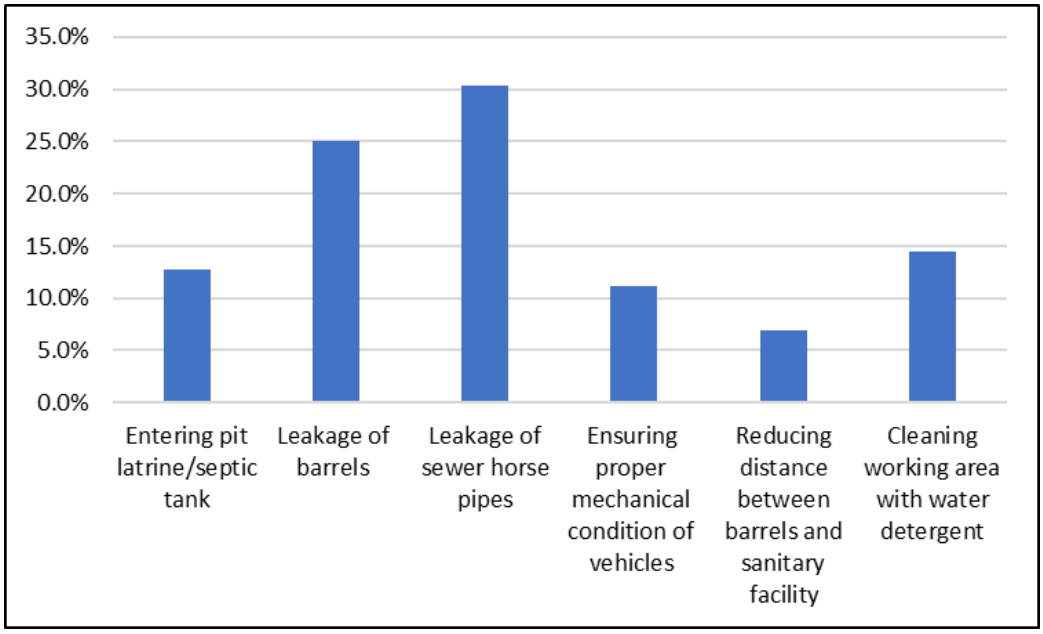

Figure 3: Sanitary and unsanitary practices among sludge emptiers at the collection phase

4.3.2: Health and Safety practices among sludge emptiers at the transportation phase

At the faecal sludge transportation phase, avoiding the use of broken equipment and vacuum trunks was the dominant sanitation practice undertaken by the sanitary operators (36%). Driving/riding the faecal collection vehicles/tricycles at controlled speed with the aim of minimizing spillage of the waste material into the environment was the least used (2.7%). Ensuring good mechanical condition of the transportation vehicles (32%), tightening valves and covering of barrels (17.3%) and covering the

transportation barrels to avoid spillage of the onboard waste (12%) were othersanitary practices used by the emptiers in the study area (Figure 4).

According to Peal et al., (2020), lack of adequate and proper functioning infrastructure are a key hindrance to the safe management of faecal sludge in in developing regions such as Sub-Sahara Africa and Asia. It is not uncommon thatfaecal sludge transportation challenges such mechanically sound vehicles and leakages of vehicle horse pipes and barrels still surfaced regardless of the little efforts undertaken by emptiers in the study area to overcome such challenges.

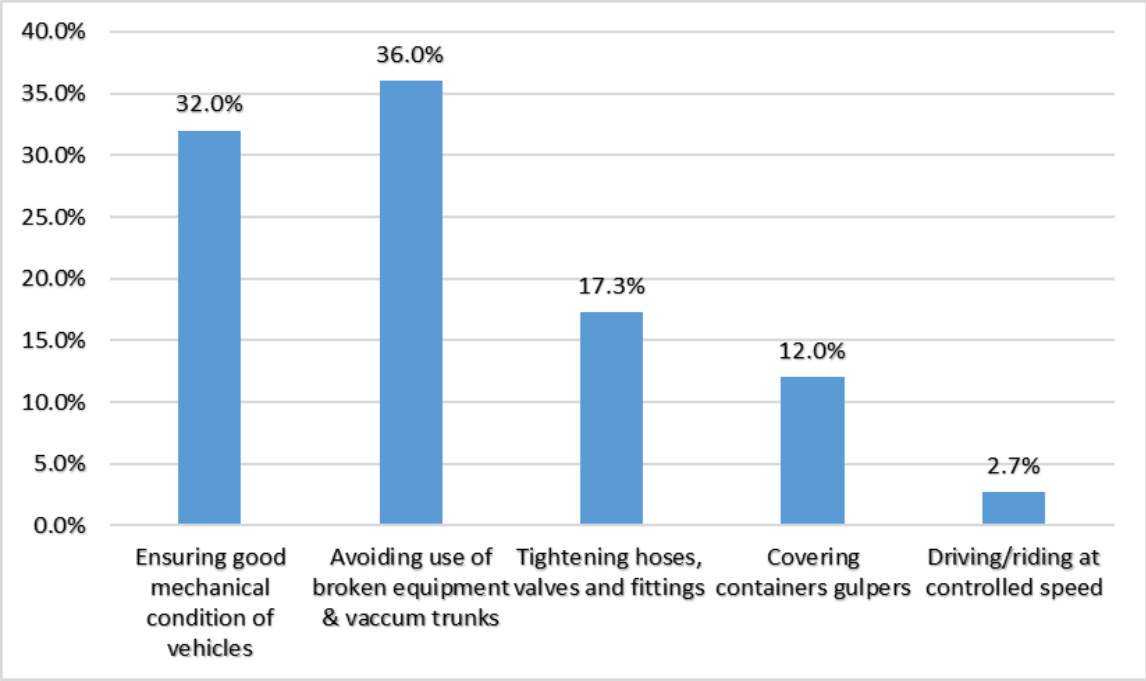

Figure 4 Sanitary practices among sludge emptiers at the transportation phase

4.3.3: Health and Safety practices among sludge emptiers at the treatment and disposal phase

At the faecal sludge treatment phase, separation and proper handling of the solid waste filtered from faecal sludge was stated by 27.7% of the emptiers, ensuring treatment of the faecal sludge at the designated site (20%) and using trained personnel for the treatment of the faecal sludge 23.1% were among the most

common sanitary practices. Other sanitary practices carried out by the emptiers at the treatment stage included the presence of properly designed layout of the treatment area (15.4%) and use of PPE (9.2%) (Table 4. 4).

Table 4. 4: Sanitary practices among sludge emptiers at the treatment phase

Treatment phase frequencies			
		Responses	
		Frequency	**Percent**
1a	Using recommended treatment chemicals	3	4.6%
	Treating at the designated site using unplanted drying beds	13	20 %
	Using trained personnel	15	23.1%
	Separation and proper handling of solid waste from liquid sludge	18	27.7%
	Proper layout and designing of treatment site	10	15.4%
	PPE use	6	9.2%
Total		65	100%
a Dichotomy group tabulated at value 1.			

At the disposal stage of faecal sludge, the emptiers indicated that numerous sanitation measures were undertaken to ensure sustainable faecal sludge management. The measures included ensuring use of personal protective gears (29.4%), controlling the volume of waste accumulation at the disposal site through controlled waste volumes and incineration of non-biodegradable drained and dry solid materials (23.5%), putting in place penalties for bad disposal (17.6%), and ensuring hygiene such as practicing handwashing and cleaning of the equipment (11.8%) (Figure 5).

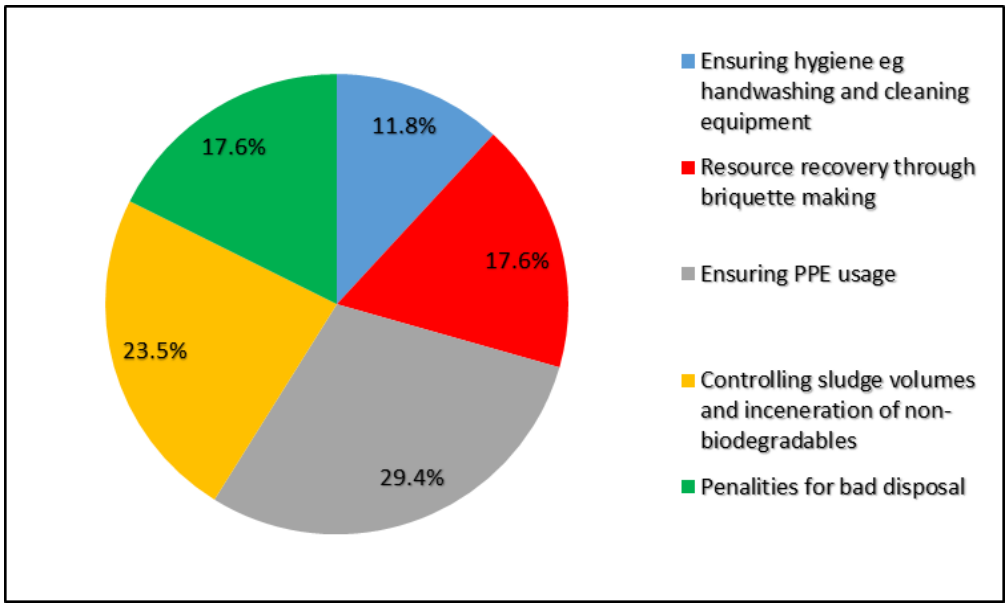

Figure 5: Sanitary practices among sludge emptiers at the disposal and re use phase

Faecal sludge treatment and disposal are important stages within the faecal sludge management cycle because their absence can promote public health concerns and unsanitary practices such as de-sludging/disposal of feacal sludge into the environment among sanitary operators (Devaraj *et al.*, 2021). According to Klinger *etal.*(2019), a typical faecal sludge treatment chain comprises of preliminary separation of solids from the sludge, settling tanks, drying beds where the leachate goes to ponds and/or co-treatment with wastewater, and resource recovery ordisposal of the dewatered sludge. Based on the sanitary practices reported by the emptiers during this study, it is evident that majority of the procedures recommended for faecal sludge treatment and disposal stages were being followed. This can be attributed to a number of factors including institutional arrangement observed in the recent years (Nakyagaba et al., 2021) and availability of guidelines such as the Kampala Capital City Ordinance of 2019 that regulates Sewage and FaecalSludge Management in Kampala (KCCA, 2019).

Just as it has been reported in the current study that briquettes were one of the bi-products of faecal sludge resource recovery and reuse process (Figure 5), it has been widely reported that items such as briquettes and poultry feeds are some of the end use products of faecal sludge management (Mallory, Holm and Parker, 2020; Mkude, Gabrielsson and Kimwaga, 2021). This is an indication of technological adoption for safe faecal management amongst the different stakeholders including the emptiers and the local communities. In Uganda, this can also be attributed to the large investment in sustainable faecal sludge management from local authorities and development through capacity building and supply of machinery for making briquette making (KCCA, 2016; GIZ, 2018). Indeed studies conducted at a regionaland global scale have shown that turning faecal sludge into environmentally friendly products such as agricultural fertilizers entails low-cost technological options available for developing countries like Uganda (Strande, Ronteltap and Brdjanovic, 2014; Singh *et al.*, 2017). On the other hand, the use of PPE at the faecal sludge disposal and resources phases is encouraged to avoid inhalation of bad odour and gases that might original from some of the processes of faecal sludge management such as incineration (Harada and Strande, 2016).

However, the treatment and disposal stages require some good degree of technical expertise for the proper management of the faecal sludge (Harada and Strande, 2016; UNICEF, 2016). Besides all this, existing strategies such as treatment at designated areas and use of professionals seems not to have been fully taken up byall the emptiers who were interviewed. This somehow indicates the loopholes in the supervision and policy implementation by the relevant bodies such as NEMA and KCCA to ensure compliance in use of designated dumpsites and treatment chemicals.

Studies have shown that supervision is key in the implementation of regulations and ensuring compliance of the workers and employers to established guidelines (Qiao *et al.*, 2018; Wong et al., 2020). In this regard, strategies such as awareness creation, sanctions and training of the emptiers come in handy for the ill-trained and experienced sanitary operators (Jenkins, et al., 2015; Chipeta et al., 2017).

4.4 Factors influencing safe faecal sludge management among households in the study area

Outputs of the multiple regression model (Table 4.5) show the socio-economic factors that influenced safe faecal sludge management among households in the study area. The duration of stay of the respondents in the study area statistically significantly (P=0.005) through facilities like toilets and pit latrines. The beta value for duration of stay was 0.24 (Table 4.5); indicating that every increase in years of stay in the area increase the chances of a household owning an on-site pit latrine by
0.24 units. This implied that respondents and households that had stayed in the study areas for a longer time (5-10 years) were more likely to own on-site toilet or pit latrine unlike individuals or households that had just recently moved there.

Mulimira slum was used as the reference category amongst the different villages in the multiple regression analysis because, there was a statistically significant difference observed in on-site toilet/latrines ownership between respondents living in Mulimira and Naguru Bank Villages (P=0.000). The beta value for Naguru Bank Village was -0.368 (Table 4.5); indicating that living in this village reduced the chances of a household owning an on-site pit latrine by -0.368 units. Since Mulimira Village is a slum area, and Naguru Bank Village an urban area in Kampala, these
results indicated that there was a statistically significant difference observed in on-

site toilet/latrines ownership between households found in the slum and urban areas of Kampala. Therefore, the assumption that there was a statistically significant difference in the sanitary practices between urban and slum households in Kampala was accepted.

Similarly, there was a significant difference observed in on-site toilet/latrines ownership between respondents living in Mulimira and Naguru Go-down slum (P=0.000). The beta value for Naguru Go-down slum was -0.379 (Table 4.5); indicating that living in this village reduced the chances of a household owning an on-site pit latrine by -0.379 units. Since both Mulimira and Naguru Go-down Villages are both slum areas of Kampala, these results revealed that there was a statistically significant difference observed in on-site toilet/latrines ownership between households in the slums. The assumption that there was no statistically significant difference in the sanitary practices amongst slum households in Kampala was rejected.

However, there was no significant influence observed between safe faecal sludge management and other socio-economic factors such as average daily income (P=0.805), gender of the respondent (P= 0.727), age of the respondent (P= 0.52) and the size of a given household (P= 0.303) in the study area.

The R^2 = 0.522 showed that ownership of a pit latrine or toilet which was the independent variable, accounted for 52.2% of the variance in the safe faecal sludge management in the study area. Generally, the Multiple regression model was significant (F= (11.661, 31.151) =3.690, $p < 0.01$, R^2 = 0.522). This implied that the

regression model ran was important in predicting the determining factors of safe faecal sludge management among households in the study area.

There was a correlation observed on-site faecal sludge management between household in slums and urban areas, the duration of stay in the study area and amongst households in different slum areas in the current study. These findings of the current study are in agreement with findings from Kabir and Salahuddin (2014). Kabir and Salahuddin (2014) reported that there was a direct correlation been access to sanitary toilets/latrines in cities of Southern Bangladesh and the different areas that they lived in. More so, low income households have been reported to be more involved in open defecation than household with medium income status (Jenkins, et al., 2015; Gitau et al., 2020). This justifies why some studies have argued that accessto on-site sanitary facilities for faecal sludge management is still low and highly shared amongst households in developing countries such as Uganda (Peal et al., 2014;Simiyu et al., 2021).

On another hand, it is possible that the growing population in the study areas in the recent years has limited space for the construction of onsite faecal facilities in the -slums such as Mulimira and Naguru Go-down Villages (NEMA, 2012; MWE, 2018). Such situations are likely to make it hard for the economically disadvantaged households and other community members to engage in unsanitary faecal sludge management practices like open defecation and release to the environment. This points to the need for a combined effort between local communities, state agencies and development partners to improve faecal sludge management amongst communities inUganda. In cases, where mass sensitization and yet the unsanitary fecal sludge management practices continue to exist, other stringent measures such as sanctions

and penalties could be tried to check if this can convince the households to adopt safe feacal sludge management practices. Penalties and sanctions have been associated with grooming positive health and sanitation behaviour among individuals (Lombardi et al., 2009).

Elsewhere, studies have shown that faecal sludge management is a vigorous activity that calls for proper monitoring and management along its value chain (Peal et al., 2020). Therefore, the significant correlation observed between slums and urban areas amongst households in different slum areas might simply indicate the variance in the levels of regulation, monitoring and management processes by the responsible authorities in these different areas. Peal et al., (2014) calls for well-organized institutional arrangement and enabling environment in order to ensure streamlined and well-coordinated safe faecal sludge management along its value chain.

There was no statistically significant association observed between socio-economic characteristics of respondents such as sex, age, education level and the size of the household in the current study. However, previous studies have shown that socio-economic characteristics of respondents such as sex, age, education level significantly influence their knowledge and perceptions thus affecting their active participation in ensuring safe faecal sludge management.

Table 4. 5: Results of the multiple regression model showing the factors influencing safe faecal sludge management

Model	Coefficients	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.315	0.157		8.351	0	1.005	1.625		
	Average daily income	4.96E-07	0	0.028	0.248	0.805	0	0	0.271	3.686
	Average monthly income	-9.62E-09	0	-0.011	-0.108	0.914	0	0	0.341	2.935
	Sex of the respondent	0.021	0.06	0.024	0.35	0.727	-0.098	0.14	0.743	1.345
	Age of the respondent	0.003	0.004	0.066	0.645	0.52	-0.005	0.01	0.335	2.987
	Duration of stay in the area	-0.009	0.003	0.24	-2.857	0.005	-0.015	-0.003	0.499	2.005
	Household size	0.014	0.014	0.082	1.032	0.303	-0.013	0.041	0.559	1.788
	Naguru Go-down	-0.396	0.072	-0.379	-5.489	0	-0.539	-0.254	0.738	1.355
	Naguru Go-down	-0.432	0.091	-0.368	-4.755	0	-0.611	-0.253	0.587	1.703
	Old Kira Road	0.12	0.112	0.067	1.074	0.284	-0.101	0.341	0.913	1.096
	No formal education	-0.14	0.122	-0.082	-1.145	0.254	-0.381	0.101	0.677	1.477
	Primary	-0.02	0.098	-0.014	-0.206	0.837	-0.213	0.172	0.793	1.261
	Vocational	-0.036	0.085	-0.033	-0.42	0.675	-0.204	0.132	0.581	1.72
	Bachelor degree	-0.041	0.1	-0.037	-0.406	0.685	-0.238	0.157	0.431	2.322
	Post-graduate degree	-0.029	0.294	-0.009	-0.1	0.92	-0.61	0.551	0.442	2.262
	Divorced	-0.015	0.135	-0.007	-0.111	0.912	-0.282	0.252	0.784	1.276
	Widowed	0.063	0.136	0.034	0.467	0.641	-0.204	0.331	0.665	1.503
	Formally employed	0.095	0.095	0.095	1.007	0.315	-0.091	0.282	0.392	2.551
	Casual labour	0	0.097	0	-0.005	0.996	-0.192	0.191	0.694	1.44
	Business person	0.007	0.081	0.008	0.091	0.928	-0.152	0.167	0.447	2.236
	Crop cultivator	-0.072	0.289	-0.016	-0.249	0.803	-0.642	0.498	0.908	1.101
	Livestock keeper	-0.08	0.275	-0.021	-0.29	0.772	-0.623	0.463	0.67	1.492
a Dependent Variable: Faecal sanitary facility ownership										

Households with a longer duration of stay were more likely to own an on-site latrine /toilet than recently settled household P=0.005). On-site latrines/toilets ownership differed between urban and slum households (P=0.000) and amongst slums (P=0.000)

CHAPTER FIVE - CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter comprises the conclusions and recommendations that have beendrawn from this study based on the key findings and the specific objectives.

5.2 Conclusions

A larger proportion of the respondents at household level possessed some knowledge and good attitude towards faecal sludge management with over 74.1 % of households owning an onsite pit-latrine/toilet and 97.2% aware of the need for emptiers to wear appropriate PPE when emptying toilets/latrines and 77.3% perceived the importance of latrine/toilet emptying. However, there also existed unsanitary feacal sludge management practices such as lack of water seals for toilets, lack of pit-latrine covers that provided access of houseflies to feacal matter and lack of an onsite-toilet or pit-latrine. The low response on some sanitation practices such as ownership of an on-site latrine/toilet, ownership of lined pit-latrines and daily cleaning of the toilets/latrines indicated the need for continued awareness creation amongst the households and individuals to engage in sanitary feacal sludge management practices. Some of these sanitary feacal sludgemanagement practices include ownership of on-site latrines/pit latrines, avoided shared latrines/pit latrines and putting hand washing facilities at latrines/pitlatrines.

Based on the responses from the gulper and cesspool emptiers operating in the study area, it was observed that these emptiers were engaged in both sanitary and unsanitary practices along the faecal sludge management value chain during their

operations especially at collection transportation and treatment stages. Some of the prominent hygienic practices at collection stage include included cleaning of the working area with water and detergent; tightly covering collection barrels and ensuring proper mechanical condition vehicles at treatment phase; and at disposal stages were PPE usage and controlling sludge volumes and incineration of non-biodegradables. The common unsanitary practices included leakage of feacal sludge collection barrels, leakage of hose pipes and entering the pit latrines or septic tanks; Based on the different sanitary practices identified amongst the faecal sludge emptiers operating in the study area, it's with no doubt that efforts towards achieving safe faecal sludge management were being put in place with only a few individual emptiers doing contrary to this.

The socio-economic factors were found to have a statistically significant influence on the safe feacal sludge management practices amongst the households in the study area.

Other socio-economic factors such as average daily income, the size of a given household, gender and age of the respondent, also have a statistically significant influence on the safe feacal sludge management practices amongst households in the study area.

5.3 Recommendations

i. Households within Bukoto I and Naguru II Wards of Nakawa Division should continuously be sensitized and educated by relevant authorities and health and safety practitioners on the importance of health and safe faecal sludge management practices. Some of these practices include but not limited to;

owning or having access to an on-site pit-latrine/toilet, use of lined pit-latrines and emptying of the sanitary facilities. This will be important in increasing the knowledge and awareness levels on proper faecal sludge management, and thus shaping positive attitudes and behaviour towards sustainable faecal sludge management at household level.

ii. Emptiers should be educated on the necessary sanitary guidelines to follow along faecal sludge management value chain and the need to adhere to them in order to promote good sanitary and safe behaviour among the emptiers during their operations. This can be done by the relevant authorities such as NEMA, MWE and NWSC. The unsanitary practices that need to be eliminated include entering the on-site sanitation facilities such as pit-latrines, use of broken equipment such as broken hose pipes and vacuum trucks and leakage of barrels/sewer horse pipes during faecal sludge collection and transportation.

iii. The emptiers including the gulper and cesspool trunk operators need to be financially supported by some development partners like GIZ and the government of Uganda in order to help them acquire new equipment. This will also enable the emptiers to ensure maintenance of the new and the existing equipment in good conditions for safe faecal sludge management. This can be achieved through strategies such as exempting the imported machinery of emptiers from high taxes by the government and donations by other development partners. This will boost the efforts already being made by some NGOs such as GIZ, Water for People and Water Aid in transforming faecal sludge management in Kampala and other towns of Uganda.

iv. Some level of capacity building and awareness creation is required to eliminate unsanitary practices such as leakage of collection barrels, and leakage of hose pipes entering the pit latrine while emptying on-site sanitation facilities.

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APPENDICES

Appendix 1: Questionnaire

Hello dear, my name is **Juliet Nansikombi** a postgraduate student from Uganda Christian University. I am conducting a study titled "AN EXPLORATION OF THE HEALTH AND SAFETY PRACTICES IN FAECAL SLUDGE MANAGEMENT. A CASE OF NAGURU GO-DOWN AND MULIMIRA SLUM AREAS OF KAMPALA". You have been selected as one of the respondents of this study and I request to participate. The outcomes will be purely academic and your response will be treated with outmost confidentiality.

Consent of Participation: Yes…… No……..

Part A: Socio-demographic data

1. Name of the respondent/ Respondent ID …….

2. Sex of respondent

a. Male b. Female

3. Age of the respondent: ……

4. Duration of stay in the area (Years); …….

5. Marital status of the respondent

a. Single b. Married c. Divorced/Separated d. Widower e. Window

6. Occupation of the respondent?

a. Crop cultivator b. Livestock keeper c. Casual labour d. Formal employee e. Business person f. Unemployed g. Others specify

7. What is the highest level of education attended?

a. Never attended school b. Primary c. Secondary (O level) d. Secondary (A level) e. Tertiary (Diploma) f. Bachelor degree g. post-graduate degree

8. Which ethnic group do you belong to?

9. How far is your household from this site?

10. What is your AVERAGE DAILY income earned at the household (UGS)?

11. What is your AVERAGE MONTHLY income earned in the household (UGS)?

Part B: ACCESS, USE AND NATURE OF SANITARY FACILITIES

1. Do you own an onsite sanitation facility for Faecal Sludge Management in your household?

a. Yes b. No

2. If no, state how you manage feacal sludge in your household

3. If yes what is the onsite sanitation facility for faecal Sludge Management in your household?

i. Pit latrines
ii. Toilet

4. Does your toilet have a septic tank?

i. Septic tank
ii. Bio-digester tank

5. Is the feacal facility shared with other households? a. Yes b. No

6. How many other households do you share the feacal facility with?

Part C: PROPER USE AND MAINTENANCE OF SANITATION OF LATRINES/SEPTIC TANKS

1. Is the pit latrines/ covered or septic tanks has a water seal?
Does your latrine/septic tank have a lining? Yes b. No

2. Dose the latrine/toilet reduce direct contact of feaces with humans and direct to the environment Yes b. No

3. Do house flies access the faecal matter in your toilet/latrine/septic tank?

Yes b. No

4. Does your toilet/latrine/septic have a soak pit to avoid contamination of surface or groundwater? Yes b. No

5. Do you deposit any solid waste materials in the latrine? Yes b. No

6. How long have has your toilet/septic tank or latrine been in existence

7. Has your septic tank or latrine ever been gotten full? Yes b. No

8. Did you empty the toilet when it got full? Yes b. No

9. How many times have you emptied the toilet/septic tank or latrine since its existence?

10. When did you last empty your toilet?

i. Less than a year
ii. 1year back

iii. 2years
iv. 3years
v. Above 3years

11. Who empts (emptied) the toilet/septic tank or latrine when it gets (got) full?

i. Empty in myself
ii. Empty by a provision health provider

12. What type of service provide do your use

i. Manual/sweepers
ii. Mechanical emptier/ cesspools

13. Gulper operators Is the latrines/ toilet/septic tanks blocked?

14. Is the latrines/toilet pan & floor not deposited with feces?

15. Are the latrines/toilet doors and walls are in place and not broken

16. Is the latrines/toilet stocked with toilet brush/brooms stored there?

17. Is the latrines/toilet fitted with a water supply e.g. tap or bucket?

18. Do you clean toilet/latrine daily?

PART D: SAFE TREATMENT AND DISPOSAL PRACTICE AND KNOWLEDGE

1. Do you think is important/necessary a) Yes b) No
2. Rank the importance of toilet/ septic/latrine emptying
3. Are you aware of the place where the emptier dumps the collected faecal sludge? Yes b) No
4. Is the dump site a designated place? Yes b) No
5. Where do the operators dump the faecal sludge?

a. Bugolobi plant b. Lubigi plant c. Into the Environment d. others specify

6. Do you use the sludge as a reusable resource e.g. composite manure for agriculture or biogas Fish feed, poultry feed? Yes b) No
7. Mention how your sludge is reused ……
8. How long does it take you before you use the sludge as a renewable resource after emptying from toilet?

PART E: <u>PRACTICE AND KNOWLEDGE</u> ON SAFETY DURING EMPTYING OF FROM PIT LATRINE/SEPTIC TANK

1. Do emptier wear protective gear while emptying pit latrine or septic tank

a. Yes b) No

2. Do emptier enter pit latrine or septic tank while emptying a. Yes b) No
3. Is your pit latrine or septic tank connected to the sewage system? a. Yes b) No
4. Is there any form of leakage of the sewer pipes your toilet is connected to? a. Yes b) No
5. Do you Use of sludge as a reusable resource e.g. composite manure for agriculture or biogas Fish feed, poultry feed a. Yes b) No
6. Mention the main way you use the feacal sludge …….
7. How long does it take you before you use the sludge as a renewable resource after emptying from toilet? ……

PART F: DRIVERS AND CHALLENGES OF SUSTAINABLE FAECAL SLUDGE MANAGEMENT

8. List down the challenges you face in ensuring proper faecal sludge management.
9. State the incentives and motivations that exist for ensuring proper faecal sludge management in your household/community.
10. State the regulations and By-laws exist for ensuring proper faecal sludge management in your household/community.
11. Mention some of the penalties that are used against offenders of faecal sludge management in your area.

Appendix 2: Interview guide with Gulper and cesspool operators

1. Do you as the gulper operator wear protective gear while emptying pit latrine or septic tank?
2. Mention all the different type of protective gear you personally use while emptying pit latrine or septic tank.
3. Do you enter pit latrine or septic tank while emptying them?
4. Is there any form of leakage of the sewer pipes your toilet is connected to?
5. Mention all the measures you undertake to prevent environmental contamination at each of the following stages.
   A. Sludge collection
   B. Sludge transportation
   C. Sludge treatment
   D. Sludge disposal or reuse.
6. Mention what you face in ensuring sustainable sludge management at each of the following stages
   A. Sludge collection
   B. Sludge transportation
   C. Sludge treatment
   D. Sludge disposal or reuse.

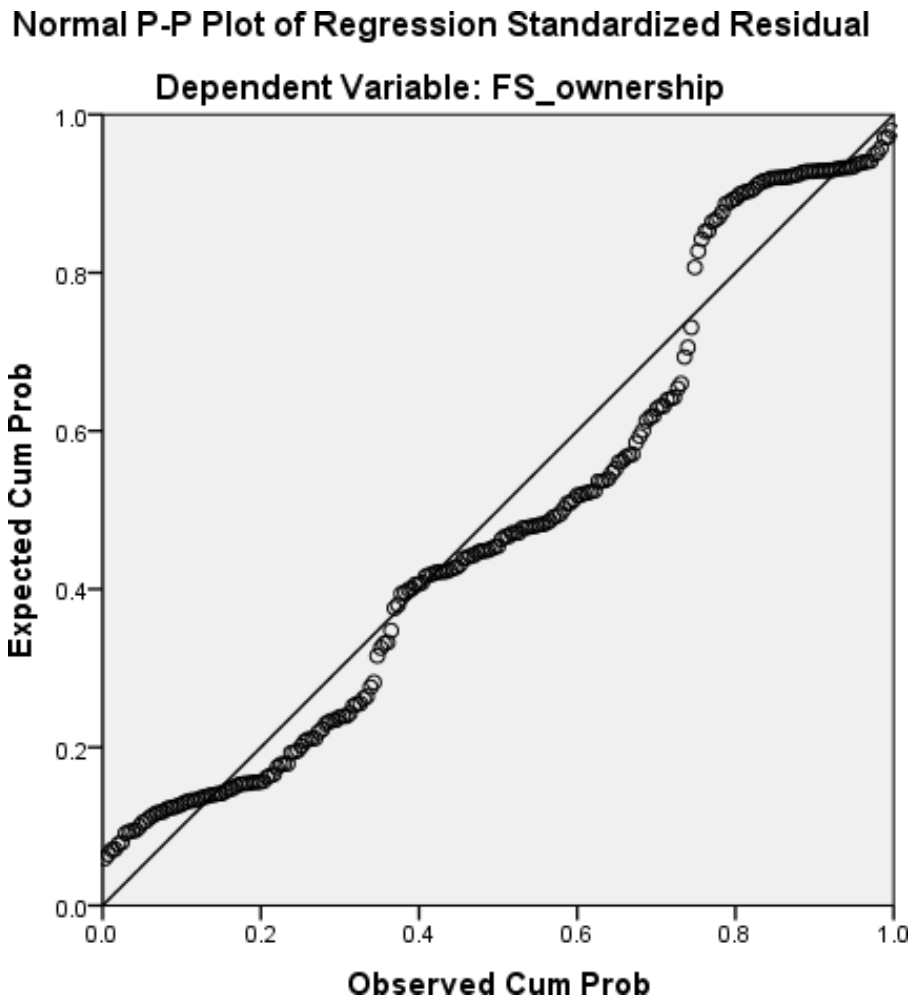
Appendix 3: Key informant interview guide

1. Comment on the level of sludge management at household level in Kampala
2. What are the major challenges faced in ensuring sustainable faecal sludge management at household level in Kampala?
3. List if down any by-laws that are in place to ensure sustainable faecal sludge management household and community level.
4. What policy frameworks are in place to ensure sustainable faecal sludge management amongst emptiers (gulper and cesspool) in Kampala?
5. What incentives and motivation sustainable faecal sludge management amongst emptiers (gulper and cesspool) in Kampala?
6. Comment on the level of faecal sludge management amongst emptiers (gulper and cesspool) in Kampala.
7. What are the major challenges faced in ensuring sustainable faecal sludge management amongst emptiers (gulper and cesspool) in Kampala?
8. What policy frameworks are in place to ensure sustainable faecal sludge management amongst emptiers (gulper and cesspool) in Kampala?
9. What incentives and motivation sustainable faecal sludge management amongst emptiers (gulper and cesspool) in Kampala?

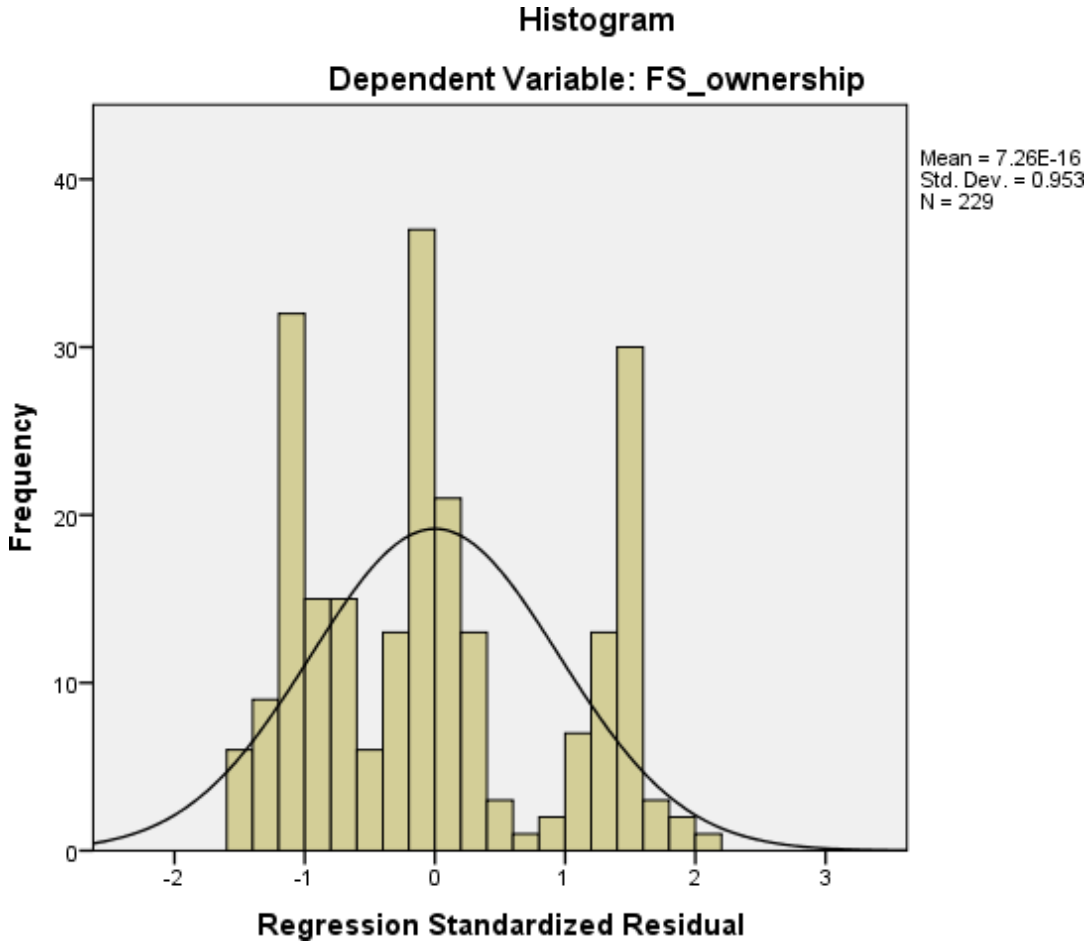
Appendix 4: The ANOVA table of the Multi regression model on the factors influencing safe faecal sludge management among households in the study area.

ANOVA a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.661	21	0.555	3.69	.000b
	Residual	31.151	207	0.15		
	Total	42.812	228			
a Dependent Variable: FS_ownership						
b Predictors: (Constant), Livestock keeper, Crop cultivator, Kira Road, No_education, Casual_labour, Sex of the respondent, Master's degree, Divorced, Primary, Total number of people in your household, Vocational, Naguru Go-down, Business_person, Widowed, Godown, Duration_of_stay, Bachelor_degree, Formally employed, Age_of_respondent, AVERAGE_DAILY_income						

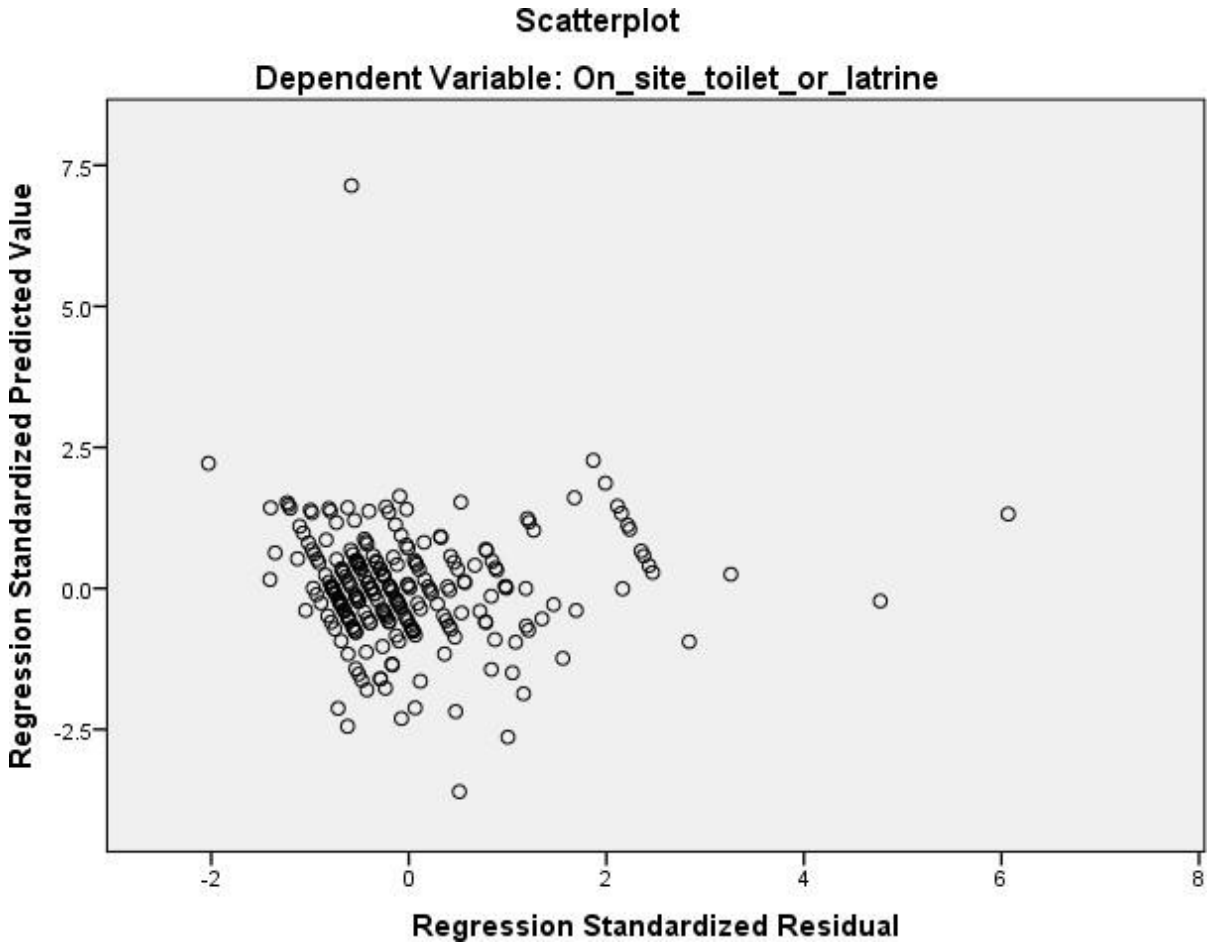
Appendix 5: Assumed normality tests results with the data forming a straight line along the diagonal



Appendix 6: Histogram of normal distribution in the data



Appendix 7: Random scatter values of the homoscedasticity test of standardized residuals against the standardized predicted values



Appendix 8: Permission from local leaders to undertake research in the study areas.

KCCA
KAMPALA CAPITAL CITY AUTHORITY
For a better City

DIRECTORATE OF PUBLIC HEALTH AND ENVIRONMENT

REF: DPHE/KCCA/1301

11th March, 2021

Ms. Nansikombi Juliet Kintu
Institute of Petroleum Studies
KAMPALA

RE: PERMISSION TO CONDUCT RESEARCH

The above subject refers.

This is to inform you that permission to conduct a study titled "Institutions and their relationship to sustainable sanitation" has been extended to you for a period of 4 months from the date of this letter.

The above permission is granted to you on the following conditions;

1. Participation in your study is voluntary and the informed consent process should be observed at all times.
2. You will provide a report to the office of the Director Public Health and Environment of your findings.

By copy of this letter, the Chairperson Uganda Gulpers Association and Division Town Clerks are requested to render you all the necessary support.

Dr. Okello Ayen Daniel
FOR: DIRECTOR PUBLIC HEALTH & ENVIRONMENT

Copy: Division Town Clerks, KCCA
Chairperson, Uganda Gulpers Association

P.O. BOX 7010 Kampala - Uganda
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Appendix 9: Letter Seeking Informed Consent

Participant selection will be based on a study to explore the health and safety practices associated with faecal sludge management in Naguru Go-down and Mulimira slum areas and in urban areas (Naguru Bank Village and Old Kira Road Village) of Kampala.

The response you will give will be treated with maximum confidentiality therefore; you are requested to be free in all what you feel to say. The responses will be used strictly for purpose of the study to accomplish my Master of Science in Environmental Health and Safety Management at Uganda Christian University and will only be shared by the university supervisors and the researcher. You are freeto take part or not take part in the study.

Thank you very much for your cooperation

Yours faithfully,

…….

Juliet Kintu

M20M16/015

I ……. accept to take part in the study entitled "An exploration of the health and safety practices in faecal sludge management. A case of Naguru Go-down and Mulimira slum areas of Kampala" being conducted by Juliet Nansikombi.

Signature :…… Date……..

Appendix 10: The model summary table of the Multi regression model on the factors influencing safe faecal sludge management among households in the study area.

Model Summary										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				Durbin-Watson	
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.522a	0.272	0.199	0.38793	0.272	3.69	21	207	0	0.621
a Predictors: (Constant), Livestock keeper, Crop cultivator, Master's degree, Kira Road, No_education, Casual_labour, Sex of the respondent, Divorced, Primary, Total number of people in your household, Vocational, Naguru Go-down, Business_person, Widowed, Godown, Duration_of_stay, Bachelor_degree, AVERAGE_MONTHLY_income, Formally employed, Age_of_respondent, AVERAGE_DAILY_income										
b Dependent Variable: FS_ownership										