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The influence of economic factors on feacal emptying, conveyance and disposal: a case of Meru Slums, Kenya

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ABSTRACT

Safe management of faecal waste is one of the Sustainable Development Goals (SDGs) which envisions safe sanitation for all. However, although efforts to improve sanitation conditions in slums have been made, faecal emptying, conveyance and disposal still remain a challenge endangering the health of the public. The study examined the influence of economic factors on faecal emptying, conveyance and disposal in on-site sanitation facilities in Meru slums. A convergent design with a mixed methods approach was adopted. Quantitative data was collected using structured questionnaires from a sample of 228 household heads selected using cluster and proportionate simple random sampling techniques. Correlation and regression analysis was carried out to ascertain the association between emptying, conveyance and disposal of faecal waste and the economic factors. Qualitative data was gathered using focus group discussion participants with eight (8) who included four (4) pit operators, 3 household heads and 1 Public Health Officer (PHO) and results analyzed thematically. Findings showed that only 31% of slum dwellers emptied latrine pits and that manual emptying was more common (84%) than mechanical emptying because of its cost efficiency, reliability and the effectiveness in handling plastics, glasses, metal pieces, diapers and sanitary pads contained in pits. Increased cost constrained faecal emptying, conveyance, and disposal (r=0.499, p-value=0.000). Residents who were able to pay for faecal handling services were more likely to practice hygienic faecal emptying, conveyance, and disposal (r=0.524, p-value=0.000). Low level of income for majority of slum dwellers influenced the design of the latrines adopted. Emptying faeces from poorly designed pit latrines was more expensive due to operators' safety concerns. The study concluded that the inability to meet the costs associated with faecal emptying, conveyance and disposal services facilitated poor sanitation status in slums. There is need to sensitize the slum community on the benefits of practicing safe management of faecal waste. The study recommended development of government policies to regulate mechanical emptying conveyance and disposal of faecal matter.

Introduction

Safe emptying, conveyance and disposal of the accumulated excreta from sanitation facilities constitute an essential part of hygienic faecal sludge management (Öberg *et al.,* 2020). Safely managed faecal waste is one of the agenda in the Sustainable Development Goals (SDGs) which envisions safe sanitation for all (United Nations,

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2015). However, management of faecal waste has been a challenge due to increase in population in unplanned urban areas. Globally, 3.6 billion people lack access to safely managed sanitation systems and 38% of the urban population access sanitation facilities which do not completely separate them from faecal contact (WHO/UNICEF, 2020). Access to unsafe sanitation could predispose the population to the risk of contracting helminthes infection and polio as well as diarrheal diseases such as dysentery and cholera which is responsible for 88% of children mortalities in sub-Saharan Africa (Demissie *et al.*, 2021). The health of residents in urban slums could be in danger unless sustainable sanitation through appropriate management of accumulated faecal waste in toilets is addressed.

To ensure achievement of sustainable sanitation in slums, it is important that reliable and safe faecal management systems are in place. Conventional sewerage systems, which involve removal of faecal waste from the point of generation to allocated treatment and disposal facilities through water-based pipe networks, are among the practical options in urban areas (Peal *et al.,* 2020). However, the systems have been associated with remarkable challenges due to their inflexible and high resource demanding nature. In Nigeria, a study by Öberg *et al.* (2020) that examined the effectiveness of conventional systems found out that establishment of the systems required 14%-37% allocation of the state's annual budget and plenty of water for operation.

High cost of setting up conventional systems and limited access to water in urban areas could leave the poor population underserved. Alternative options include onsite sanitation systems such as pit latrines, pour flush toilets, septic tanks and urine diverting toilets where excreta is managed at the point of collection. However, although onsite solutions have been promising sanitation options for 2.7 billion people globally (Harada *et al*., 2016), little attention is given to the ways of emptying, conveyance and disposal of human waste that accumulate in the systems. A study by Peal *et al.* (2020) that estimated excreta management in urban areas indicted that 14% of contents in pits and septic tanks in Sub-Saharan Africa remained unemptied resulting in overflow of sludge to the environment. Failure to empty filled up sanitation facilities could result in spillage of untreated sludge which contain diarrheal-related pathogens (Demissie *et al*., 2021). There is need for a paradigm shift in the ways of emptying, conveyance and disposal of accumulated faecal waste in urban slum areas which this study sought to address.

Faecal emptying, conveyance and disposal involves payment of servicing fees for effective management of accumulated waste in on-site sanitation systems. However, operational cost could be influenced by the type of sanitation design and quality of material deposited in pits informing the emptying technology to be adopted. While analyzing economic characteristics of low-income urban population in Malawi, Chunga *et al.* (2016) found out that 93% of respondents owned unimproved on-site sanitation facilities. Unimproved sanitation facilities could limit mechanized emptying options since the facilities do not have provisions for emptying leaving the poor urban population with the option of manual pit emptying. Although operation cost defines household choices of managing the accumulated excreta, a study by Jenkins *et al.* (2015) and Simiyu *et al.* (2021) found out that unimproved sanitation facilities elicited high cost of operation which was inclusive of the cost of emptying the pit and the maintenance cost of repairing the concrete slab demolished during emptying process estimated to be $35- $57. Unless the poor urban population adopt improved sanitation facilities, operational cost of faecal emptying, conveyance and disposal could be unaffordable resulting to unhygienic disposal of faecal waste in slum which could have a negative effect on the slum population

Economic status of individuals could inform household choices of sanitation facilities, emptying and disposal options (Chunga *et al.*, 2016). The practice of hygienic emptying, conveyance and disposal of faecal waste in low-income urban

areas is facing numerous challenges affiliated to the willingness and ability to pay for sanitation services. A study by Chunga *et al.* (2016) that analyzed economic characteristics of population in Malawi found out that 93% of respondents earning a low income of K 10,000- K40,000 owned sanitation facilities incapable of cutting human contact with excreta since they could not afford proper latrine construction materials. In Zambia, a study by Holm *et al.* (2015) reported that besides the poor types of sanitation facilities owned by households, 50% of the respondents were unwilling to pay for on-site sanitation emptying services.

According to Orner and Mihelcic (2018), whereas mechanized pit emptying remain to be the most hygienic option of faecal waste management, manual pit emptying practice was common among poor urban dwellers despite the associated health and environmental risk. Management of accumulating faecal waste in low –income urban areas could be limited by space. As urban areas continue to develop the value of land could continue appreciating at a high rate ruling out the probability of the poor urban population to acquire extra land for faecal management when toilets get filled up. In India, a study by Prasad and Ray (2019) found out that the cost for emptying of a full pit was estimated to be $25 to $80. However, urban dwellers who considered putting up new facilities payed 10 times more than the cost of emptying existing toilets. There is need for economically viable faecal emptying, conveyance and disposal choices that ensure collection, emptying, conveyance or disposal of faecal waste do not shoot beyond the range that slum dwellers are unwilling to pay.

High demand for on-site sanitation facilities in low-income urban areas has resulted in ratification of onsite sanitation emptying services for management of accumulated faecal sludge (Awere *et al.* 2020). However, high user capacity, poor sanitation facility design and poor quality of materials deposited in the pits could have an influence on frequency of emptying toilets which could be a burden to low-income communities. In Zambia, a study by Tembo *et al.* (2019) found out that use of pit latrines encouraged domestic waste disposal for material like clothes, broken glasses and plastics which fastened their filling up rates resulting in high emptying frequency. Increased frequency of emptying could be expensive to low-income earners and could encourage accumulation of faeces in pit latrines due to inability to empty toilets thus exposing the population to diseases.

A study by Parikh *et al.* (2016) in Sierra Leone found out that most of the low- income urban households desludged their toilets more frequently with an equal spilt on manual and mechanized pit emptying technologies. Besides disposal of poor quality materials in pits, a study by Jenkins *et al.* (2015) in Tanzania that explored pit latrine emptying behaviors reported that pit emptying frequencies were high during rainy season as a result of poorly constructed pit latrines which flooded when it rained. Flooded toilets could facilitate overflows of faecal contaminated water to the environment which could endanger the health of the public.

Poor urban settlements are characterized by closely confined household set ups and often vacuum trucks cannot find their way through narrow streets thus require either demolishing of the settlement to pave way for trucks or adoption of manual emptying practice. In Malawi, a study by Chipeta *et al.* (2017) found out that sanitation facilities in unplanned poor urban settlements were inaccessible compelling the poor urban household owners to rely on manual pit emptying for management of faecal waste. Limited access to pits for emptying could facilitate unhygienic and unsafe manual pit emptying practices which predispose the poor urban population to the risk of diarrheal infection.

Studies by Harada *et al.* (2016), Öberg *et al.* (2020) and Chunga *et al.* (2016) confirmed that on-site sanitation technologies, despite being a promising solution to the poor urban population present a challenge of excreta accumulation

Strata	Total Population	Households	Sample per cluster
Mjini	351	169	68
Majengo	1540	250	100
Shauri Yako	700	150	60
Total	**2591**	**569**	**228**

Table 1: *Distribution of Samples per Cluster*

which could predispose the population to the risk of contracting helminthes infection as well as diarrheal diseases such as cholera and dysentery. It remains questionable on whether onsite sanitation facilities are economically viable solutions particularly in urban slum areas with regard to the mechanisms of faecal emptying, conveyance and disposal.(activity of faecal emptying is expensive) There is limited documentation on economic factors influencing onsite sanitation emptying, faecal conveyance and disposal in slums. This study sought to examine the influence of economic factors on faecal emptying, conveyance and disposal in on-site sanitation technologies in low- income urban areas.

Problem Statement

Universal access to sustainable sanitation is considered the most important yet challenging Sustainable Development Goal (SDG) due to the environmental, technical and economic complexity in providing safe, equitable and affordable sanitation to all citizens (Delaire *et al.*, 2020). Low-income urban dwellers could be facing the brunt of poor sanitation due to access to onsite sanitation facilities whose faecal emptying, conveyance and disposal could be a challenge given the constraints encountered in the areas like limited space and basic services and high population. However, although efforts to improve sanitation conditions in slums have been made, faecal emptying, conveyance and disposal still remain a challenge endangering the health of the public which was the focus of the study.

Methodology

Research Design

The study adopted a convergent mixed method research design which enabled simultaneous gathering of both qualitative and quantitative data.

Study Area

The study was carried out in the 3 slums of Meru which included Mjini, Majengo and Shauri Yako. The area is located in the Eastern region of Kenya in Imenti North Sub- County, Meru County (Ombuya *et al.*, 2022).

Study Population

The total population for the slums is 2,591 people and total number of households is 569 (KNBS, 2019). The study targeted household heads from households within the slums because they were likely to possess in depth desired information concerning sanitation for their households. The area chief was involved in identification of household heads who had lived in the slums for at least 3 years. The study also targeted pit operators as they were the people involved in maintenance of the sewerage systems as well as emptying pit latrines. A Public Health Officer (PHO) was also engaged due to his knowledge and experience in urban community sanitation issues.

Sample Size Determination and Sampling Techniques

A sample of 236 participants calculated using Yamane's (1967) formula was used. Eight participants who included four (4) pit operators, 3 household heads and 1 Public Health Officer (PHO) identified using purposive sampling technique were engaged in the qualitative study and 288 household heads were targeted for the quantitative study.

Cluster sampling technique was used to classify the area into its three respective slums namely: Mjini, Majengo and Shauri Yako. Household heads

from each cluster were selected using proportionate simple random sampling technique. Given the unequal distribution of households per cluster, participants from every cluster were obtained by dividing the product of population per cluster and the total sample by the total number of households as illustrated in Table 1.

Data Collection and Analysis

Quantitative data was collected using structured questionnaires which were distributed to household heads at the household level and analysed in both descriptive and inferential statistics. An observation checklist was also used alongside questionnaires for validation of emptying, conveyance and disposal practices. Qualitative data was gathered from a focus group discussion consisting of household heads, pit operators and a Public Health Officer. The data was analyzed thematically and results presented in a narrative way.

Ethical Considerations

Permission to carry out the study was sought from Meru University of Science and Technology Institutional Research Ethics Review Committee (MIRERC). A research permit was obtained from the National Commission for Science, Technology and Innovation (NACOSTI). Participation of the respondents in the study was based on voluntary basis and the respondents were required to sign a consent form to ascertain their willingness to participate. Participants' information was treated with utmost confidentiality.

Results and Discussion

Demographic Information

The study found out that many 127 (55.7%) of the respondents were males while the rest 101 44.3% were women. The findings suggested that males were the primary decision makers in household sanitation matters. Inadequate involvement of women in sanitation-related decision-making could facilitates establishment of women non-friendly toilets which could encourage disposal of poor materials like sanitary towels in toilets capable of blocking exhauster machines during emptying. These findings were similar to the findings by Greed (2016) Africa who confirmed the importance of women involvement in sanitation in regard to hygienic disposal of faecal waste in latrines.

	Frequency	Percent
Above 40,000	35	15.4
26,000- 40,000	1	0.4
11,000- 25,000	78	34.2
Below 10,000	114	50.0
Total	**228**	**100.0**

Table 2: *Level of income in Kenya shillings (Ksh)*

The sampled respondents also constituted a majority of persons aged over 30 years (84.2%) . The findings implied that majority of the respondents were of active childbearing age and could have established families as confirmed by a study in America by Lundberg *et al.* (2016).

The study sought to find out the education level of the respondents. Findings showed that a majority(91.7%) had attained at least elementary education. This implies that the majority of the participants were literate and could have been aware of the essence of proper emptying, conveyance and disposal of faeces in relation to prevention sanitation-related diseases. These results were similar to the findings by Agestika *et al.* (2022) in Indonesia who confirmed the importance of formal education attainment towards peoples' practices of excreta management.

Level of Income

The study sought to find out the income level of the families. It was established that 50% of the respondents had a monthly income of below KSh 10,000. The summary of income levels is summarized in Table 2. Monthly income of below KSH 10,000 among household heads implied that such earnings could not sustain the cost associated with faecal emptying, conveyance and disposal. Low level of income among household heads has been associated with type of sanitation facility

	Frequency	Percent
0-4	42	18.4
5-9	126	55.3
10-14	47	20.6
Above 15	13	5.7
Total	**228**	**100.0**

Table 3: *Household size*

design adopted and the ability to pay for sanitation services such as pit emptying as confirmed by a study in Malawi by Chunga *et al.* (2016).

The study also established that majority of the slum households (63.1%) had more than four members served by a single toilet. The fact that household in the study area constituted an average of four members suggested that some families were composed of grown up members who had moved out to start their own families elsewhere. The findings also suggested that respondents were aware of the different sanitation need of vulnerable family members including women and children who required more attention in regard to establishment of hygienic faecal management practices. Further, the findings implied that most of the families did not strain in accessing sanitation services such as toilet use as confirmed by a study in Kenya by Wasonga *et al.* (2016).

Sanitation Conditions in Slums

Toilet facilities

The study sought to find out the sanitation facility used by the households. It was established that 83.8% of the participants used pit latrines, 8.8% Ventilated Improved Pit (VIP) latrines while 7.5% used flush toilets. This is summarized in Table 4. The findings showed that pit latrines were the predominant types of sanitation facilities which could be attributed to the fact that their construction and maintenance cost was lower than the other toilets. Besides, pit latrines required minimal space to put up and little water for hygienic maintenance hence the most ideal sanitation option in slum areas with limited space and water supply challenges. These findings were similar to the findings in Malawi by Chunga et al. (2016) who reported that unimproved on-site sanitation facilities were common among residents in low-income urban areas.

	Frequency	Percent
Basic pit latrine (Ordinary latrine)	191	83.8
Flush toilet	17	7.5
VIP (Toilet with a ventilation pipe)	20	8.8
Total	**228**	**100.0**

Table 4: *Toilet facility used by Households*

Toilet emptying

Findings revealed that only 31% of slum dwellers emptied latrine pits of which manual emptying was more common (84%) than mechanical emptying (16%). The findings revealed poor sanitation conditions in Meru slums which do not guarantee complete separation of faecal waste from human contact. As well the predominant use of buckets for emptying suggests its affordable nature and the ability to address the challenge of indiscriminate waste disposed in pits. The low adoption of mechanical emptying (16%) implied that besides limited space for exhausting toilets in slum areas mechanical emptying was unaffordable to low-income slum dwellers. The findings were similar to those in India by Tyagi (2017) who established that as a result of high service fee for mechanical emptying, households opted for manual emptying practices for management of filled up pits.

Sanitation Status

Findings revealed that 69% of the available toilets had flies and odour nuisances and that 98% of the toilets did not have provision of a manhole for emptying, as shown in Figure 1. Findings showed that 79.8% of the toilets were made of poor quality materials such as wood and used iron sheets superstructures. When asked to rate the

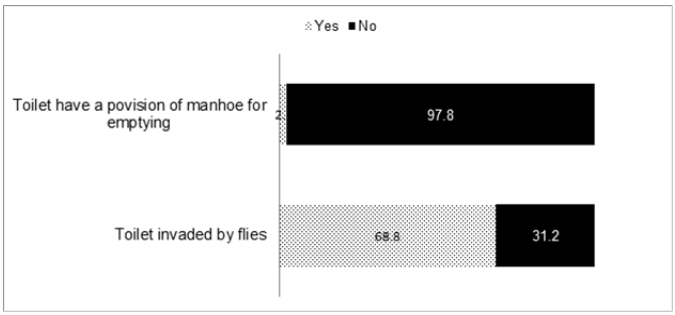

Figure 1:*Sanitation status*

safety and hygiene standards of toilets only 20.5% of participants reported that the toilets guaranteed safety and hygiene for users and pit operators. Presence of flies and odour in toilets suggested that slum residents were predisposed to the risk of interacting with pathogens such as protozoa, helminthes, bacteria and viruses which could result to more expenditure on treatment of sanitation diseases. Superstructures made of poor quality material implied that besides resident not affording improved sanitation designs, respondents utilized locally available materials for construction of toilets. These findings were similar to the findings in Zambia by Nyambe *et al.* (2020) who established a direct relationship between low -income earners, unimproved sanitation designs and the prevalence of diarrheal diseases.

Results also implied that the challenge of excreta accumulation in the study area could be attributed to lack of economically viable faecal management options, poor sanitation designs and unplanned settlements which constrained space for emptying, conveyance and disposal of faecal waste.

Influence of Economic Factors on Faecal Emptying, Conveyance, and Disposal

Respondents were given statements formulated in a five-point likert scale to indicate their degree of agreement to the statements as shown in in Table 2.

Findings showed that 64.5% of respondents agreed and 16.2% strongly agreed that they had never emptied toilets since they started using them. At a mean of 3.47, SD= 0.782, slum residents agreed that they would prefer digging new pits than emptying the filled up pits. at a mean of 3.39, SD=0.618 participants reported that they could not afford the cost associated with construction of new toilet. It was revealed in the focus group discussion that the decisions on whether to empty or construct a new toilet was dependent on the financial capacities of residents. A focus group discussion participant said that:

> *"When faced with the challenge of filled up toilets, people made decisions based on the financial capability at the moment. To be sincere most of us wished to have new toilets but could not afford to build them and the only option was to look for affordable emptying services from those who remove faeces from pits with hands. They were cheaper than using trucks."*

The results suggested that the overall cost incurred in the management of accumulated faecal waste in the slums in relation to faecal emptying, conveyance and disposal influenced the sanitation options adopted by households.The findings concurred with those of Simiyu *et al.* (2021) in Kenya who established that pit emptying was limited by residents' low financial capacity to cater for the emptying costs.

Participants were asked to rate their willingness and ability to pay for toilet emptying services. From the findings 70.6% of the participants agreed and 9.6% strongly agreed that they were willing and able to pay for toilet emptying services while only 13.6% disagreed. The findings suggested that although residents in slums were mostly willing to pay for emptying services, the high costs and scarcity of emptying services affected human faecal management in filled up toilets. The results were confirmed in Malawi and Zambia by Holm *et al.* (2018) who reported that toilet users were often willing to pay for pit emptying services when faced with the challenge of filled up pits.

When asked whether availability and affordability of pit emptying services influenced faecal emptying, conveyance and disposal, respondents agreed at a mean of 3.49, standard deviation (SD) =0.849. At a mean of 4.28, SD=0.412, partici-

	Strongly Disagree	Disagree	Moderate	Agree	Strongly Agree	Mean	Std. Dev
Frequency of Desludging							
I have never emptied my toilet since I started using it	3(1.3%)	19(8.3%)	22(9.6%)	147(64.5%)	37(16.2%)	3.26	.673
When faced with a filled up toilet, I would prefer digging a new pit than emptying the filled pit.	7(3.1%)	31(13.6%)	8(3.5%)	161(70.6%)	21(9.2%)	3.47	.782
Ability and Willingness to Pay for Emptying Conveyance and Disposal of Faecal Waste							
I am willing to pay for emptying of my toilet	3(1.3%)	31(13.6%)	11(4.8%)	161(70.6%)	22(9.6%)	3.62	.547
I cannot afford to pay for construction of a new good toilet	5(2.2%)	43(18.9%)	16(7.0%)	122(53.5%)	42(18.4%)	3.89	.618
Operational Cost							
Availability and affordability of pit emptying services can influence faecal emptying, conveyance and disposal.	16(7.0%)	22(9.6%)	27(11.8%)	120(52.6%)	43(18.9%)	3.49	.849
The availability and affordability of construction materials can influence the design of on-site sanitation facilities.	0(0.0%)	6(2.6%)	10(4.4%)	185(81.1%)	27(11.8%)	4.28	.412
The overall cost of emptying, transporting and disposal of faeces is affordable.	57(25.0%)	112(49.1%)	19(8.3%)	29(12.7%)	11(4.8%)	2.21	.976
Level of Income							
My level of income does not influence the choice of sanitation option available	83(36.4%)	112(49.1%)	1(0.4%)	31(13.6%)	1(0.4%)	1.82	.604
In this community, household type of toilet is determined by the level of income	0(0.0%)	0(0.0%)	4(1.8%)	119(52.2%)	105(46.1%)	4.89	.292
Toilet Design							
I would prefer building a toilet with utility access hole for emptying	86(37.7%)	109(47.8%)	29(12.7%)	4(1.8%)	0(0.0%)	1.76	.427
Charges in Relation to Space Availability							
Narrow paths in our community makes it difficult for pit emptier to access toilets	2(0.9%)	11(4.8%)	15(6.6%)	180(78.9%)	20(8.8%)	4.18	.599
Providing ample space in toilets is necessary for maintaining sanitation and hygiene during the emptying, conveyance, and disposal process.	0(0.0%)	0(0.0%)	5(2.2%)	199(87.3%)	24(10.5%)	4.86	.310
Access to Credit							
There is a possibility of borrowing money to build toilets in the community	51(22.4%)	131(57.5%)	11(4.8%)	20(8.8%)	9(3.9%)	2.52	.716
CDF and other NGOs have funded building of some toilets in the slums	4(1.8%)	15(6.6%)	9(3.9%)	171(75.0%)	29(12.7%)	4.01	.691

Table 5: *Influence of Economic Factors on Faecal Emptying, Conveyance and Disposal*

pants agreed that availability and affordability of latrine construction materials influenced the design of on-site sanitation facilities. The overall cost of emptying, transporting and disposal of faeces was unaffordable for most of the residents (Mean=2.21, SD=0.976). Concerning level of income, a mean of 1.82, SD= 0.604, showed that residents' income levels had an influence on the choice of sanitation options available. The findings implied that the sanitation status in slums was poor owing to the residents' inability to afford improved sanitation facilities. These results were also reported in the focus group discussion where a participant said:

"For pit emptying services we even accept instalment payment, however, a down payment must be made before we begin emptying. Most of our clients are poor and you can tell from the type

of sanitation facilities they own. Most household prefer us to exhausters since our services are relatively affordable so when their toilets fill up we usually respond and do a good job for them."

The results concurred with the findings in by Orner and Mihelcic (2018) who established that although mechanized pit emptying remained the most hygienic option of faecal waste management, low-income urban dwellers considered manual pit emptying practice, which was cheaper despite the associated health and environmental risk.

When asked whether they could consider building toilets with utility access holes, participants disagreed at a mean 1.76, SD= 4.27. At a mean of 4.18, SD=0.599, participants strongly agreed that narrow paths in the slums made toilet access difficult for pit emptiers. More than 97% of the participants reported that providing enough space in toilets was necessary for maintaining sanitation and hygiene during the emptying, conveyance, and disposal process. It was revealed in the focus group discussion that emptying of faeces from toilets was limited by poor accessibility and absence of space for disposal of faeces. Participants also reported a high cost of emptying poorly designed toilets because of the occupational health risks associated with dealing with faulty structures. Focus group discussion participants said that:

"Sometimes back I was called to empty filled up pits but the space to the toilets was very limited. I really struggled to locate a disposal site around the household. I remember I was once forced to dig an adjacent pit for seepage of the waste from the filled up pit to the new one because it was the only alternative. The limited space could not allow for use of buckets to empty the toilet. The waste could have spilled to the neighbouring compound resulting in a lot of misunderstandings."

"Very few households used good toilets but the toilets constructed by others could require demolishing of the slab for mechanized empting. The poor cannot save for construction of better toilets because they needed to cater for basic family needs. We charge extra money to empty toilets without provision for emptying."

Results implied that majority of residents in the slums used sanitation facilities which did not guarantee safe emptying, conveyance or disposal of faecal waste. As urban areas continue to develop the appreciating value of land rules out the probability of poor urban population to acquire extra land for faecal management when toilets fill up. Poorly designed toilets with minimal space for accessing faecal waste during desludging could contribute to frequent demolishing of the slab to pave way for emptying procedures which could weaken the structure and could mean a high cost of servicing the toilets. The fact that space influenced faecal emptying, conveyance and disposal was also confirmed by Chipeta *et al.* (2017) in Malawi and by Zzwa *et al.* (2016) in Uganda.

Residents were asked whether they could borrow money to build toilets. Findings showed that there was mostly no possibility for slum residents to borrow money for building toilets (mean=2.52, SD=0.716). The findings implied that slum dwellers had no access to sanitation financing options due to lack of savings, limited collateral and failure to meet the minimum requirements for loan acquisition which could have resulted to the poor hygienic practices in low-income urban areas.Development Funds (CDF) and other Non-Governmental Organizations had funded the construction of some slum toilets. The findings suggested that some slum residents were supported to construct toilets noting the effort of Non-Governmental Organizations and the local government in improving the sanitation conditions in slum areas as revealed in the focus group discussion where a respondent said that:

"Well-wishers in collaboration with the county government have supported construction of public toilets to allow for access to sanitation services to the less privileged."

The findings were similar to the results obtained in India by Augsburg *et al.* (2022) who established that access to credit for toilet construction had a direct relationship with uptake of sani-

			Faecal Emptying, Conveyance, and Disposal		
			Emptying	Conveyance	Disposal
Economic Factors	Operational Cost	Pearson Correlation	.499**	.330**	.370**
		Sig. (2-tailed)	.000	.000	.000
		N	228	228	228
	Access to Credit	Pearson Correlation	.179**	.096**	.009
		Sig. (2-tailed)	.007	.047	.891
		N	228	228	228
	Toilet Design	Pearson Correlation	.627**	.283	.158
		Sig. (2-tailed)	.000	.099	.129
		N	228	228	228
	Freuency of Desludging	Pearson Correlation	.044	.003	.015
		Sig. (2-tailed)	.092	.193	.081
		N	228	228	228
	Charges in relation to space availability	Pearson Correlation	.747**	.129**	.028**
		Sig. (2-tailed)	.000	.009	.032
		N	228	228	228
	Level of Income	Pearson Correlation	.679**	.491**	.372**
		Sig. (2-tailed)	.002	.001	.012
		N	228	228	228
	Ability and willingness to Pay	Pearson Correlation	.524**	.291**	.508**
		Sig. (2-tailed)	.000	.000	.000
		N	228	228	228

Table 6: *Correlation for Economic Factors and Faecal Emptying, Conveyance, and Disposal*

tation services. However, the role of CDF and NGOs in supporting sanitation programs in the slums was appreciated.

Correlation Analysis

A correlation analysis was done using Person Product Moment approach to establish the strength and direction of association between economic factors and faecal emptying, conveyance and disposal and results were as shown in Table 6.

The study established that there was a positive and significant correlation between operational cost and faecal emptying (r=0.499), conveyance (r=0.330) and disposal (r=0.370) (p-value<0.05). The findings suggested that operational cost had a moderate positive significance association with all the indicators of the dependent variable. The study also found out that access to credit recorded a weak positive significant relationship with faecal emptying (r=0.179, p-value=0.007) and conveyance (r=0.96, p-value=0.047) while the correlation between access to credit and disposal was not significant. Toilet design showed a strong positive association (r=0.627, p-value=0.000) with only faecal emptying. Frequency of desludging did not have a significant association with any of the indicators of the dependent variable. Charg-

			Emptying	Conveyance	Disposal
Economic Factors	Operational cost	Beta	0.124	0.098	0.197
		p-value	0.038	0.029	0.002
		R^2	0.137	0.109	0.242
	Access to credit	Beta	0.027	0.008	0.007
		p-value	0.006	0.117	0.318
		R^2	0.032	0.009	0.000
	Toilet design	Beta	0.321	0.069	0.017
		p-value	0.000	0.057	0.074
		R^2	0.393	0.080	0.025
	Frequency of desludging	Beta	0.004	0.007	0.004
		p-value	0.181	0.169	0.189
		R^2	0.002	0.000	0.000
	Charges in relation to space availability	Beta	0.524	0.007	0.012
		p-value	0.000	0.096	0.361
		R^2	0.558	0.017	0.000
	Level of Income	Beta	0.397	0.229	0.097
		p-value	0.002	0.001	0.021
		R^2	0.461	0.241	0.138
	Ability and willingness	Beta	0.176	0.063	0.191
		p-value	0.017	0.104	0.010
		R^2	0.200	0.085	0.258

Table 7: *Regression of Economic Factors Indicators on Faecal Emptying, Conveyance, and Disposal Indicators*

es in relation to space availability showed the greatest positive significant relationship with emptying of faeces (r=0.747, p-value=0.000) followed by conveyance (r=0.129, p-value=0.009) and with faecal disposal (r=0.028, p-value=0.032). The level of income showed a directly and significant correlation with faecal emptying (r=0.679, p-value=0.002), conveyance (r=0.491, p-value=0.001) and disposal (r=0.372, p-value=0.012). Residents ability and willingness to pay for sanitation services also showed a significant relationship with faecal emptying (r=0.524, p -value=0.000), conveyance (r=0.291, p-value=0.000) and disposal (r=0.508, p-value=0.000).

The fact that an increase in operational cost increased chances of faecal emptying, conveyance and disposal was confirmed in Malawi by Chunga *et al.* (2016) who established a direct relationship between operational cost and emptying of toilets. On the other hand, an increase or decrease in access to credit could result in an increase or decrease in emptying and conveyance of faeces as confirmed in India by Augsburg *et al.* (2022) who established that access to credit for toilet construction had a direct relationship with uptake of sanitation services. Charges in relation to space availability, reduced level of income and low ability and willingness to pay for sanitation services constrained faecal emptying, conveyance and disposal.

Regression Analysis

Linear regression analysis was done to determine the influence of the indicators of economic factors on the indicators of faecal emptying, conveyance, and disposal and the findings summarized in Table 7

Findings in Table 7 give the beta coefficients, indicating the contribution of each economic indicator factor indicators on faecal emptying, conveyance, and disposal. Operational cost had the

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.596	0.228		7.003	0.000
	Economic Factors	0.615	0.227	0.597	25.998	0.001
a. Dependent Variable: Faecal Emptying, Conveyance, and Disposal						

Table 8: *Regression Coefficient of Economic Factors and Faecal Emptying, Conveyance, and Disposal.*

greatest significant contribution on faecal disposal (0.197), access to credit was a significant contributor to faecal emptying only (0.027), toilet design contributed significantly to faecal emptying only (0.321), frequency of desludging did not have a significant contribution on any of the variables, space had a significant contribution on faecal emptying only (0.524), and lastly level of income significantly contributed to faecal emptying (0.397), faecal conveyance (0.229), and faecal disposal (0.097), the contribution was greatest on faecal emptying, and lastly, willingness and ability to pay had significant positive contributions on faecal emptying (0.176) and faecal disposal (0.191), it however did not have significant contribution on faecal conveyance as indicated by the p -value of the beta coefficient being greater than 0.05 (0.063,0.104>0.05).

Based on the value of the coefficient of determination (R^2), operational cost had the greatest explanatory power (24.2%) on faecal disposal, access to credit had the greatest explanatory power (3.2%) on faecal emptying, toilet design had the greatest explanatory power (39.3%) on faecal emptying, space explained 55.8% of the variation in faecal emptying, and level of income explained 46.1% of changes in faecal emptying, frequency of desludging has no explanatory power on faecal emptying, conveyance, and disposal. Lastly, willingness and ability to pay significantly explained 20.0% of variations in faecal emptying and 25.8% of variations in faecal disposal.

To determine the overall contribution of economic factors on faecal emptying, conveyance, and disposal an overall regression analysis was done and results were as shown in Table 8.

The simple linear regression findings in Table 8 indicate that economic factors significantly influence faecal emptying, conveyance, and disposal. The coefficient of the constant term (and economic factors (are both statistically significant. Therefore, the model of regression for faecal emptying, conveyance, and disposal on economic factors is given by indicating that for each change of one unit in economic factors, faecal emptying, conveyance, and disposal is marginally transformed by 0.615 units. It was therefore, concluded that economic factors and faecal emptying, conveyance, and disposal have a positive linearly association.

To establish the proportion of change in faecal emptying, conveyance, and disposal that can be accounted for by economic factors. A model summary from the regression was generated and presented in Table 9

Based on the outcome of the analysis displayed in Table 9, economic factors as a predictor variable explains 29.0% of the change in faecal emptying, conveyance, and disposal. Since the conveyed p-value is 0.000 which falls below 0.05 significance level, it is then concluded that the value is significant. The study findings agree with the findings in Kenya by Simiyu et al. (2021) who reported that economic factors such as operational cost and toilet design influence the practice of faecal waste management is low-income urban settlements.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.539 [a]	0.290	0.283	0.009	0.282	615.897	1	226	0.000

a. Predictors: (Constant), Economic Factors

Table 9: *Model Summary of Economic Factors and Faecal Emptying, Conveyance, and Disposal*

Conclusion

The study concluded that the inability to meet the costs associated with faecal emptying, conveyance and disposal services facilitated poor sanitation status in slums. Hygienic and safe faecal emptying, conveyance and disposal remained unaddressed in the slums due to the influence of economic factors such as level of income, operational cost, ability and willingness to pay for sanitation services, access to credit, and charges in relation to space availability. Improvement of sanitation conditions in slums through promotion of improved toilet designs and financial support could influence hygienic faecal sludge management practices.

Recommendations and Future Research

The study recommends partnership between the County Government, Non-Governmental Organizations, and sanitation implementers to financially support slum communities to move up the sanitation ladder through adoption of toilets which guarantee safe management of faecal waste through emptying, conveyance and disposal.

To promote hygienic management of faecal waste the county government should open access points where pit emptiers could directly dispose faecal waste into sewer lines for conveyance.

The Ministry of Health, through the Public Health Officers should sensitize communities on the need to adopt toilets with provision of manholes for guarantee of hygiene and safety to users and pit operators.

Development of government policies to regulate pricing and increase the capacity of mechanical handling of faeces in slums could be essential. The study also recommends the need for future researchers to examine faecal emptying conveyance and disposal alongside other factors like social, demographic and suitability of sanitation technologies.

Competing Interests

The authors declare that there are no competing interests

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