frontiers | Frontiers in Water

TYPE Original Research
PUBLISHED 23 December 2022
DOI 10.3389/frwa.2022.1055227

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Water and Climate, a section of the journal Frontiers in Water

RECEIVED 27 September 2022
ACCEPTED 05 December 2022
PUBLISHED 23 December 2022

CITATION
Grisaffi C, Oluoch P, Hamuchenje EM, Phiri J, Salano G, Hawkes L and Parker A (2022) Transforming citywide sanitation provision: Utility voices on pit emptying and transport services in Kenya and Zambia.
Front. Water 4:1055227.
doi: 10.3389/frwa.2022.1055227

Transforming citywide sanitation provision: Utility voices on pit emptying and transport services in Kenya and Zambia

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This paper documents the key challenges faced by utilities in sub-Saharan Africa attempting to establish citywide safe manual and semi-mechanized latrine pit emptying, transport and disposal services. The research aims to take a snapshot of utilities at a pivotal point in service development, where initial services have been piloted and the utilities are looking to go to scale. We use the CWIS framework to guide analysis of perspectives of the implementing agencies in Livingstone, Zambia, and Malindi, Kenya, using a secondary data review and 34 key informant interviews. This paper confirms previous findings around the high cost of safe sanitation services in low-income areas, the barriers of emptiability, the engagement of manual pit emptiers and the requirement for investment in supporting systems. Areas for future research were identified, including approaches for service delivery to reduce the decision load on the household, structures of engagement and regulation of pit emptiers, and finally how regulation could support incremental improvements toward full coverage, including the lowest income households. The research documents, for the first time in the region, the challenges of dealing with disgust in establishing these new services and the conflicting role of public utilities as both commercial and social organizations. The current model for private sector delivery of the service is politically viable and reduces the risk and cost burden on the utilities. However, it is likely to leave the utilities unable to scale sanitation to low-income areas.

KEYWORDS

water and sanitation utilities, urban, fecal sludge management, informal sector, pit emptiers

1. Introduction

Across sub-Saharan Africa 84% of the urban population (JMP, 2022) rely on onsite (non-sewered) sanitation, including pit latrines and septic tanks. Across urban areas the most significant portions of unsafely managed excreta are from onsite sanitation systems, creating public health and environmental challenges (Peal et al., 2014). Poor sanitation can cost economies billions of dollars, pollutes ecosystems and leads to a heavy burden of disease (Hutton et al., 2007). In 2019, diarrheal diseases accounted for 9% of all deaths among children under 5 (UNICEF, 2022). This challenge will be exacerbated by the rapid rate of population growth and urbanization across Africa, particularly in secondary cities, which are under researched (Grant, 2015) yet predicted to be the economic drivers of development in the future (Roberts, 2014).

Onsite sanitation is typically quicker to scale than offsite systems and the first accessible improved sanitation option (Dickin et al., 2020). Sewered sanitation is slow to install, expensive and water intensive (Fry et al., 2008; Öberg et al., 2020). The high levels of onsite sanitation in cities across sub-Saharan Africa, therefore, also provide an opportunity to take a very different route to more climate resilient safe sanitation coverage (Fry et al., 2008; Schrecongost et al., 2020). However, urban sanitation investment remains largely focused on the expansion of centralized sewer infrastructure, with little attention paid to approaches needed to reach full coverage (Schrecongost et al., 2020).

For urban onsite sanitation facilities to be considered "safely managed" under the WHO/UNICEF Joint Monitoring Program fecal sludge should be contained and then safely transported and treated (JMP, 2022). Emptying and transport of fecal sludge from onsite systems across sub-Saharan Africa is predominantly outsourced by municipalities or utilities to a highly heterogeneous private sector with service providers ranging from individual manual or semi-mechanized pit emptiers to companies operating vacuum tankers (Peletz et al., 2020b; Mallory et al., 2021). Informal and unsafe fecal sludge management practices disproportionately affect low-income neighborhoods, where manual or semi-mechanized pit emptiers are the main service providers (Peletz et al., 2020a). These pit emptiers typically come from marginalized backgrounds and have a precarious livelihood, facing significant health risks, social discrimination and financial insecurity (Zaqout et al., 2020; Mallory et al., 2021). Manual or semi-mechanized pit emptiers are largely informal workers (following the definition given in Hussmanns, 2004), not recognized by the state (Zaqout et al., 2020; Lerebours et al., 2021b; Mallory et al., 2021). The challenges in providing safe and inclusive manual or semi-mechanized pit emptying services are well documented, including low willingness or ability to pay and challenges of emptiability, with an estimated 18% of latrines in LMICs rated unemptiable (Jenkins et al., 2015; Greene et al., 2021; Mpanang'ombe et al., 2021).

Scaling-up safe fecal sludge management services has been blocked by logistical and procedural barriers such as lack of basic treatment and policy framework (Peal et al., 2014, 2020). However, fecal sludge management is increasingly seen as an essential component of urban sanitation as part of Citywide Inclusive Sanitation (CWIS) (Gambrill et al., 2020; Schrecongost et al., 2020) and where those blocks are being addressed there is an opportunity to research early implementation, and support learning for the region (ESAWAS, 2021a,b). CWIS is an overarching framework formed from seven principles focusing on inclusion within service provision (Schrecongost et al., 2020). Currently, CWIS is being implemented in over 40 cities globally (Gambrill et al., 2020). Schrecongost et al. (2020) lay out a CWIS service framework for the core outcomes of "equity, safety and sustainability, for everyone in an urban area" and the functions of responsibility, accountability and resource planning and management.

This increased focus on CWIS is supported by governments, regulators and utilities across sub-Saharan Africa; with new mandates to reach universal sanitation coverage, and nascent regulation for onsite sanitation and fecal sludge management services (ESAWAS, 2019, 2022; Schrecongost et al., 2020). A review of the water supply and regulatory landscape completed by the Eastern and Southern Africa Water and Sanitation (ESAWAS) Regulators Association (ESAWAS, 2022) flags the promise of the growing momentum around regulating onsite sanitation. Attempts to reach citywide coverage of safe sanitation, including onsite sanitation, are ongoing in several locations under different service models. This is an emerging policy shift so has not been extensively documented in the academic literature so far.

This paper documents the key challenges faced by utilities in secondary cities in sub-Saharan Africa attempting to establish safe latrine pit emptying, transport and disposal services, for complete coverage, including low income and difficult to access areas. The research aims to take a snapshot of utilities at a pivotal point in service development, where initial services have been piloted and the utilities are looking to go to scale. The paper uses the CWIS framework to understand the issues faced from the perspective of the implementing agencies. The main research question is: What are the key challenges during the initial establishment of emptying and transport fecal sludge services? Are there any common learning which could be generalizable to other locations?

2. Materials and methods

The research considers two case studies and completes a cross case synthesis, bringing out common challenges and

learning. The research was completed through a review of literature and project data, supplemented by semi-structured key informant interviews with staff within utilities and supporting implementing partners.

This case study research aims to both understand and postulate learning for similar utilities at an earlier stage of implementation. The research questions are focused on what can be learnt from ongoing implementation and how this can be fed back into guidance at the utility, national and regional level (ESAWAS, 2019). Flyvbjerg (2006) presents case studies as an appropriate methodology to respond to such questions, which aim to inform adaptation, and an essential part of developing knowledge albeit "noisy, fallible, and biased".

2.1. Case study area

The case study utilities and cities, Southern Water and Sanitation Company (SWSC) in Livingstone Zambia, and Malindi Water and Sewerage Company (MAWASCO) in Kenya, were chosen for this research paper as being at a critical point in responding to new mandates to provide complete sanitation coverage. Both utilities have nascent fecal sludge emptying and transport services, and are now looking forward to how these could be scaled into a permanent service line. These two case study locations are thought to demonstrate the "extreme" conditions (Yin, 2009) aiming to maximize "information content" (Flyvbjerg, 2006).

Livingstone, Zambia, and Malindi, Kenya, are secondary cities, and major tourist hubs. Livingstone, in the Southern Province of Zambia, is at the border with Zimbabwe and on the banks of the Zambezi River, adjacent to the Victoria Falls. Malindi is a coastal city in Kilifi County, southeastern Kenya. The two utilities and implementing partners, Water & Sanitation for the Urban Poor (WSUP) and Sanivation, were funded under the TRANSFORM Utility Intrapreneur Challenge to develop manual, or semi-mechanized, latrine pit emptying, transport and disposal services over an 18 month period, from December 2020. TRANSFORM is a joint initiative between Unilever, the UK's Foreign, Commonwealth and Development Office (FCDO) and EY supporting impact enterprises to deliver market-based solutions to development challenges.

Kenya and Zambia have similar institutional arrangements for sanitation; an independent regulator and decentralized (regional or city level) utilities with a combined mandate for water and sanitation. In both Kenya and Zambia utilities are publicly owned, with tariffs set by the economic regulator, but expected to operate as financially independent organizations able to cover operational costs and generate funds for investment. In both Kenya and Zambia mandates for onsite sanitation have shifted over the last 4 years from the Ministry of Health to the line ministry for water and sanitation. Utilities are now mandated to provide complete sanitation coverage, expanded from sewer systems only. Both countries have high levels of stated political support for onsite sanitation expansion. Zambia's National Water Supply and Sanitation Council (NWASCO), the sector regulator has strong strategic frameworks for provision and regulation of urban onsite sanitation and fecal sludge management, however implementation of these frameworks is limited (ESAWAS, 2022). Kenya's pending revisions to the Water Act 2016 are expected to include onsite sanitation, and the Kenyan Water Services Regulatory Board (WASREB) has published guidelines that encompass non-sewered sanitation (ESAWAS, 2022).

SWSC and MAWASCO are both high performing utilities within their contexts. SWSC was the top ranked commercial utility in Zambia in 2021, scored by the national regulator against the 9 performance indicators, including sanitation coverage (NWASCO, 2021). MAWASCO was ranked 18th of 87 utilities across Kenya, by the national regulator, and was the top performing water utility in the coast region in 2022 (WASREB, 2022). The two utilities also face some similar challenges with both being ranked low by their national regulators on staff efficiency and with high O&M costs compared to collection (NWASCO, 2021; WASREB, 2022). Both utilities have established citywide sanitation plans and sanitation strategies, however they have no previous experience in onsite sanitation. To date MAWASCO has managed only water services, SWSC has managed water and sewerage services.

2.2. Data collection and sampling

Project data was made available through the utilities and other partners—including Unilever (who provided in-kind support through TRANSFORM), WSUP and Sanivation. Project data reviewed included project reports, financial models developed to support the first phases of the business, marketing materials and tools, assessment and sales data, and workshop records. Only data which had been reviewed by both the utility leads and implementing partners was used in this review.

The project data was used to understand the context within the case study locations and the design and status of the nascent fecal sludge emptying and transport services. The project data informed the sampling strategy and identified major areas of change; utility capacity for the new sanitation mandate, engaging customers around non-networked services, engaging and incentivizing previously informal pit emptiers. These areas were then explored through a series of semi-structured interviews, with an initial set of prompts to elicit discussion. Interview guides were developed and agreed by all authors. Key informants were taken from the two utilities, Unilever and the implementing partners: Water & Sanitation for the Urban Poor and Sanivation (Kenya only).

Purposive sampling (Kuzel, 1992) was used to identify interviewees across utilities and partner organizations,

TABLE 1 Summary of interviewees.

Organization	Zambia	Kenya
Utility	12	10
Implementing partners	4	8
Total	16	18

incorporating the direct project implementation team, senior management team and others involved in meeting the sanitation mandate. The primary focus was on the utility staff, as the mandate holder and implementer. Initial samples were provided by co-authors, using an interest influence matrix to identify and include people who might be perceived as blockers as well as facilitators. The initial sample was verified by asking each interviewee to recommend further interviewees. This process largely confirmed the initial sample group, with only two new additions. A small number of utility staff were included as peripheral samples to verify the extent of the sample. The final group of interviewees incorporates all staff with a strong interest in and/or influence over onsite sanitation within each utility, ranging across the organization. The breakdown of interviews between organizations and locations is given in Table 1.

The interviews were all completed by the UK based first author, online through the Microsoft Teams platform and in English. Most interviewees were familiar with the platform, having used it extensively through project implementation. Completing interviews remotely increases consistency between locations and reduces the time burden on Kenya and Zambia based co-authors (Tilley and Kalina, 2021). However, it also prevents participant observation and introduces a need to be more sensitive to both social and spatial hierarchies (Melis Cin et al., 2021). Additional time was invested to researching participant backgrounds, and additional space provided for interviewees to add information within the time allocation, as advised by Hicks et al. (2021). Remote interviews were also facilitated by existing relationships between co-authors and interviewees.

2.3. Data analysis

Interviews were recorded and transcribed. A minority of interviews, <10% and excluding any utility decision makers, relied on detailed notes rather than full transcriptions. Consent for data collected, including audio recordings and interview notes, was obtained from all key informants before the commencement of the interviews. Interviewees were informed of the purpose of the research and assured of confidentiality in line with ethical approvals obtained from Cranfield University Research Ethics CURES/14895/2021.

A simplified verbatim transcription was taken which removed repetition and did not directly transcribe filler words, false starts, interruptions, discussions to clarify questions or other verbal cues. Issues which might impact on the overall weighting of the interview, for example if the informant was highly distracted, or the connection was very poor, were instead recorded in field notes and considered in the analysis. The approach taken may reduce some of the content, and precludes a discourse analysis, but was considered to facilitate sharing of transcripts (Forbat and Henderson, 2005) and to be appropriate to the research scope (Halcomb and Davidson, 2006).

The initial coding framework, laid out in Table 2, was established prior to data collection. This framework is based on the CWIS principles laid out in Schrecongost et al. (2020). Each principle covers multiple different aspects and considers every actor in the chain, from national to household. The project data review was used to focus the framework to be relevant to the scope of this project, at the utility level and focusing on the transition to scale. As outlined in Table 2, focus areas are identified under each principle, broken down by household, utility, pit emptier and the wider enabling environment.

Detailed interview notes and transcripts were analyzed thematically by the first author using Nvivo (QSR International Pty Ltd., 2020).

The initial coding framework was developed as the interviews progressed. Priority and emerging themes within this framework, and the links between them, were triangulated with co-authors as the research progressed. Greater weight was given to those interviewees who were more closely involved in the onsite sanitation mandate, and with direct decision-making responsibility within each utility. These informants were considered more representative of, and influential on, the wider organization. Voices from implementing partners were used to cross check and inform themes. Themes from implementing partners not reflected by utility staff were reviewed carefully. For example, a strong narrative from partners about utilities feeling a moral duty to get pit emptiers "out of the pit" was not reflected in interviews with utility staff and so is not reflected in the results section.

This process was done iteratively until the data were organized into a set of codes that were verified by the co-authors and represented the data collected. Themes emerging from interviews were then checked back against project data to understand how perceptions may differ.

Only common themes emerging across both locations were considered for analysis and discussion. There were important site-specific learning which are briefly referenced, for example the barriers to transfer stations in Malindi. However, the focus for this paper is on learning common to both utilities. Themes reported by multiple staff across both locations are considered to be both more robust findings and more likely to be relevant to other utilities going through a similar process.

TABLE 2 Initial coding framework.

Principle (Schrecongost et al., 2020)	Coding—Stakeholder: Theme
Everyone in an urban area, including the urban poor, benefits from equitable safe sanitation service	Household: Affordability of service Utility: Ability to scale to full coverage Enabling environment: Public finance availability
Gender and social equity are designed into planning, management, monitoring	Household: Prioritization of service due to alignment with needs Pit emptiers: Protection of health and rights Pit emptiers: Prioritization of safe practices due to alignment with needs
Human waste is safely managed along the sanitation service chain, starting with containment	Household: Containment quality and emptiability Pit emptiers: Safe practices for emptying and transport Utility: Resource recovery incentives
Authorities operate with a clear inclusive mandate, performance targets, resources and accountability	Utility: Incentives to scale to full coverage Utility: Financial resources sufficient for mandate Enabling environment: Clear mandates and regulatory framework
Authorities deploy a range of funding, business and hardware approaches to reach goals	Utility: Business models adapted to user group Enabling environment: Integrated and incremental systems
Comprehensive long term planning fosters demand for innovation and is informed by analysis of needs/resources	Utility: Capacity and innovation Utility: Climate and environmental resource constraints Enabling environment: Urban planning
Political will and accountability systems incentivize service improvements in planning, capacity and leadership	Utility: Institutional reforms Enabling environment: Commitment

The final coding framework following the iterative development of themes is given in Table 3. The key themes emerging, or verified, through the analysis were structured as follows; (i) affordability and prioritization of the service by households and household level containment and emptiability of pits; (ii) meeting the needs and protecting health of pit emptiers, while balancing protecting rights and prioritizing safe practices for emptying and transport; (iii) the utilities' ability to scale to full coverage, and the need for institutional change and capacity; and (iv) clarity of mandates and the regulatory framework.

In the reporting of findings, Sections 3.1 and 3.2 are informed by the project data review and provide a background of the context and nascent fecal sludge emptying and transport services. Sections 3.3–3.5 are findings from the key informant interviews. Summaries of the key findings were shared with each author through the research; validation was highly reliant on authors' extensive experience of working on the MVP. Key informant interviews identified unreported areas of learning, for example around the importance of disgust, but did not contradict the project data review. The analysis has tried to put a greater weight on results from those people close to the work and to decision making. All quotations given in the results section are taken from interviews with senior utility staff. Initial drafts of the paper were shared with every interviewee, over email, who were given 20 working days to respond, with follow-up reminders. The interviewees were requested to confirm whether the findings resonated, if they had any concerns about how the work were presented, and the relevance and usefulness of the discussion and conclusion. Interviewees were asked to flag any issues which might be missed, under or over-represented. Positive responses, some with minor corrections, were provided by more than 70% of the interviewees. The paper is therefore thought to have testimonial validity (Stiles, 1993).

2.4. Sources of bias and limitations of the methodology

The co-authors from each utility and WSUP have been closely involved in the development and implementation of this new service line and have "authority and accountability in knowledge creation" (Sarna-Wojcicki et al., 2017) for this area. This involvement has facilitated access within each organization and reduces the possibility of data being missed or hidden. However, it has been challenging to put our substantial vested interest in the work to one side and reflect critically on what has been learnt. Additional sources of bias may be created by the interviews being completed by the first author, a white Briton, reflecting the colonial structures inherent in the development sector (Daoust and Dyvik, 2022) and, in many cases, initial interview responses were more guarded and carefully framed.

Potential sources of bias have been addressed by (i) positioning the paper to look at learning rather than project performance, (ii) actively looking for people who disagree with the approaches being taken by the co-authors, (iii) reporting a balance of perspectives, rather than single conclusions, and (iv) each author completing a positionality statement (Vong, 2021) reflecting on their background and role in the work may have influenced their perspective (Holmes, 2020).

The study is limited to considering only the perspectives of the utility, informed by reflections from partners. Therefore, in

TABLE 3 Summary of final coding structure.

Stakeholder	Code	Sub codes
Household:	Affordability and prioritization	Building awareness and desirability of the service Challenges of affordability Prioritization of the service, compared to water and other basic services Need for increased flexibility
	Containment and emptiability	Consolidated sludge cake in unlined pits Solid waste management blocking pits Poor quality containment
Pit emptiers:	Meeting needs and protecting health	Choice to work with informal pit emptiers Initial formalization and fears Meeting needs, motivations to engage Changing status Protecting health
	Protecting rights and prioritizing safe practices for emptying and transport	Increased costs of compliance Holistic livelihood, full time engagement The utility as a regulator Regulatory models considered Concerns of non-compliance Expectations on the private sector and known challenges
Utility:	Ability to scale to full coverage	Mandate understanding and fears for financial sustainability Revenue stream and resource constraints Business model and cross subsidy External budget allocations (public finance and international funders) Financial planning
	Institutional change and capacity	Technical capacity Staffing constraints Shifting mindsets to sanitation Shifting mindsets from sewerage
Enabling environment:	Clear mandates and regulatory framework	Mandates and framework Mandate shift from the Ministry of Health Legal framework along the sanitation chain

many areas, such as motivations of pit emptiers and challenges in the enabling environment, the findings are around utility perceptions. The study therefore provides only a partial picture. This is made clear in the results section and is discussed further in suggested future research directions.

3. Results

3.1. Context

Malindi has no sewer network. The majority of the city, around 60%, have pit latrines and a small percentage, around 5% practice open defecation. The remaining households have septic tanks. Livingstone is unusual in having more than 40% of households connected to sewers. The other towns within the SWSC catchment are more reflective of secondary cities in the region, with low to no sewer network. Within Malindi and Livingstone, households with onsite sanitation are split into two main groups; high to middle income households with septic tanks and middle to lower income households with pit latrines. Households with septic tanks use vacuum tanker services, apart from a small percentage not accessible by road. Pit latrines are emptied by informal manual or semi-mechanized pit emptiers. Informal, in that they were not licensed or operating under any minimum standards.

Prior to the work described in Section 3.2 no formal manual or semi-mechanized pit emptying services were available in either location, no minimum operational standards were in place and there was no relationship between the informal pit emptiers and the utility. Pit emptiers were untrained, often using rudimentary equipment and entering pits with no personal protective equipment (PPE). Fecal sludge was either disposed of in the environment, or by digging a hole next to a full pit then emptying and burying waste onsite. Pit emptying was seen as low status work in both locations. In Malindi handling of fecal sludge was illegal, pit emptiers face high levels of prejudice, being referred to as "frogmen", working at night, and not wanting to be identified. In Livingstone pit emptiers reportedly considered themselves to be providing a community service and have deep rooted ties in the local community, they are neither protected nor prohibited under law.

There was no agreed tariff structure, with per pit charges being based on negotiation and households' ability to pay. Reported average tariffs charged are summarized in Table 4. The tariff levels reported by customers and pit emptiers in Malindi are much higher than those in Livingstone. This is understood

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TABLE 4 Reported average tariffs and tariffs fixed under the Minimum Viable Product (MVP)—per pit or tank.

Service	Livingstone (USD)		Malindi (USD)	
	Current	MVP	Current	MVP
Informal pit empty	15		85–210	
Self empty	10			
Formal pit empty: domestic/lower band		20		100
Formal pit empty: commercial/upper band		40		200
Vacuum Tanker	30		250	

TABLE 5 Summary of pit emptying assessments and sales, as of August 2022.

	Total		Monthly peak	
	Livingstone	Malindi	Livingstone	Malindi
No. assessments	200	143	23	24
No. paid sales	41	20	7	8
% Conversion of assessments to sales	20	14		

to be due to pits in Malindi being much deeper and also due to a standard practice of fully emptying the pit, including consolidated sludge.

The Minimum Viable Product (MVP) described below was developed and piloted within this context. It was the first attempt by each utility to engage pit emptiers and provide latrine pit emptying services. At the time of writing, September 2022, the MVP had been running for 9 months in Livingstone and 6 months in Malindi.

3.2. Outline of the minimum viable product developed and piloted

There are multiple definitions of an MVP. In this case the MVP follows the definition recommended by Lenarduzzi and Taibi (2016) "a version of a new product, which allows a team to collect the maximum amount of validated learning about customers with the least effort".

The development of the MVP aimed to change behaviors in both customers, to choose formal pit emptying services, and pit emptiers, to adopt new ways of working and dispose of sludge safely. The teams followed the Unilever 5 levers of change approach (Lawrence et al., 2019) to identify possible triggers, barriers and motivations to making these changes. Interventions are designed to make the change understood, easy, desirable, rewarding and a habit.

To respond to the anticipated challenges of low demand for services and willingness to pay, both utilities developed a deep understanding of existing informal practices and how they were perceived by customers. Marketing materials were drafted following observations of informal emptying and initial focus group discussions with potential customers. These were then developed iteratively based on feedback from customer groups to make the service more desirable and differentiate it from informal services. Different channels and materials were tested and amended with a short turnaround time. Services in both cities evolved to rely on door-to-door communication as one of the most trusted routes for communication, with a focus on cleanliness. Both utilities followed a process of targeted marketing, followed by a free pit assessment (checking whether pits could be safely emptied, and the urgency of emptying) and then the sale of services. Conversions, from pit assessments to sales of pit emptying services, remained at or below 20%, as shown in Table 5.

Existing pit emptiers working informally were targeted for formalization. A small group of pit emptiers was selected in each location and engaged on a payment by commission basis, with agreed ways of working laid out in a memorandum of understanding. Pit emptiers were provided with training, vaccinations, PPE, disinfectant, equipment and materials. Emptying technologies were selected based on demonstrations using professional pit emptying teams from other utilities, assessed by utility staff and local stakeholders. Modified garden tools were selected in Livingstone and, alongside the trash pump, eventually also adopted in Malindi. Standard Operating Procedures were developed setting out approved ways of working. Each utility managed the customer journey, coordinating pit assessments, sales and payment and managing enquiries and feedback. Transport was provided by the utilities to ensure safe disposal of the fecal sludge.

Basic financial modeling was developed to estimate the costs of the service and determine tariff levels for the MVP, given in Table 4. The tariffs were determined by the minimum operational costs for safe emptying; wages for the pit emptiers, vaccinations, and the provision of disinfectant, materials and equipment. The remaining costs for safe disposal, comprising the vehicle costs for transport and disposal and permit and tipping fees, were fully subsidized by the utility. As shown in Table 4, tariffs in Malindi were significantly higher than those in Livingstone, but with a similar relative margin to market prices for informal services. Tariffs in Malindi were higher partly because of the selection of trash pumps for pit emptying, rather than the modified garden tools used in Livingstone and also due to the much greater transport distance for disposal. Efforts were made through the process to reduce operational costs, most notably around transport, but were not always possible.

In Malindi in particular, attempts to introduce transfer stations were stymied by resistance from local authorities and the public health regulator.

There was a high level of uncertainty in estimating the total cost to the utility of providing the service. The potentially substantial costs for marketing, IT, billing, customer care, dedicated sanitation staff, governance and overheads were therefore excluded from the cost estimates and are expected to be fully subsidized by the utility.

3.3. Selling emptying and transport services to households: Translating interest to sales

3.3.1. Building demand and translating demand to sales

Professional manual or semi-mechanized pit emptying services were completely new to both the utilities and the target populations. The marketing activities were therefore initially both building awareness that there was a different way of emptying latrines, as well as selling the service itself. Reported feedback, from both customers and people observing improved service delivery, was positive. *"The customers . . . were able to say okay, we didn't get any smell, there are no flies, the service has been done in a professional way. . . [the utility staff] were able to see the big gap between how the service was being done by the informal pit emptiers and in how the professional services are done, and even the emptiers themselves, when we asked them, they were able to see where they were not doing fine."*

The lack of data on sales of informal pit emptying, and the novelty of the formal service, makes comparisons of performance challenging. However, feedback from potential customers was that the service was not affordable, countering findings from previous willingness to pay surveys. Follow-up from utility staff indicated that customers did not prioritize sanitation, with competing demands for other basic essentials, such as water, education and food bills and also with status items, such as satellite television. Seasonal variations were also noted, in one location the service was launched around the same time as school fees were due, which was cited as a major barrier to payment. In one city where bylaws requiring pit emptying were in place, the Public Health Department enforced these with inspections. This was potentially positive for the utility, however moral issues around this more legalistic approach were raised, as to whether households should be forced to choose between sanitation and other essential services, even when legally required to do so.

As the MVP was implemented customer concerns about affordability were addressed by each utility through increased face to face follow-up with customers after the assessment, flexible payment (including negotiated tariffs, payment by installments and partial emptying) and trialed scheduled desludging (targeted to areas with smaller latrine pits). Initial feedback from utility staff is that these approaches are positively received and are credited with increased sales.

3.3.2. Emptiability limiting the market and increasing costs

Markets for emptying services were limited by the poor quality of household containment and poor solid waste management. A substantial proportion of latrines assessed were not possible to empty due to concerns about pit collapse or due to highly consolidated sludge cake. In isolated cases when highly consolidated sludge was removed, either by adding water and agitating the sludge or digging with modified garden tools, it could add more than 4 h to the emptying process. Poor quality containment leads to groundwater contamination and increases the time to fill. For example, in Livingstone average emptying intervals for pit latrines were estimated as 7 years (in comparison to the 3-year interval being mandated by the regulator).

Disposal of solid waste in latrine pits also emerged as a major issue, increasing the time needed to empty pits and presenting a challenge for treatment. Solid waste needed to be separated from the sludge, dried and then disposed of as hazardous waste, requiring either an additional treatment step at the FSTP or payment for disposal at a certified site. MAWASCO has developed a solid waste management plan, for implementation by the local authority, in parallel with the CWIS plan to try to preempt this challenge, although it will take time to see the benefits (Akinyi et al., 2021).

Poor quality containment and solid waste management was identified by senior utility staff as the major barrier to being able to scale safe sanitation services. Despite initial awareness in both utilities, the scale of the challenge was not fully appreciated prior to the implementation of the MVP. Bylaws for construction and appropriate standard designs for pit latrines, alongside improved solid waste management, were identified as some of the priority measures to remedy this challenge. Both utilities are moving forward with advocacy efforts with local municipalities using the results of the MVP.

3.4. Manual and semi-mechanized pit emptiers: Keen to be integrated, challenging to sustain compliance

3.4.1. Motivations to provide safe services and response to initial attempts at formalization

Both SWSC and MAWASCO focused on engaging existing manual or semi-mechanized latrine pit emptiers and integrating them into formal systems. Where consulted, Vacuum Tanker Operators and other businesses were reportedly not interested in engaging in these services given the perceived low profitability.

Formalizing existing pit emptiers to provide the MVP service was perceived as an easier route to provide a service in the short term, recognizing that the existing pit emptiers were the main competition and had some of the needed skills and knowledge. Looking outside of this group was considered risky due to the disgust factor; *"To train somebody who has not had an encounter, an experience directly with fecal sludge is such a problem. Because you know... it was difficult for some of our team members to just witness a pit being emptied"*.

Expectations were that pit emptiers would be resistant to formalization, due to the gray legal space they occupied and the perceived low status and social stigma of the work. There was indeed a low response rate to open calls, for example through radio advertisements in Malindi, however pit emptiers were rapidly engaged through peer networks and local structures. Initial perceptions of the project team were challenged both by survey results which indicated that many pit emptiers saw themselves as front line workers, with an important role protecting public health, and also the willingness of pit emptiers to engage with the utilities and to be linked to a recognized brand. Reported motivations for pit emptiers to engage were similar despite their very different starting points in each location; a secure income, increased professionalization, including links to a recognized organization, and improved public perception of their role *"they don't have to identify as themselves, they associate with something bigger, and it's really helpful with business"*.

The initial intent was to take a light touch approach and incentivize widespread compliance of pit emptiers, for example through setting up pit emptier associations and enabling access to improved equipment. However, the challenges in ensuring consistent compliance by pit emptiers, and the possibility of unsafe pit emptying services being connected to the utility brands, was ultimately considered to create too much reputational risk. Both utilities have instead focused on providing targeted support and incentives to a small number of pit emptiers, who could then be closely monitored, in some cases directly supervised by utility staff.

Social status of the formalized pit emptiers has reportedly improved, responding directly to their expressed motivations. Across both utilities there was a perception that pit emptying, previously *"viewed to be a business that is done by people who are not quite sane"* was increasingly seen as *"a business like any other"*.

3.4.2. Providing a livelihood and incentivizing compliance

This positive initial engagement between the utilities and pit emptiers was tempered by challenges in providing a sustainable livelihood and the cost of compliance. Working in line with the established Standard Operating Procedures increases costs and time to provide the service. Typically, pit emptying would be just one of multiple income sources for pit emptiers, so a holistic livelihood strategy was needed, *"... now they are fully engaged... because now we had to look for ways to make them stay with us... they have a whole days work every day"*. Levels of sales during the project period were not considered sufficient to provide a viable livelihood and there were also concerns about side jobs, and retention, if pit emptiers were not fully engaged. Both utilities ultimately opted to engage pit emptiers full time, providing a stipend to support pit assessments, marketing activities and low skilled work, including working with vacuum tankers. This decision considered that stability of income, and building a relationship with the utility, would be a greater motivator than higher but less reliable earnings.

Final delivery models are still under discussion, with options ranging from bringing the current pit emptiers in-house with utility-led delivery, to building entirely independent businesses. However, the majority view was that utilities would scale up independent private sector provision of the service, with themselves acting as a regulator. This choice is partly due to external constraints and resourcing expectations. *"When you talk of bringing them in as employees, the liabilities and the other issues that can arise really can blow this company structure"*.

The utilities' current engagement of pit emptiers is based on close monitoring and punishing non-compliance. However, when looking at scaling the pit emptying service, very different approaches were postulated, such as associations, zonal licensing (and coregulation), market pressure and social norms. *"...you publicize to the community who are serving them and the requirements on such people.... They need to be branded. They need to be known. ... The other thing that can be done is the issue of zoning.... You tell them—you are supposed to work in this area and anything that comes up as malpractice, in that area they should be held responsible"*.

The positive feedback reported by pit emptiers, and potential customers, on improved working conditions were taken to indicate that safe emptying practices were likely to be followed, as they were preferred by customers. This needs to be monitored as costs, such as PPE and disinfectant, transition to pit emptiers. However, *"the challenge would be where they take the sludge after emptying"* if the utilities do not continue providing transport and covering dumping fees. There are important disincentives for safe disposal if the cost of transport is transferred to the pit emptiers.

Expectations on private sector provision remain high; *"...the private sector has been very innovative with regards to sanitation. You know the public sector is always playing catch up ... with limited resources... But the private sector, it comes with money, they are able to attract funding"*. Incentivizing compliant private sector delivery appears to be expected by all parties to be quicker to scale, and potentially more cost effective, than complete direct provision by the utility. Albeit with an awareness of the challenges, such as low levels of education, in scaling engagement of pit emptiers.

3.5. Utility: Selling the dream of fecal sludge management, and dealing with the messy reality

3.5.1. Balancing competing logics of profit and public good

Each utility is mandated to provide a safe sanitation service to all residents, with ambitious targets for complete sanitation coverage. This mandate is understood and is being acted upon, with public health improvements, urban development and investment being referenced as drivers. However, the mandate needs to be aligned with the reality of high costs and limited revenue, without which it would be challenging to develop momentum. *"As for now this has been left to the utilities to do it on their own and you know that also, we have challenges on the water side. Now to refocus, to refocus the resources to sanitation is quite a huge challenge for us"*.

As described under Section 3.2, current tariffs are set to cover only immediate cash costs of the pit emptiers and an allocation for consumables. Ultimately each senior management team expects the fecal sludge management service to fully cover at least the operational costs of emptying, transport and disposal, and some have hopes of the service becoming a revenue stream which would allow expansion. However, financial models currently indicate a disparity with affordable tariffs only covering a fraction of the operational costs for providing a basic on demand service. This gap is expected to decrease, as the service becomes more established, but remain a consequential ongoing cost to the utility.

To start to respond to this financing gap, sanitation surcharges on water bills are being developed or scaled up in both locations. Cross subsidies, between industrial and domestic consumers, high and low-income areas, water and sanitation, are under discussion. There are also high hopes for future revenue generation from resource recovery and reuse, with a dedicated waste to resource plant being constructed in Malindi and sales of soil conditioner in Livingstone.

To date political support for the mandate has been high, but funding availability has been limited. Subsidy from the central government was considered *"a long shot"* and reliance on grant, or concessional, funding from external agencies is expected over the short to medium term. In parallel there appears to be a tacit understanding that sanitation is a high-risk financial investment. Internal budget allocations predominantly target expanding the water networks. Many utility staff, even those heavily personally invested in sanitation, would prefer to fund water supply as customer demand is higher and it is easier to control payment. *"There could be a mindset to say look, it's so challenging, look, so slow. Look, we're not getting more revenues, why don't we just concentrate on water … because at the end of the day, we need to make a business out of it"*.

3.5.2. Institutional change and dealing with the disgust factor

Sanitation units are being developed within each utility to manage and run these services, with staff dedicated purely to fecal sludge management. It was initially hoped that revenues from sanitation tariffs would allow these units to be self-financing. However, as outlined above, current financial models indicate that, even if successful in building willingness to pay, providing an affordable service across each city would require substantial levels of subsidy.

SWSC and MAWASCO are managing this significant change in mandate with little in-house expertise. Resource constraints, and regulatory incentives around staff efficiency, mean that nascent sanitation units are largely resourced through internal reallocations. People are covering multiple roles to move forward the sanitation mandate. They are often moving from working in water, in which they feel comfortable and confident, to a new technical area. Shifting delivery modes, from networked supply to a non-networked on-demand service, also requires a very different skill set. The sampling process for this paper has served to illustrate how sanitation services are highly dependent on a very small core team of dedicated staff. Senior management teams noted both the rapidly growing capacity and also the very low baseline, where *"maybe in the entire utility you may find nobody has trained in sanitation"*.

Full staffing of the units is expected to progress incrementally as revenues are generated. There are risks for both current and future work as existing staff are realigned and covering multiple roles. Significant individual shifts in dealing with disgust and perceptions of fecal sludge were noted by staff moving into this area. *"Most people are comfortable talking about water, working water. But in terms of sanitation, with regards to toilets and fecal sludge.… It's one of those jobs that are looked at as a dirty job … Obviously now the mandate requires that we come out in the open and talk about it openly… So that mindset within the company also has to be changed"* A number of senior staff members noted that the sanitation units were shifting to being desirable places to work and offering potential career progression, in parallel with investment and interest from international agencies.

Extensive work has been done internally in each utility *"so that they want to buy that dream"* of fecal sludge management as a revenue stream and a career opportunity. However, sewers are still seen as the preferred option by most staff, if resources were not a limitation. Sewers are seen as modern, and networked services as easier to manage and control.

3.6. Enabling environment: Emerging legal framework

There is a complex web of regulators in each location with overlapping mandates in onsite sanitation and sometimes contradicting drivers and incentives; environmental, public health, water and sanitation, labor and urban planning. This regulatory framework is rapidly evolving as WASREB and NWASCO continue to develop guidance and standards for utilities to meet their mandates. Given the potential reluctance of utility staff and negative perception of the sector described in Section 3.5.2 these national drivers were noted as critical for change.

In both locations the primary roles and responsibilities for onsite sanitation are progressively shifting from the Public Health Department to the utility. This was perceived as positive as *"... really, when you talk of sanitation, for long it has been in the background. For it to come out as a mandate to [the utility], meaning it will now be addressed head on, and also the fact that, it will be very visible"*. However, responsibilities between Public Health departments and utility are not always clear, there is a *"thin line between mandates"*.

Some policies are not fully disseminated from the national level, creating challenges for implementation. For example, in Malindi the use of modified garden tools was initially rejected due to the prohibition on physical handling of fecal sludge, despite being supported by WASREB. Legal frameworks at the local level need to be aligned to support formal services, both promoting safe sanitation services and facilitating improved containment at the household level. In terms of containment, a particular challenge, both utilities are responsible for ensuring safe sanitation coverage. However, household latrine construction quality is controlled through the municipal government's construction permitting process. With the establishment and enforcement of clear minimum standards the municipalities could control household latrine construction quality and thereby reduce the cost for the utility to deliver safe sanitation services.

4. Discussion

The requirement for utilities to provide citywide safe sanitation is a highly challenging new mandate to protect public health and the environment. These two utilities are among some of the first in secondary cities in either country to proactively develop new services with an explicit aim of reaching all households, including those with pit latrines and in low-income areas. The MVPs developed enabled both utilities to engage with existing informal pit emptiers, potential customers and understand more clearly what it would take to reach citywide inclusive sanitation. The interventions demonstrated good practice by aiming to provide decent work (Zaqout et al., 2020) for pit emptiers whose unsafe working practices and precarious livelihoods reflect a global challenge (Oza et al., 2022).

Findings indicate that the MVP of on demand, outsourced service delivery, financed through user payments, would be very challenging to scale. It would be unlikely to reach high levels of coverage without significant levels of subsidy for both initial investment and ongoing operating costs, including building specialized skill sets within the utility. This point is not a surprise. No location has managed to rapidly reach complete safe urban sanitation coverage without extensive public investment and political support (Northover et al., 2014; Cummings et al., 2016; Peletz et al., 2020a).

As described above, the three functions of the CWIS service framework (Schrecongost et al., 2020), responsibility, accountability and resource planning and management, are still under development. The utilities are the responsible authorities executing a clear, legal mandate for inclusive urban service delivery. They are starting to be held to account for delivering this mandate. However, there is limited support for planning and managing resources and addressing barriers along the sanitation service chain. The discussion below reviews the key challenges, from household to the enabling environment from the utility perspective and tries to bring out common learnings which could be generalizable to other locations.

4.1. Selling the service to households

The challenges of selling latrine pit emptying services to households and the difficulty of understanding the real drivers for payment (Isunju et al., 2011; Jenkins et al., 2015; Burt et al., 2019; Mpanang'ombe et al., 2021) were seen through the implementation of the MVP. It is not considered possible to comment on the success or otherwise of the sales approaches trialed due to the short time period, the novelty of the service and other contributing factors, such as a global cost of living crisis (UNDP, 2022). We believe the level of interest in this new service indicates that the MVP was able to make the service understood and desirable. However, the low levels of sales, the apparent need for more flexible payment options and hands-on follow-up, indicate that the MVP was not sufficiently easy or rewarding, at least in these initial stages.

Research looking at decision making in low-income households has stressed not only managing competing priorities, but also the issue of bandwidth. Low-income households are "sophisticated economists", but cognitive capacity to deal with additional demands, such as financial planning for a one-off payment, is significantly decreased when living in a resource stressed environment (Ray and Smith, 2021). This consideration makes sense considering that, in similar settings, sanitation services have not been prioritized even when provided at a very low cost (Mpanang'ombe et al., 2021). This argument

has also been made when looking at the success of the sachet economy, which allows smaller, more frequent payments and enables households to work on daily or weekly budgets (Singh et al., 2009). For pit emptying this could look like very small installment payments for scheduled desludging (Mehta et al., 2019) or very regular partial emptying of pits. A "sachet economy" approach to marketing in low-income areas has been criticized as increasing costs to households (Borchardt et al., 2020). However, for the utility this approach could support balancing affordability and access, while increasing revenue to invest in scaling services (Agnihotri, 2013). More regular desludging also reduces the compaction of sludge, making pits easier to empty (Mills et al., 2014). Adopting this approach to pit emptying would increase costs to administer the service but may increase revenue and reliability of income to both the utility and the pit emptiers providing the service. Scheduled desludging appears to be part of frameworks under development in Zambia (IWA, 2022).

4.2. Resourcing sanitation at a citywide scale

4.2.1. Financing going to scale

The identified investment constraints align with existing research. Investment is constrained by; the high cost and low rate of return on sanitation services, the challenges of obtaining public funding for sanitation (Hutton and Chase, 2016; Perard, 2018; Acey et al., 2019; Sinharoy et al., 2019; Capone et al., 2020) and the preference to invest in water rather than sanitation (Cairncross et al., 2010; Isunju et al., 2011). Grant funding from the international development sector is left as the main source of capital investment for financing inclusive sanitation, as is common across the region (Boex and Edwards, 2014). The CWIS approach, being followed in both locations, is backed by major funders and provides an opportunity to scale onsite sanitation at a level not previously seen (Gambrill et al., 2020). However, there are potential challenges in the reliance on grant or concessional funding, with reduced control, lack of focus on long term capacity building and limited impact (Hutchings et al., 2018). In addition, as seen above, even once the initial investment is in place, sanitation services scaled to the poorest areas would be a significant ongoing operational cost.

High expectations on private sector delivery reflect a widespread narrative that the private sector is able to bring resources, expertise and efficiency into delivering sanitation services (Budds and McGranahan, 2003; Marin, 2009). Research has demonstrated that pit emptying businesses have the potential to be profitable (Mbéguéré et al., 2010; Taylor et al., 2013; Laker, 2020). There are now some examples where businesses are providing profitable and safe emptying and transport services, largely in capital cities and/or through Vacuum Tanker Operators (Chowdhry and Kone, 2012; WSUP, 2017; Peletz et al., 2020b). However, this is only one small section of the sanitation chain and the models referenced do not consider full cost recovery in terms of governance and overheads. Looking more widely in water and sanitation, the performance of the private sector does not always live up to expectations (Budds and McGranahan, 2003; Furlong, 2011; Adams et al., 2019). The assumption that private sector delivery is the preferred way to move forward should be challenged (Schaub-Jones, 2010). Bringing the pit emptiers in house, and providing the services directly, may be a more cost-effective route as it retains core services and capacities within the utility, albeit increasing risks and liability in the short term (Lonsdale, 1999; MacGillivray et al., 2006).

Waste to resource markets driving sanitation improvements is an ideal scenario where environment, public health and profit fully align (Diener et al., 2014). There is limited evidence of cost recovery from waste to resource schemes to date. A recent review identified that few cases were able to achieve more than $5/person/year from sludge reuse (Mallory et al., 2020) and other resource recovery schemes within Kenya are reliant on government investment to be viable (Mallory et al., 2022). However, to dismiss it as an opportunity would be short sighted. Waste to resource is likely to become an increasingly important part of the market in the future, as alternative fuels (Ferronato et al., 2022) or alternatives to depleting phosphorus supplies (Daneshgar et al., 2018).

4.2.2. Developing utility capacity

The sanitation units being developed incrementally within each utility are structured in line with recommendations from the regional regulatory body (ESAWAS, 2019), with staff dedicated purely to fecal sludge management and the sanitation manager reporting directly to the MD or senior manager. The continued transition of these units to desirable places of work will need support to overcome the reported feelings of disgust (Curtis et al., 2004). This raises the question—how can utility champions educate their wider organization, and external partners support a long-term transition, to *"talking shit"* with pride? This institutional change is likely to be as critical as building technical capacity. One part of the answer could be co-creating a vision of a more exciting waterless future to match the utilities' ambition. The CWIS approach has been an important step to reposition fecal sludge management as something more aspirational and leverage funding into a wider range of sanitation options (Gambrill et al., 2020). As a next step perhaps, we need to demonstrate how fecal sludge management is not just a stepping-stone to sewers but leapfrogging to something much more sophisticated, in line with national visions of modernity. A compelling vision might support utility capacity and support selling the current service.

4.3. Regulatory frameworks: The utility as regulator and regulated

4.3.1. Regulation of the utility

The findings underline the importance of clear regulation and allocation of roles and responsibilities (Mumssen and Saltiel, 2018; ESAWAS, 2021a,b; Lerebours et al., 2021a). The potential benefits of increased cross subsidy (Acey et al., 2019) and visibility from combined water and sanitation mandates, align with positive traits identified in recent ESAWAS publications (ESAWAS, 2021b, 2022). However, some aspects of existing regulation may push utilities to take short term decisions and slow scale-up. For example, the staffing efficiency targets set by both WASREB and NWASCO do not allow for the increased human resources needed for a new sanitation service. Ranking a utility against cost coverage does not incentivize the investment needed to scale fecal sludge management services, which provide limited initial revenue. Both SWSC and MAWASCO scored low in these two areas in the most recent regulators' sector reports and cited this as a concern even as they perform well on sanitation benchmarks. Given the time and investment needed to build the service, safe pit emptying services may need to be developed while fecal sludge treatment sites are being built. It would be useful to consider how regulation could support incremental improvements and de-risk scaling services for utilities. For example, by giving exemptions for services below a certain scale, or at an early stage of development, or support to overcome local resistance to transfer stations (a common challenge as illustrated by Holm et al., 2021).

4.3.2. Utility as a regulator

In the outsourced arrangement expected, at least in the short to medium term, the utility would be regulating the activity of pit emptiers. The positive engagement from pit emptiers described in the findings was also reported by Lerebours et al. (2021b) in multiple locations across sub-Saharan Africa. As discussed, command and control (Baldwin et al., 2011) seems to be a preferred approach by both utilities, which is typical for areas where the impact of non-compliance on public health and the environment would be high (Taylor et al., 2019). However, utilities' suggestions for future regulation at scale are closer to less traditional "Smart" approaches (Drahos, 2017, p. 133), being much wider ranging and including the use of financial and non-financial incentives, self-regulation and co-regulation approaches, and information and education schemes.

Regulating this section of the sanitation chain is complicated by the need to reconcile two very different types of service; emptying and transport/disposal. The customer facing emptying services can be considered a retail service, with private benefits to both customers and pit emptiers (Evans, 2007). As outlined in the findings, there are some clear potential motivators for pit emptiers to be visibly regulated and adopt safe emptying practices, both from increasing customer base and hence revenue, and also increased personal safety and social status. If it could be verified that pit emptiers really have adopted safe emptying practices, and are using this to generate business, it would be a great success of the MVP to date. Safe transport and disposal of fecal sludge, conversely, is effectively a hidden wholesale service with significant public benefits, but private costs (Evans, 2007). The reported concern from utilities around continued unsafe disposal appears reasonable. The incentives for pit emptiers to comply with safe transport and disposal practices are weak (Peal et al., 2020); there are indeed serious financial disincentives which may outweigh income generated through providing the service. Burying on site is low cost and difficult to prevent where population densities are low, particularly relevant for secondary cities. A heavy-handed approach to enforcement may force pit emptiers out of the market entirely, or back into nighttime emptying and cheaper informal practices.

More innovative approaches to regulation by the utility could be informed by the findings, which indicate that non-financial motivations are an important part of any change. The findings that pit emptiers may be looking for security of income, rather than maximizing revenue, is supported by recent work on concepts of formalization (Gallien and van den Boogaard, 2021). Developing research which considers informal workers as social actors, as well as financial actors, identifies that trust, both peer to peer and vertically with the authorities, is a strong driver of compliance (Williams and Oz-Yalaman, 2020). This is reflected in the reported self-perception of pit emptiers, as front-line workers providing a social good, and in their reported motivations which map closely to the basic human motives of comfort, affiliation and status identified by Aunger and Curtis (2013).

More innovative approaches to regulation are touted as potentially reducing costs and improving compliance (Drahos, 2017, p. 30). They have been developed for environmental regulation in Europe (Taylor et al., 2013, 2019) and are recommended for regulating informal and hard to control markets such as street vendors (Song, 2020). This more innovative approach may be needed given the challenges identified; the private costs for service providers are high, enforcement capacity may be weak and there may be substantial disincentives to comply (Mumssen and Saltiel, 2018; Peal et al., 2020; Lerebours et al., 2021b).

5. Conclusion

This paper extends existing understanding of the challenges faced in scaling safe fecal sludge emptying and transport services. It confirms many previous findings around the high cost of safe sanitation services in low-income areas, the barriers of emptiability, the engagement of manual pit emptiers and the requirement for investment in supporting systems. The

research documents for the first time in the region the challenges of dealing with disgust in establishing these new services and the conflicting role of public utilities as both commercial and social organizations.

The review of challenges and successes through the initial stages of establishing pit emptying services in these two cities have identified a number of shared issues. In large part the findings have confirmed and added to existing understanding of the challenges and triggers in establishing safe fecal sludge management services. A number of areas were identified which require further research and may be relevant for others.

If household bandwidth to plan and order pit emptying services does prove to be a significant factor then very different approaches to providing pit emptying services would be more effective. A routine service provided with minimal effort required on the part of the customer and much smaller, but more regular charges.

The findings reinforce the reported willingness of pit emptiers to be regulated, but also indicate a more nuanced picture requiring regulators (in this case the utility) to understand motivations and take a holistic view of livelihoods. Non-financial motivations and relationships, between the pit emptiers and also between pit emptiers and the utility may be an important element. Future research could develop a clearer picture on structures of financial engagement for pit emptiers to ensure decent work and what non-financial interventions might be effective in increasing compliance.

The model of grant funding for initial service establishment and then private sector delivery reducing risk and cost burden on the public sector is politically viable and appears currently to be the most feasible route for the utilities to follow. The findings indicate that this model is likely to leave the utility unable to scale sanitation to low-income areas and does not align with the stated mandate of complete safe sanitation coverage. As utilities move into this regulatory role, further research into what regulatory structures might be appropriate for utilities with low enforcement capacity, but potentially wide social reach, may help to address this issue. However, the policy choice not to subsidize sanitation, in the same way that other sectors are routinely subsidized such as agriculture or education, bears inspection. Alongside the national funding models, regulation needs to support incremental change and be adapted to promote risk taking and investment in the human resources needed for scale.

This research is likely to be relevant for secondary cities with similar socio-economic conditions, urbanization, water and sanitation access, and levels of linked overseas development aid (cluster 5 in Onda et al., 2014), similar institutional arrangements for water and sanitation (combined mandates under a utility and an independent regulator) and relatively high levels of political support for improved sanitation services. It is hoped that the research will be useful for the regional water and sanitations regulators association.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Cranfield University Research Ethics System (CURES/14895/2021). The participants provided their written informed consent to participate in this study.

Author contributions

CG was solely responsible for the data collection, data analysis, and drafting the article. AP, EH, GS, JP, LH, and PO contributed equally and were closely involved in the conception and design of the work, interpreting the data collected, critical review, and revision of the article. All authors contributed to the article and approved the submitted version.

Funding

This research was funded by UKRI Engineering and Physical Sciences Research Council (EPSRC grant number EP/S022066/1) through the Center for Doctoral Training in Water and Waste Infrastructure and Services Engineered for Resilience. The MVP and associated work reviewed as part of this paper was funded through the TRANSFORM Utilities Intrapreneur Sanitation Challenge. TRANSFORM is a joint initiative between Unilever, the FCDO and EY.

Acknowledgments

The authors wish to acknowledge the support and contributions of all organizations involved in this work; SWSC, MAWASCO and their implementing partners, the teams at TRANSFORM, WSUP, and Sanivation.

Conflict of interest

CG, PO, EH, JP, GS, and LH were part of the implementation team for the pilot project reviewed in this paper. CG is part time staff at WSUP and was a programs advisor for this work. JP and GS are engaged as technical specialists at WSUP and lead the WSUP teams on this project in Zambia and Kenya respectively. EH is SWSC Community Relations Officer and led the work in Livingstone. PO is Head of Sanitation and Programs at MAWASCO and led the work in Malindi. LH is an employee of UNILEVER and the grant manager.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frwa.2022.1055227/full#supplementary-material

References

Acey, C., Kisiangani, J., Ronoh, P., Delaire, C., Makena, E., Norman, G., et al. (2019). Cross-subsidies for improved sanitation in low income settlements: assessing the willingness to pay of water utility customers in Kenyan cities. *World Dev.* 115, 160–177. doi: 10.1016/j.worlddev.2018.11.006

Adams, E. A., Sambu, D., and Smiley, S. L. (2019). Urban water supply in Sub-Saharan Africa: historical and emerging policies and institutional arrangements. *Int. J. Water Resour. Dev.* 35, 240–263. doi: 10.1080/07900627.2017.1423282

Agnihotri, A. (2013). Doing good and doing business at the bottom of the pyramid. *Bus. Horizons* 56, 591–599. doi: 10.1016/j.bushor.2013.05.009

Akinyi, E., Foote, A., Bohnert, K., Oyamo, P., and Oluoch, P. (2021). *Towards a Cleaner and more Productive Malindi and Watamu: A City-Wide Inclusive Sanitation and Municipal Solid Waste Plan*. MAWASCO. Available online at: https://www.wsup.com/insights/towards-a-cleaner-and-more-productive-malindi-and-watamu/ (accessed December 14, 2022).

Aunger, R., and Curtis, V. (2013). The anatomy of motivation: an evolutionary-ecological approach. *Biol. Theory* 8, 49–63. doi: 10.1007/s13752-013-0101-7

Baldwin, R., Cave, M., and Lodge, M. (2011). *Understanding Regulation: Theory, Strategy, and Practice*. Oxford, Oxford University Press.

Boex, J., and Edwards, B. (2014). *Triggering Increased City-Level Public Finance for Pro-Poor Sanitation Improvements: The Role of Political Economy and Fiscal Instruments. Research Report*. Urban Institute. Available at: https://webarchive.urban.org/UploadedPDF/2000063-triggering-increased-city-level-public-finance.pdf (accessed December 14, 2022).

Borchardt, M., Ndubisi, N. O., Jabbour, C. J. C., Grebinevych, O., and Pereira, G. M. (2020). The evolution of base of the pyramid approaches and the role of multinational and domestic business ventures: value-commitment and profit-making perspectives. *Indust. Mark. Manag.* 89, 171–180. doi: 10.1016/j.indmarman.2019.05.013

Budds, J., and McGranahan, G. (2003). Are the debates on water privatization missing the point? Experiences from Africa, Asia and Latin America. *Environ. Urbaniz.* 15, 87–114. doi: 10.1177/095624780301500222

Burt, Z., Sklar, R., and Murray, A. (2019). Costs and willingness to pay for pit latrine emptying services in Kigali, Rwanda. *Int. J. Environ. Res. Public Health* 16, 4738. doi: 10.3390/ijerph16234738

Cairncross, S., Bartram, J., Cumming, O., and Brocklehurst, C. (2010). Hygiene, sanitation, and water: what needs to be done? *PLoS Med.* 7, e1000365. doi: 10.1371/journal.pmed.1000365

Capone, D., Buxton, H., Cumming, O., Dreibelbis, R., Knee, J., Nalá, R., et al. (2020). Impact of an intervention to improve pit latrine emptying practices in low income urban neighborhoods of Maputo, Mozambique. *Int. J. Hyg. Environ. Health* 226, 113480. doi: 10.1016/j.ijheh.2020.113480

Chowdhry, S., and Kone, D. (2012). *Business Analysis of Fecal Sludge Management: Emptying and Transportation Services in Africa and Asia*. Seattle, WA: The Bill and Melinda Gates Foundation.

Cummings, C., Langdown, I., Hart, T., Lubuva, J., and Kisela, H. (2016). *What Drives Reform? Making Sanitation a Political Priority in Secondary Cities*. London: Overseas Development Institute.

Curtis, V., Aunger, R., and Rabie, T. (2004). Evidence that disgust evolved to protect from risk of disease. *Proc. R. Soc. London. B Biol. Sci.* 271(Suppl. 4), S131–S133. doi: 10.1098/rsbl.2003.0144

Daneshgar, S., Callegari, A., Capodaglio, A. G., and Vaccari, D. (2018). The potential phosphorus crisis: resource conservation and possible escape technologies: a review. *Resources* 7, 37. doi: 10.3390/resources7020037

Daoust, G., and Dyvik, S. L. (2022). Reconceptualizing vulnerability and safeguarding in the humanitarian and development sector. *Soc. Polit. Int. Stud. Gender State Soc.* 29, 355–378. doi: 10.1093/sp/jxaa040

Dickin, S., Bayoumi, M., Giné, R., Andersson, K., and Jiménez, A. (2020). Sustainable sanitation and gaps in global climate policy and financing. *NPJ Clean Water* 3, 1–7. doi: 10.1038/s41545-020-0072-8

Diener, S., Semiyaga, S., Niwagaba, C. B., Muspratt, A. M., Gning, J. B., Mbéguéré, M., et al. (2014). A value proposition: resource recovery from fecal sludge—Can it be the driver for improved sanitation? *Resour. Conserv. Recycl.* 88, 32–38. doi: 10.1016/j.resconrec.2014.04.005

Drahos, P. (2017). *Regulatory Theory: Foundations and Applications*. ANU Press. doi: 10.22459/RT.02.2017

ESAWAS (2019). *Regulation Strategy and Framework for Inclusive Urban Sanitation Service Provision Incorporating non Sewered Sanitation Services*. Eastern and Southern Africa Water and Sanitation Regulators Association. Available online at: https://www.esawas.org/index.php/pt/publications/sanitation/download/8-sanitation/26-regulation-framework-and-strategy-for-inclusive-urban-sanitation-service-provision (accessed December 14, 2022).

ESAWAS (2021a). *Citywide Inclusive Sanitation: How Can Accountability be Strengthened? Citywide Inclusive Urban Sanitation Series*. Available online at: https://www.esawas.org/index.php/publications/sanitation (accessed May 28, 2022).

ESAWAS (2021b). *Citywide Inclusive Sanitation: Who is Responsible? Citywide Inclusive Urban Sanitation Series*. Available online at: https://www.esawas.org/index.php/publications/sanitation (accessed May 28, 2022).

ESAWAS (2022). *The Water Supply and Sanitation Regulatory Landscape Across Africa—Continent Wide Synthesis Report*. East and Southern Africa Water and Sanitation Regulators Association. Available online at: https://esawas.org/index.php/publications/general/download/2-general/61-esawas-report2022 (accessed December 14, 2022).

Evans, B. (2007). *Understanding the Urban Poor's Vulnerabilities in Sanitation and Water Supply*. Bellagio: Innovations for an Urban World, the Rockefeller Foundation's Urban Summit.

Ferronato, N., Mendoza, I. J. C., Portillo, M. A. G., Conti, F., and Torretta, V. (2022). Are waste-based briquettes alternative fuels in developing countries? A critical review. *Energy Sustain. Dev.* 68, 220–241. doi: 10.1016/j.esd.2022.03.013

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualit. Inquiry* 12, 219–245. doi: 10.1177/1077800405284363

Forbat, L., and Henderson, J. (2005). Theoretical and practical reflections on sharing transcripts with participants. *Qualit. Health Res.* 15, 1114–1128. doi: 10.1177/1049732305279065

Fry, L. M., Mihelcic, J. R., and Watkins, D. W. (2008). Water and nonwater-related challenges of achieving global sanitation coverage. *Environ. Sci. Technol.* 42, 4298–4304. doi: 10.1021/es7025856

Furlong, K. (2011). Neoliberal water management: trends, limitations, reformulations. *Environ. Soc.* 1, 46–75. doi: 10.3167/ares.2010.010103

Gallien, M., and van den Boogaard, V. (2021). *Rethinking Formalisation: A Conceptual Critique and Research Agenda*. ICTD WORKING PAPER 127, Institute of Development Studies. doi: 10.19088/ICTD.2021.016

Gambrill, M., Gilsdorf, R. J., and Kotwal, N. (2020). Citywide inclusive sanitation—business as unusual: shifting the paradigm by shifting minds. *Front. Environ. Sci.* 201, e00201. doi: 10.3389/fenvs.2019.00201

Grant, R. (2015). Cities of the future: reflections from Africa, India, and North America. *Am. Behav. Sci.* 59, 287–293. doi: 10.1177/0002764214550300

Greene, N., Hennessy, S., Rogers, T. W., Tsai, J., and Francis, I. I. I., L. (2021). The role of emptying services in provision of safely managed sanitation: a classification and quantification of the needs of LMICs. *J. Environ. Manag.* 290, 112612. doi: 10.1016/j.jenvman.2021.112612

Halcomb, E. J., and Davidson, P. M. (2006). Is verbatim transcription of interview data always necessary? *Appl. Nurs. Res.* 19, 38–42. doi: 10.1016/j.apnr.2005.06.001

Hicks, N., Millar, R. J., Girling, L. M., Yamashita, T., and Cummins, P. A. (2021). Conducting virtual qualitative interviews with international key informants: insights from a research project. *Qualit. Rep.* 26, 2857–2871. doi: 10.46743/2160-3715/2021.4909

Holm, R. H., Chunga, B. A., Mallory, A., Hutchings, P., and Parker, A. (2021). A qualitative study of NIMBYism for waste in smaller urban areas of a low-income country, Mzuzu, Malawi. *Environ. Health Insights* 15, 1178630220984147. doi: 10.1177/1178630220984147

Holmes, A. G. D. (2020). Researcher positionalit—a consideration of its influence and place in qualitative researc—a new researcher guide. *Shanlax Int. J. Educ.* 8, 1–10. doi: 10.34293/education.v8i4.3232

Hussmanns, R. (2004). "Statistical definition of informal employment: Guidelines endorsed by the Seventeenth International Conference of Labour Statisticians (2003)," in *7th Meeting of the Expert Group on Informal Sector Statistics (Delhi Group)*. p. 2–4.

Hutchings, P., Johns, M., Jornet, D., Scott, C., and Van den Bossche, Z. (2018). A systematic assessment of the pro-poor reach of development bank investments in urban sanitation. *J. Water Sanit. Hyg. Dev.* 8, 402–414. doi: 10.2166/washdev.2018.147

Hutton, G., and Chase, C. (2016). The knowledge base for achieving the sustainable development goal targets on water supply, sanitation and hygiene. *Int. J. Environ. Res. Public Health* 13, 536. doi: 10.3390/ijerph13060536

Hutton, G., Haller, L., and Bartram, J. (2007). Global cost-benefit analysis of water supply and sanitation interventions. *J. Water Health* 5, 481–502. doi: 10.2166/wh.2007.009

Isunju, J. B., Schwartz, K., Schouten, M. A., Johnson, W. P., and van Dijk, M. P. (2011). Socio-economic aspects of improved sanitation in slums: a review. *Public Health* 125, 368–376. doi: 10.1016/j.puhe.2011.03.008

IWA (2022). *Regulation as a Means to Ensuring CWIS in Zambia. Inclusive Urban Sanitation Stories*. International Water Association. Available online at: https://iwa-network.org/wp-content/uploads/2022/08/3-Regulation-as-a-means-to-achieving-CWIS-in-Zambia.pdf (accessed December 14, 2022).

Jenkins, M. W., Cumming, O., and Cairncross, S. (2015), Pit latrine emptying behavior and demand for sanitation services in Dar Es Salaam, Tanzania. *Int. J. Environ. Res. Public Health* 12, 588. doi: 10.3390/ijerph120302588

JMP (2022). *Progress on Drinking Water, Sanitation and Hygiene in Africa 2000-2020: Five Years Into the SDGs*. New York, NY: United Nations Children's Fund (UNICEF) and World Health Organization (WHO)

Kuzel, A. J. (1992). "Sampling in qualitative inquiry," in *Doing Qualitative Research*, eds B. F. Crabtree and W. L. Miller (Sage Publications, Inc), 31–44.

Laker, F. (2020). Assessment of sustainable business model for improved fecal sludge emptying and transport in informal settlements. A case of Kampala city, Uganda. *Habitat Int. Vol.* 125, 102596. doi: 10.25831/qj8q-gq57

Lawrence, J., Rasche, A., and Kenny, K. (2019). "Sustainability as opportunity: Unilever's sustainable living plan," in G. G. Lenssen, and N. C. Smith (Eds.), *Managing Sustainable Business* (Dordrecht: Springer), 435–455. doi: 10.1007/978-94-024-1144-7_21

Lenarduzzi, V., and Taibi, D. (2016). "MVP explained: a systematic mapping study on the definitions of minimal viable product," in *2016 42th Euromicro Conference on Software Engineering and Advanced Applications (SEAA)*. IEEE, 112–119. doi: 10.1109/SEAA.2016.56

Lerebours, A., Scott, R., and Sansom, K. (2021b). Private emptiers' perspectives on the regulation of fecal sludge emptying services in Sub-Saharan Africa. *J. Water Sanit. Hyg. Dev.* 11, 785–793. doi: 10.2166/washdev.2021.026

Lerebours, A., Scott, R., Sansom, K., and Kayaga, S. (2021a). Regulating sanitation services in sub-saharan africa: an overview of the regulation of emptying and transport of fecal sludge in 20 cities and its implementation. *Utilities Policy* 73, 101315. doi: 10.1016/j.jup.2021.101315

Lonsdale, C. (1999). Effectively managing vertical supply relationships: a risk management model for outsourcing, *Supply Chain Manage.* 4, 176. doi: 10.1108/13598549910284499

MacGillivray, B. H., Hamilton, P. D., Strutt, J. E., and Pollard, S. J. (2006). Risk analysis strategies in the water utility sector: an inventory of applications for better and more credible decision making. *Crit. Rev. Environ. Sci. Technol.* 36, 85–139. doi: 10.1080/10643380500531171

Mallory, A., Holm, R., and Parker, A. (2020). A review of the financial value of fecal sludge reuse in low-income countries. *Sustainability* 12, 8334. doi: 10.3390/su12208334

Mallory, A., Mdee, A., Agol, D., Hyde-Smith, L., Kiogora, D., Riungu, J., et al. (2022). The potential for scaling up container-based sanitation in informal settlements in Kenya. *J. Int. Dev.* 34, 3639 doi: 10.1002/jid.3639

Mallory, A., Omoga, L., Kiogora, D., Riungu, J., Kagendi, D., and Parker, A. (2021). Understanding the role of informal pit emptiers in sanitation in Nairobi through case studies in Mukuru and Kibera settlements. *J. Water Sanit. Hyg. Dev.* 11, 51–59. doi: 10.2166/washdev.2020.193

Marin, P. (2009). *Public-Private Partnerships for Urban Water Utilities: A Review of Experiences in Developing Countries. Trends and Policy Options*; *no. 8*. World Bank. doi: 10.1596/978-0-8213-7956-1

Mbéguéré, M., Gning, J. B., Dodane, P. H., and Koné, D. (2010). Socio-economic profile and profitability of faecal sludge emptying companies. *Resour. Conserv. Recycl.* 54, 1288–1295. doi: 10.1016/j.resconrec.2010.04.008

Mehta, M., Mehta, D., and Yadav, U. (2019). Citywide inclusive sanitation through scheduled desludging services: emerging experience from India. *Front. Environ. Sci.* 7, 188. doi: 10.3389/fenvs.2019.00188

Melis Cin, F., Madge, C., Long, D., Breines, M., and Tapiwa Beatrice Dalu, M. (2021). Transnational online research: recognizing multiple contexts in Skype-to-phone interviews. *Qualit. Res.* 14687941211024824. doi: 10.1177/14687941211024824

Mills, F., Blackett, I., and Tayler, K. (2014). "Assessing on-site systems and sludge accumulation rates to understand pit emptying in Indonesia," in *WEDC 37th International Conference*, Hanoi, Vietnam.

Mpanang'ombe, W., Bray, B., and Tilley, E. (2021). Pit emptying subsidy vouchers: a two-phased targeting and structuring experiment in Blantyre, Malawi. *Int. J. Urban Sustain. Dev.* 13, 1–16. doi: 10.1080/19463138.2021.1981910

Mumssen, Y., and Saltiel, G. (2018). *Aligning Institutions and Incentives for Sustainable Water Supply and Sanitation Services: Report of the Water Supply and Sanitation Global Solutions Group, Water Global Practice*. Washington, DC: World Bank.

Northover, H., Ryu, S. K., Brewer, T., and Ryu, S. K. (2014). *Achieving Total Sanitation and Hygiene Coverage Within a Generation: Lessons from East Asia*. London: WaterAid, 1–9.

NWASCO (2021). *Urban and Peri-Urban Water Supply and Sanitation Sector Report 2021*. NWASCO. Available online at: https://www.nwasco.org.zm/index.php/media-center/publications/urban-and-peri-urban-wss-sector-reports?task=download.send&id=81&catid=12&m=0 (accessed December 14, 2022).

Öberg, G., Metson, G. S., and Kuwayama, Y., and, A., Conrad, S. (2020). Conventional sewer systems are too time-consuming, costly and inflexible to meet the challenges of the 21st century. *Sustainability* 12, 6518. doi: 10.3390/su12166518

Onda, K., Crocker, J., Kayser, G. L., and Bartram, J. (2014). Country clustering applied to the water and sanitation sector: a new tool with potential applications in research and policy. *Int. J. Hyg. Environ. Health* 217, 379–385. doi: 10.1016/j.ijheh.2013.07.017

Oza, H. H., Lee, M. G., Boisson, S., Pega, F., Medlicott, K., and Clasen, T. (2022). Occupational health outcomes among sanitation workers: a systematic review and meta-analysis. *Int. J. Hyg. Environ. Health* 240, 113907. doi: 10.1016/j.ijheh.2021.113907

Peal, A., Evans, B., Ahilan, S., Ban, R., Blackett, I., Hawkins, P., et al. (2020). Estimating safely managed sanitation in urban areas; lessons learned from a global implementation of excreta-flow diagrams. *Front. Environ. Sci.* 8, 1. doi: 10.3389/fenvs.2020.00001

Peal, A., Evans, B., Blackett, I., Hawkins, P., and Heymans, C. (2014). Fecal sludge management: a comparative analysis of 12 cities. *J. Water Sanit. Hyg. Dev.* 4, 563–575. doi: 10.2166/washdev.2014.026

Peletz, R., Feng, A., MacLeod, C., Vernon, D., Wang, T., Kones, J., et al. (2020b). Expanding safe fecal sludge management in Kisumu, Kenya: an experimental comparison of latrine pit-emptying services. *J. Water Sanit. Hyg. Dev.* 10, 744–755. doi: 10.2166/washdev.2020.060

Peletz, R., MacLeod, C., Kones, J., Samuel, E., Easthope-Frazer, A., Delaire, C., et al. (2020a). When pits fill up: Supply and demand for safe pit-emptying services in Kisumu, Kenya. *PLoS ONE* 15, e0238003. doi: 10.1371/journal.pone.0238003

Perard, E. (2018). Economic and financial aspects of the sanitation challenge: a practitioner approach. *Utilities Policy* 52, 22–26. doi: 10.1016/j.jup.2018.03.007

QSR International Pty Ltd. (2020). *NVivo (released in March 2020)*. Available online at: https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home

Ray, I., and Smith, K. R. (2021). Towards safe drinking water and clean cooking for all. *Lancet Global Health* 9, e361–e365. doi: 10.1016/S2214-109X(20)30476-9

Roberts, B. (2014). *Managing Systems of Secondary Cities*. Brussels: Cities Alliance.

Sarna-Wojcicki, D., Perret, M., Eitzel, M. V., and Fortmann, L. (2017). Where are the missing coauthors? Authorship practices in participatory research. *Rural Sociol.* 82, 713–746. doi: 10.1111/ruso.12156

Schaub-Jones, D. (2010). Should we view sanitation as just another business? The crucial role of sanitation entrepreneurship and the need for outside engagement. *Enterp. Dev. Microfinance* 21, 185–204. doi: 10.3362/1755-1986.2010.017

Schrecongost, A., Pedi, D., Rosenboom, J. W., Shrestha, R., and Ban, R. (2020). Citywide inclusive sanitation: a public service approach for reaching the urban sanitation SDGs. *Front. Environ. Sci.* 8, 19. doi: 10.3389/fenvs.2020.00019

Singh, R., Ang, R. P., and Sy-Changco, J. A. (2009). Buying less, more often: an evaluation of sachet marketing strategy in an emerging market. *Mark. Rev.* 9, 3–17. doi: 10.1362/146934709X414297

Sinharoy, S. S., Pittluck, R., and Clasen, T. (2019). Review of drivers and barriers of water and sanitation policies for urban informal settlements in low-income and middle-income countries. *Utilities Policy* 60, 100957. doi: 10.1016/j.jup.2019.100957

Song, S. (2020). Street stall economy in China in the post-COVID-19 era: dilemmas and regulatory suggestions. *Res. Globaliz.* 2, 100030. doi: 10.1016/j.resglo.2020.100030

Stiles, W. B. (1993). Quality control in qualitative research. *Clin. Psychol. Rev.* 13, 593–618. doi: 10.1016/0272-7358(93)90048-Q

Taylor, C. M., Gallagher, E. A., Pollard, S. J., Rocks, S. A., Smith, H. M., Leinster, P., et al. (2019). Environmental regulation in transition: policy officials' views of regulatory instruments and their mapping to environmental risks. *Sci. Total Environ.* 646, 811–820. doi: 10.1016/j.scitotenv.2018.07.217

Taylor, C. M., Pollard, S. J. T., Angus, A. J., and Rocks, S. A. (2013). Better by design: rethinking interventions for better environmental regulation. *Sci. Total Environ.* 447, 488–499. doi: 10.1016/j.scitotenv.2012.12.073

Tilley, E., and Kalina, M. (2021). "My flight arrives at 5 am, can you pick me up?": the gatekeeping burden of the African academic. *J. Afr. Cult. Stud.* 33, 538–548. doi: 10.1080/13696815.2021.1884972

UNDP (2022). *Addressing the Cost-of-Living Crisis in Developing Countries: Poverty and Vulnerability Projections and Policy Responses*. United Nations High-Level Political Forum on Sustainable Development (HLPF). Available online at: https://www.undp.org/sites/g/files/zskgke326/files/2022-07/Addressing-the-cost-of-living-crisis-in-vulnerable-countries.pdf (accessed December 14, 2022).

UNICEF. (2022). *Diarrhoea Remains a Leading Killer of Young Children, Despite the Availability of a Simple Treatment Solution, Child Health: Diarrhoea*. UNICEF. Available online at: https://data.unicef.org/topic/child-health/diarrhoeal-disease/ (accessed December 14, 2022).

Vong, S. (2021). From dispositions to positionality: addressing dispositions of the student researcher in the ACRL framework. *J. Acad. Librarianship* 47, 102457. doi: 10.1016/j.acalib.2021.102457

WASREB (2022). *Impact Report 14, A Performance Report of Kenya's Water Services Sector – 2020/21*. WASREB. Available online at: https://wasreb.go.ke/impact-report-issue-no-14/ (accessed December 14, 2022).

Williams, C., and Oz-Yalaman, G. (2020). Explaining the informal economy in Western Europe: beyond a rational economic actor perspective. *J. Econ. Stud.* 48, 1084–1096. doi: 10.1108/JES-05-2020-0233

WSUP. (2017). *A Guide to Strengthening the Enabling Environment for Faecal Sludge Management, WSUP Insights*. Available online at: https://www.wsup.com/content/uploads/2017/11/Guide-to-strengthening-the-enabling-environment-for-FSM_final.pdf (accessed December 14, 2022).

Yin, R. K. (2009). *Case Study Research: Design and Methods (Vol. 5)*. Sage.

Zaqout, M., Cawood, S., Evans, B. E., and Barrington, D. J. (2020). Sustainable sanitation jobs: prospects for enhancing the livelihoods of pit-emptiers in Bangladesh. *Third World Quart.* 42, 329–347. doi: 10.1080/01436597.2020.1810560