BUILDING CONTEXT-SPECIFIC SANITATION BUSINESS MODELS IN EASTERN DRC

An initial assessment of cost-effective sanitation delivery

A view of part of the city of Bukavu, North Kivu Province. Photo credit: Sanergy

I.   CONTEXT

Addressing the needs of the most vulnerable populations is a crucial challenge in the sanitation sector. Traditionally, initiatives aimed at improving access to sanitation have focused on the construction of containment infrastructure, such as latrines, and treatment infrastructure, such as large-scale wastewater treatment plants. Additionally, efforts have been made to promote behavioral change at both the household and community levels through the implementation of Community-led Total Sanitation (CLTS) programs.

Despite progress achieved through various innovations, the results have been mixed. A systematic review revealed that most sanitation interventions had only a minor impact on improving latrine coverage and utilization across all populations[1]. The application of market-based approaches has garnered considerable attention worldwide, but there is limited knowledge regarding the integration of demand creation and market-based sanitation in the context of Bukavu, a city situated in the South Kivu Province of the

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[1] Plan International UK, SNV, UNICEF, WaterAid, World Bank, and WSSCC. 2019. A Call to Action: Delivering Rural Sanitation Programs at Scale, with Equity and Sustainability

Democratic Republic of Congo (DRC). This region is characterized by hilly terrain and experiences prolonged periods of rainfall, which exacerbates the risk of flooding and landslides, and adds complexity to the provision of sanitation services. Additionally, there is a lack of evidence on the implementation of cost-effective and sustainable sanitation service delivery systems that engage key stakeholders such as governmental bodies, regulatory authorities, and private sector entities.

In response to the efforts of the local authorities in South Kivu, in the eastern DRC, to improve sanitation services, USAID's Sustainable Water and Sanitation Systems Activity (SWASSA), led by Sanergy as part of a consortium that includes Mercy Corps and Tetra Tech, conducted a sanitation assessment to obtain a comprehensive understanding of the current sanitation situation in Bukavu. The assessment sought to identify an optimal location for piloting comprehensive sanitation services that guarantee safe management throughout the entire sanitation value chain.

Container-Based Sanitation (CBS) services have been successfully implemented in various low-income urban communities worldwide, offering sanitation solutions in areas where traditional systems face logistical and environmental challenges. The suitability of each CBS model is influenced by several location-specific factors, such as local topography, vulnerability to flooding, water table, and ground infiltration rates, among other geographical conditions. Additionally, factors such as the acceptability of having a toilet within the dwelling, handling sealed containers of human excreta, the availability and proximity of the required space for a waste transfer station or treatment facility, and existing facilities with sufficient capacity play a crucial role. Other important considerations include high population density, ease of access, settlement size, and the ability and willingness to pay for sanitation services. Determining the optimal location for a CBS pilot necessitates also an effective method for collecting customer tariffs and assessing the financial capacity and density of the potential customer base.

To minimize potential risks, specific CBS business models incorporating integrated affordability, demand creation, and market-based activities are incorporated based on the assessment objective. CBS models involve collecting human excreta in sealable and removable containers that are transported to treatment facilities. This type of sanitation system offers a commercial service that provides portable toilets and replaces them with empty containers when full. The service safely disposes or reuses the collected excreta, with the cost of collection typically borne by users. CBS can be an effective and cost-efficient solution for providing low-income urban populations with safe collection, transportation, and treatment of excrement, compared to installing and maintaining sewers. These models aimed to stimulate demand for sanitation services by delivering an unparalleled level of service and customer satisfaction, and to promote market-based approaches to addressing sanitation challenges in the target zones.

II.   EVALUATION METHODOLOGY

Figure 1. Bukavu sanitation coverage map

Locally led development is vital to achieving sustainable sanitation. The team started by adjusting their expectations for the results to allow sufficient time for local actors to take ownership of the process. Identifying a pilot zone is crucial to determine the most suitable strategic location for an iterative pilot. A comprehensive assessment was conducted across the entire city of Bukavu to understand the sanitation situation and to select a specific zone for piloting full-value-chain sanitation services. Each of the 13 districts in Bukavu's three Communes was assigned a score using a Likert scale established for population density, urban vs. rural areas, presence of existing waste operators, accessibility based on the number of existing roads and their penetration, level of informality of settlements, local authority and stakeholder priorities, proximity to Mercy Corps offices for operations management, and proximity to waste treatment sites.

The Sanergy team employed geographic information system (GIS) mapping to evaluate the accessibility and proximity of districts in Bukavu to potential waste treatment sites. They also used GIS mapping to identify the city's existing and planned water and sewage infrastructure, sanitation coverage, and solid waste collection services. Additionally, the team applied geographic analysis to determine the types and coverage of sanitation infrastructure and services in Bukavu.

Through key informant interviews (KII), the Sanergy team conducted qualitative analyses to gather data on current waste flows in Bukavu across the entire value chain from 36 public and private sector stakeholders. Furthermore, reconnaissance visits allowed the team to gain a comprehensive understanding of the layout, density, informality, and overall atmosphere of all the identified districts through GIS mapping and stakeholder engagement.

The Nyamugo and Keredi districts in Bukavu City, South Kivu Province, were selected for in-depth quantitative data collection based on an initial assessment of the entire city. The assessment utilized a variety of methods, including GIS mapping, stakeholder engagement centered around Shit Flow Diagram (SFD) workshops, and reconnaissance visits, to gather both qualitative and quantitative data. This information was then used to assign a score, utilizing a Likert scale, to each of the eight criteria to identify the most appropriate location for the pilot of a full-value-chain sanitation service. The criteria used to determine the districts' suitability included population density, urban or rural nature of the districts, presence of existing waste operators, accessibility based on the number of existing roads and their penetration, level of informality of settlements, local authority and stakeholder priorities, proximity to Mercy Corps offices for operations management, and proximity to waste treatment sites.

Based on the outcomes of the initial evaluation, Keredi in Ibanda Commune and Nyamugo in Kadutu Commune were selected as potential sites for the pilot project. A more detailed assessment (the main subject of this learning brief) was subsequently conducted to determine which of the two locations was the most suitable for the pilot. This entailed gathering primary data through a household survey, direct observation, and sampling of pit latrine waste. Key informant interviews were conducted on the market for agricultural products derived from sanitation waste in and around Bukavu.

To gather the primary data for the household survey, proportional sampling techniques were used to randomly select 280 households (140 in Keredi and 140 in Nyamugo) from a total population of 73,086 individuals. The data were collected over a period of four days by a team of nine trained enumerators who used a standardized questionnaire to collect information on sanitation in both Keredi and Nyamugo. Furthermore, enumerators were trained on the program's overall objective to enable them to gather qualitative data through observations during their field visits. The household survey conducted in Nyamugo and Keredi gathered information on the following aspects: access to improved sanitation services, access to private sanitation services, type of existing sanitation facilities, willingness to pay for sanitation services, current household expenditure on sanitation and water, current expenditure on solid waste disposal, rent expenditure, home ownership, satisfaction with the cleanliness of the toilet, satisfaction with the time taken to walk to the toilet, and satisfaction with the structural stability of the toilet.

The Sanergy team collected and analyzed samples of pit latrine waste from communities in both districts to identify the characteristics of the waste. To develop a sustainable fecal sludge management system, it was necessary to identify and implement feasible reuse options. The feasibility of reuse depends on a range of aspects, including chemical

analyses of fecal sludge, financial, geographical, socio-cultural, and regulatory considerations, as well as the added value generated by reuse. The topic of reuse is a complex and sensitive issue that plays a crucial role throughout the cycle and impacts all parties and stakeholders involved.

The Catholic University of Bukavu team in charge of assessing the chemical makeup of fecal sludge in Bukavu City's targeted districts aimed to create a database on toilet waste management. By analyzing the quality of sewage sludge, its chemical composition was determined, and its potential to meet agricultural nutrient needs was evaluated. Additionally, the production of biogas in Bukavu and its surrounding rural areas requires a dependable source of high-quality organic resources, and the team's analysis of latrine waste was intended to identify its potential as a valuable source of organic materials for biogas production.

The university conducted a thorough analysis of the samples to evaluate their physical properties, including the pH, turbidity, total dissolved solids, and chemical oxygen demand. This was performed to identify any harmful pathogens, bacteria, or other contaminants that could pose a threat to the environment and human health. The safe management of fecal sludge involves various context-specific treatment, processing, and disposal options. To ensure the success of low-footprint fecal sludge management for reuse, it is crucial to closely monitor the characteristics of incoming fecal sludge, such as total solids, total suspended solids, chemical oxygen demand, ammonia, electrical conductivity, and pH.

Additionally, the team conducted key informant interviews with agricultural cooperatives, government-based agricultural institutions, local authorities, and waste conversion specialists in Bukavu to assess the current state and potential of the reuse market for waste.

III.   EVALUATION FINDINGS

The evaluation of Bukavu city led to the selection of Keredi (Ibanda Commune) and Nyamugo (Kadutu Commune) as potential pilot zones for an in-depth assessment. The second assessment involved collecting primary data through household surveys, direct observations, and sampling of pit latrine waste. Additionally, key informant interviews were conducted in the market for agricultural products derived from sanitation waste. The assessment considered factors such as willingness to pay, satisfaction with existing sanitation provisions, and operational practicality, which were critical for implementing non-sewered sanitation in cities based on SWASSA programmatic approaches and Sanergy's experience. The results revealed significant differences between districts, supporting the selection of Keredi as the optimal pilot zone for the implementation of a full-value-chain sanitation model in Bukavu. The assessment phase required close collaboration with local actors to ensure locally driven and sustainable approaches.

- **GIS Mapping**

The results of the Bukavu initial evaluation showed three main types of toilet facilities in the city: western toilets, flush toilets, and pit latrines. Additionally, a non-functioning sewer line was observed to run through the Ibanda commune and parts of the Nyakavogo and Lumumba districts. Wastewater treatment plants in the Nyamugo and Bagira districts were also found to be non-functioning. It should be noted that the majority of Ibanda and Kadutu Communes displayed urban and peri-urban characteristics, while Bagira Commune was primarily peri-urban in nature. Sanitation and solid waste management organizations primarily operated in Ibanda and Kadutu Communes, which were more accessible due to better road penetration and the presence of significant businesses and facilities, compared to Bagira.

- **Key information interviews with public and private sector stakeholders**

According to interviews, the majority of fecal sludge in Bukavu was improperly managed, with only 3% being disposed of safely. Additionally, it was observed that many people in the city depended on the on-site sanitation systems. To obtain a thorough understanding of waste flow in the city, stakeholders, including the sanitation brigade of the municipality, identified several key informal urban settlements within Bukavu.

- **Quantitative data collection**

The results of the household survey conducted in Nyamugo and Keredi, with a sample size of 280 households in total (140 in Keredi and 140 in Nyamugo) out of a combined population of 73,086, reveal the following characteristics:

- Access to improved sanitation services

A significant proportion of households in both Keredi and Nyamugo have relied on unimproved toilets. Notably, Nyamugo has the highest percentage of households using toilets that do not separate fecal waste from human contact, accounting for 42% of households, while Keredi has 34% of households using the same type of toilets. In addition, only a small percentage of households (14%) used safely managed toilets. It is crucial to mention that 9% of these households are in Keredi and 4% are in Nyamugo. Furthermore, 7% of households in Keredi and 4% in Nyamugo use basic and limited facilities.

- Access to private sanitation services

The household survey revealed that approximately 70% of respondents from Keredi reported utilizing a private, single-household toilet, while only approximately 45% of respondents from Nyamugo reported the same. It is crucial to keep in mind that these findings were based on data collected from selected cellules, which were intended to be representative of the cellules of interest and may not be reflective of the entire city, region, or country.

- Stated willingness to pay.

The outcomes of the evaluation revealed that the mean level of willingness to pay for sanitation services was 10,689 CDF (approximately US $4.45) in Keredi, and 8,231 CDF (approximately US $3.42) in Nyamugo. The findings indicated that 73% of the respondents in Keredi were inclined to pay more than their current sanitation expenditure for improved sanitation facilities, while only 25% of the respondents in Nyamugo expressed similar inclinations. Moreover, 73% of the respondents in Keredi and 75% in Nyamugo were willing to pay more for private household-level toilets. The highest level of willingness to pay, although not significantly different, was marginally higher in Keredi (15,151 CDF, approximately $6.31) than in Nyamugo (11,863 CDF, approximately $4.94).

- Current sanitation expenditure

Households in Keredi allocate notably greater funds towards sanitation (11,590 CDF, approximately $4.83) as compared to those in Nyamugo (8,125 CDF, approximately $3.39), which suggests that the former possess a higher capacity to pay for improved sanitation services. In this analysis, two outlier values were excluded, one from each of Keredi and Nyamugo, which had more than three standard deviations from the mean.

- Current water expenditure

Households in Keredi allocate a somewhat smaller amount of money to water expenses, amounting to 12,000 CDF or $5, in comparison to those in Nyamugo, who allocate 12,929 CDF or $5.39. The difference between the two amounts was 929 CDF.

- Solid waste disposal expenditure

The findings regarding willingness to pay for solid waste disposal showed that Keredi had higher expenditures than Nyamugo, amounting to 3,528 CDF ($1.47) in Keredi and 1,222 CDF ($0.51) in Nyamugo. This suggests a significant difference in the level of expenditure between the two areas.

- Current rent expenditure

The results of our analysis of current rent expenditures demonstrated a significant disparity in monthly rent expenditures between households in Keredi and Nyamugo. It was discovered that households in Keredi allocated 33,863 CDF (equivalent to approximately $14) more towards rent each month than those in Nyamugo did. The rent in Keredi is estimated to be 105,440 CDF (approximately $44). Consequently, we inferred that residents of Keredi may possess greater discretionary income for sanitation services and, hence, a higher willingness to pay than residents of Nyamugo.

- Rent and home ownership.

According to the data, the majority of sanitation decision making is carried out by property owners/landlords, with an approximate allocation of 60-40. Notably, a significant proportion of respondents (approximately 57%) owned their own homes, while the remaining 43% were tenants. Furthermore, over 50% of households with an annual service fee of up to 12,430 CDF ($5) expressed a willingness to pay for improved sanitation facilities, regardless of whether they were owners or tenants.

- Cleanliness of toilet

Respondents in Keredi indicated a greater level of dissatisfaction with the current state of cleanliness in their existing toilets, by a margin of 13.4%, compared with those in Nyamugo.

- Time taken to walk to toilet.

Respondents from Keredi expressed greater dissatisfaction with the time it took to walk to the toilet, at a 14.2% higher rate than those from Nyamugo.

- Structural stability of toilet

Respondents in Keredi reported a significantly greater level of dissatisfaction with the structural stability of existing toilets than did those in Nyamugo, with a difference of 17.9%. This finding indicates that people in Keredi were more likely to be unhappy with the stability of their existing toilets than those in Nyamugo were.

● **Reuse assessment**

The results of pit latrine waste sampling did not show any significant differences between the two areas. These findings were consistent with the general understanding that pit waste is highly variable. Therefore, we did not anticipate significant differences between the two study areas, and our primary objective was to familiarize ourselves with the attributes of pit latrine waste in the potential pilot zones. Consequently, the outcomes of the pit-sampling activity were consistent with our expectations, as no significant distinctions were observed between the two areas. However, it is worth noting that the results are generally consistent with the range of values observed in other contexts.

Following this, key informant interviews conducted with agricultural stakeholders revealed that many farmers on the outskirts of Bukavu were using compost fertilizer mixed with fecal sludge from pit latrines. However, the inclination and ability to purchase these fertilizers were low due to a lack of knowledge and a sustainable market. While some coffee farmers preferred to use organic fertilizers to comply with export requirements, the chemical fertilizers available in the local market were deemed too expensive at $50-$75 per 50 kg bag, making them unaffordable for most small-scale farmers. Additionally, farmers reported that chemical fertilizers had a negative impact on the regrowth capacity of their farms.

IV.   ACTIONS BASED ON FINDINGS

● **Confirmed Pilot Location**

Upon evaluating the two potential pilot sites, Keredi was identified as the preferred location for the iterative pilot program because of its high willingness to pay, satisfaction with existing sanitation provisions, and practicality in terms of operations. These differentiating factors were crucial in determining the optimal location for implementing non-sewered sanitation in urban areas, while aligning with programmatic priorities and Sanergy's past experience in similar initiatives in other African cities. The team conducted

a thorough assessment of both potential pilot zones to make informed decisions, considering critical factors, such as viability and programmatic priorities.

- **Revised Business Model**

Following the assessment results, the team modified the Container-Based Sanitation (CBS) business model to incorporate more accurate cost and revenue estimates through the refinement of assumptions and projections. The updated model now accounts for factors such as the average household size of seven users per toilet, the willingness of households to pay a monthly fee of $5 for sanitation services, and the market's interest in human waste-based compost (although the revenue generated from this source remains undetermined). In light of these findings, the team selected shared container-based toilets as the optimal solution for meeting the sanitation needs of the region in the Eastern Democratic Republic of Congo. This approach includes various microfinancing scenarios in which users would pay a specified amount per month for a period of two years, covering both waste collection and composting. By implementing this full value chain model, container-based toilets can ensure the safe management of all waste generated.

- **Selected Business Partners**

The team, in close collaboration with local authorities in Bukavu, conducted interviews with prospective local business partners prior to organizing a comprehensive orientation workshop that provided a detailed overview of the program and its requirements. An Expression of Interest (EOI) was advertised to invite interested local business partners to submit applications as construction and/or service provision operators. The team applied specific criteria, including legal and administrative aspects, service delivery, and capacity, to objectively shortlist and assess the ability of each local actor to provide sanitation construction and operation services. It was essential to undertake a rigorous selection process to guarantee the implementation of activities related to the provision of safe sanitation services through a full value chain approach. Local business partners play a crucial role as service providers, delivering safe sanitation and fecal sludge management services throughout the entire sanitation value chain. Additionally, they ensure the sustainability of the program through local capacity building, community engagement and management.

V.   OPPORTUNITY FOR FURTHER IMPLEMENTATION

Undoubtedly, several critical inquiries must be considered if the suggested sanitation scheme is to be extended to Bukavu. What are the most appropriate and cost-effective sanitation models for the Eastern DRC market? Can local market actors promote and utilize these models? Will these models prove sustainable in the long run, without external support? Moreover, will they deliver the expected level of impact on the sanitation sector? As a pilot sanitation project with a limited scope and duration, we have yet to obtain definitive answers to these questions. The team was in the process of designing and prototyping a Container-Based Sanitation (CBS) business model, but due to budget

constraints, the iteration could not proceed further. It is crucial for future similar projects to conduct multiple rounds of testing for different iterations of the model to assess their effectiveness and optimal fit for the region. Although the CBS business model may not be the most suitable or cost-effective, its modular and full-value chain nature makes it a cost-effective and low-risk model (relative to other technologies) through which to further define the requirements of a model suitable for the context.

The selection of Keredi as the pilot zone required the identification of business partners who possessed the necessary capacity, local knowledge, and capability to operate in Keredi, with secondary consideration given to their potential to extend services to other locations within the South Kivu province, particularly Bukavu. Establishing concrete measures for the construction of facilities that will support the manufacturing of toilets, consolidation of waste collection containers, and setup of a treatment and composting site is crucial. Owing to the limitations stated, the team was unable to engage in extensive prototyping of the CBS business model, despite having already devised and discussed the model with relevant stakeholders. Future implementation initiatives should consider partnering with local businesses for toilet design, construction, and fabrication as well as the establishment of waste consolidation facilities and treatment sites in Bukavu. It is essential to conduct rapid prototyping, iteratively refine systems and processes, and assess the potential impact of scaling up CBS models. Although the CBS model may not be the most suitable or cost-effective option in the long run, it is particularly well-suited for rapid prototyping and iterative refinement without disrupting service delivery.

The application of rapid prototyping in the development of a cost-effective sanitation business model would enable service designers and implementers to quickly produce and test multiple versions of the CBS to refine and enhance it. This approach is particularly advantageous in the sanitation sector, where there is a growing need for innovative products and services that can improve fecal sludge management and drive progress in the field. The Sanergy team intended to use rapid prototyping to gather valuable feedback from sanitation users and other actors in the value chain, with the aim of identifying design flaws and areas for improvement early in the development process, before significant resources could be invested. The goal was to contribute to the creation of sanitation services that are not only effective in assisting service providers in managing the business, but also in meeting the capacity of communities. Moreover, early feedback from actors in the value chain could extend beyond design decisions and help to identify problems in the value proposition or reshape the scope of the CBS.

VI.   LESSONS LEARNED

The results of the assessment suggest that implementing comprehensive sanitation measures requires a deep understanding of the unique challenges and opportunities encountered by communities and sanitation enterprises operating within their specific contexts as well as the market systems in which they function. The use of sanitation business models in South Kivu can lead to the promotion of growth, creation of employment opportunities, stimulation of local economic development, and provision of prospects beyond mere changes in sanitation behavior within households.

The overall assessment revealed an issue with the production of CBS toilet superstructures. Although substructures may be imported from countries with established sanitation interventions, such as [Sanergy's Fresh Life Toilets in Kenya](), the superstructure must be locally manufactured to reduce costs. Therefore, it is crucial to investigate the potential of locally available and affordable materials for CBS toilet products.

Conducting an in-depth household sanitation survey is challenging, especially in areas such as Bukavu, where the selection of a representative sample of households presents several obstacles. For instance, household registration, street tracks, and population censuses are some of the methods that can be employed. However, the absence of household registration and population databases or official censuses for decades in Bukavu poses significant challenges in selecting households and respondents. To overcome this challenge, the team had to rely on demographic data provided by the mayors of each commune or non-governmental organizations, such as Mercy Corps, operating in the area. Although this approach may offer valuable information, it could also constitute a limitation in terms of population sampling, as the data may not be entirely accurate or comprehensive. It is crucial to recognize these limitations when interpreting the assessment results.

The current state of the sanitation ecosystem in the eastern Democratic Republic of Congo (DRC) does not allow for the conclusion that it has reached a level of generativity that would enable local sanitation service providers to flourish. However, the potential of market-based sanitation (MBS) to improve service delivery and contribute to economic growth in the region is worth noting. To achieve an optimal balance between addressing the challenges faced by the sanitation sector, stakeholders must take proactive steps and continue to engage in this iterative process.