Container-Based Sanitation Implementation Guide 1st edition

CBSA

Container Based Sanitation Alliance

Cover Photo: x-runner in Lima, Peru

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Foreword

Welcome to the Container-Based Sanitation Alliance (CBS Alliance)'s first CBS implementation guide, which sets down in one place, numerous leanings from several CBS-focused organizations.

Looking back, there has been so much progress since the modern concept of CBS emerged about a decade ago. In particular, 2019 was a breakthrough year for CBS. The WHO/UNICEF Joint Monitoring Programme recognised the approach as 'improved' sanitation. This classification is fundamental to the take up of the CBS model. It can now be counted towards safely managed sanitation services under the Sustainable Development Goals, providing legitimacy at the highest level and a key step towards building the mandate for take up by governments and others.

When we first started to envision a CBS Alliance in 2016, there was an understanding that CBS was an exciting addition to the suite of sanitation options, but that CBS was still in its infancy. As such, the path to scaling CBS services would require knowledge sharing and intensive research which would enhance communal learning among CBS Alliance members. However, it has also been apparent to everyone in this sector that the path to scale is not only through the expansion of current CBS Alliance member organization but also in the replication of these models and the creation of new variations, in new locations.

To that end, the CBS Alliance has spent the last several years compiling resources and lessons learned to create this guide to implementation. CBS has the potential to be an essential addition to the suite of sanitation options if done correctly. The CBS Implementation Guide aims to breakdown in detail, preferred implementation strategies and the reasoning for using them. We do not see this as the final authority on all things CBS, instead we see it as a starting point and reference guide for any individual or organization, whether they be utilities, municipalities, entrepreneurs, researchers, or others. As CBS continues to evolve and grow, we anticipate that there will be new breakthroughs and changes to the perceived best practices. As a result, we anticipate updating the CBS Implementation Guide on a regular basis. There are always new lessons to be learned and we want to capture them here to help everyone striving to achieve sanitation for all.

We believe that CBS has the potential to play a significant role in addressing the urban sanitation crisis. As a safe, clean and climate positive service, it could enhance the quality of life for millions of people around the globe. There has been some significant progress to date and we look forward to building on this guide to support the creation of new services and the scale up of existing services.

Dr. Kory Russel, Chair, CBSA

Acknowledgements

The guide was developed in collaboration with the member and affiliate organizations of the Container-Based Sanitation Alliance (CBSA). The CBS approach's in this guide have been implemented in a variety of locations around the world including in Ghana, Guatemala, Haiti, India, Kenya, Madagascar, Peru and the UK under the guidance and with review by experts and practitioners. The document was authored by Dr. Kory Russel and Isabella Montgomery.

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1. Introduction

a. What is Container-Based Sanitation?

Container-Based Sanitation (CBS) is a sanitation service which provides toilets with sealable, removable containers that are collected on a regular basis to safely dispose of or reuse fecal sludge. While some CBS service providers manage the entire sanitation service chain themselves, others partner with other groups to implement parts of the service model.[1] Since toilet waste is not mixed with water or chemicals from other household tasks, many providers take advantage of the nutrient rich waste to convert the undiluted fecal sludge into reuse products, such as biogas, solid fuel, soil amendment and animal feed. The majority of CBS operators have employed a subscription service business model, but this is not a requirement.

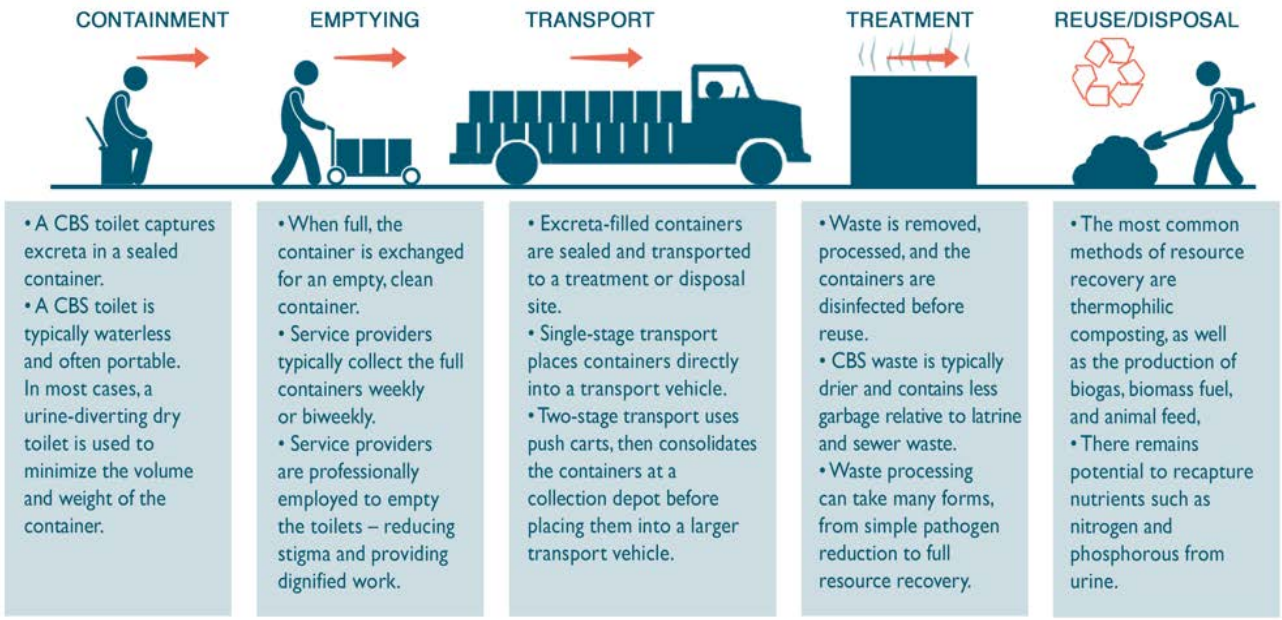

Figure 1 The CBS service model.[1] Source: Russel K., K. Hughes, M. Roach, D. Auerbach, A. Foote, S. Kramer, & R. Briceño, Taking Container-Based Sanitation to Scale: Opportunities and Challenges. Frontiers in Environmental Science 2019, 7, 190

The CBS approach provides a number of advantages:

- **Inclusive:** CBS services are able to reach users in areas where sewers are challenging or not feasible, including in areas that are densely populated or have rocky or unstable soil conditions, high water tables, limited water availability, challenging topography or are prone to flooding.
- **Hygienic and safe:** a CBS service does not leave fecal sludge untreated to contaminate the environment, even during flooding when they can be sealed to ensure no waste is released into the environment.
- **Cost effective:** CBS services are significantly lower-cost than new sewer connections. See 2020 EY report "How cost analysis dispels myths about container-based sanitation."

[1] See annex 1 for a number of different examples of CBS providers service models

- **Water saving:** As a dry or minimal-water system, water savings using CBS as compared water-flush systems can vary from 6 m3/person to 25 m3/person annually, depending on waste separating techniques.[2]
- **Climate positive:** depending on the resource recapture and reuse technology employed during treatment, CBS can have reduced greenhouse gas emissions relative to traditional sanitation services. See CBS Alliance policy brief, "Supporting the Shift to Climate Positive Sanitation."
- **Rapid deployment:** with the ability to be rapidly deployed and scaled up, CBS services are well suited to serving humanitarian contexts.
- **Non-permanent:** Services can be a good solution in temporary and informal areas, such as displaced people camps, or where there are land tenure issues such as squatter settlements. Moreover, household CBS toilets can be moved or reinstalled when a subscriber moves.
- **Supports livelihoods:** as a labour-intensive service, CBS providers creates dignified employment and training for local people.
- **Accessible:** CBS toilets increase accessibility for those with physical disabilities, the elderly and young children because they can be placed anywhere in the home.
- **Safe:** CBS toilets provide women and girls with a private, safe space to use the toilet and manage menstruation and pregnancy.[3]

b. Why Container-Based Sanitation?

Six in 10 people, or 4.2 billion, lack safely managed sanitation and 2 billion people still lack even a basic sanitation service. The majority of the 2 billion either practice open defecation (673 million) or use unimproved facilities such as pit latrines without a slab or platform, hanging latrines or bucket latrines (701 million). Additionally, low-income urban populations are expected to double from the current 1 billion by 2030, as the world's population continues to urbanize at a rapid pace, and cities are struggling to expand critical infrastructure to accommodate this unprecedented growth.

Simply put, there is a sanitation crisis in cities. Urban settlements face a suite of unique sanitation challenges that have made traditional sanitation interventions (such as sewers, pit latrines and septic tanks) ineffective and unsafe. Appropriate technologies for these communities must address issues of limited space, difficult access for waste removal, unstable populations of renters unwilling to invest in infrastructure and lack of government recognition. Additionally, much of the sanitation provision over recent decades has been focused purely on toilet provision and ignored the remainder of the sanitation supply chain. An estimated 80% of all wastewater generated globally is discharged without any treatment.

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[2] Andersson, K. (2016). Sanitation, Wastewater Management and Sustainability: From Waste Disposal to Resource Recovery. Nairobi; Stockholm: United Nations Environment Programme and Stockholm Environment Institute.

[3] BMGF. (2018). "Gender and the Sanitation Value Chain: A Review of the Evidence" and "Case Studies in Gender Integration: Sanitation Product and Service Delivery in Kenya."

Against the backdrop of a rising global population and rapidly growing urban areas, the challenge of meeting Sustainable Development Goal 6 – "to ensure availability and sustainable management of water and sanitation services for all" – is increasing. Sewerage alone is unlikely to achieve SDG targets on sanitation and calls are increasing for the use of more non-networked options. Since its conception in 2010, CBS has gained recognition as a viable, low-cost sanitation option, particularly in densely populated urban neighbourhoods, informal settlements, areas with high water tables, or where there is risk of frequent flooding.

In a significant breakthrough for CBS, the WHO/UNICEF Joint Monitoring Programme recognised the CBS approach as 'improved' sanitation in 2019. This classification is fundamental to the success of CBS scale up. As a result, it can be counted towards safely managed sanitation services under the Sustainable Development Goals, providing legitimacy at the highest level and a key step towards building the mandate for take up by governments and others.

While there is growing interest in CBS, many stakeholders remain unfamiliar with the approach. This resource aims to provide an introductory technical guide to those interested in understanding more about CBS service set up and implementation.

c. The Container Based Sanitation Alliance

The Container-Based Sanitation Alliance (CBS Alliance) was formed in November of 2016 to harness the potential of CBS and encourage its widespread, effective and efficient adoption around the world. It is a coalition of CBS practitioners around the world with extensive experience in developing and providing CBS services and a shared vision of a world where access to dignified, safe and affordable sanitation is no longer out of reach for families and communities in dense urban areas.

The six founder members of the CBS Alliance include Clean Team, Loowatt, Sanergy, Sanivation, SOIL and x-runner. In 2019, Sanitation First joined the Alliance as a member along with Mosan as an affiliate.

d. Citywide Inclusive Sanitation

In 2017, the World Bank and WASH sector partners launched a call to action on 'citywide inclusive sanitation' (CWIS) to ensure that cities develop comprehensive approaches to sanitation improvement that encompass long-term planning, technical innovation, institutional reforms and financial mobilization.

The CWIS approach aims to shift the paradigm around urban sanitation approaches. It posits that the traditional approach premised on extending sewerage networks and building

The concept of CWIS includes the following principles:

- ***Everybody benefits*** from adequate sanitation service delivery outcomes.
- Human waste is ***safely managed along the whole sanitation service chain.***
- ***Comprehensive approaches*** to sanitation improvements are deployed, with long-term planning, technical innovation, institutional reforms, and financial mobilization.
- A ***diversity of technical solutions***, which are adaptive, mixed, and incremental, is embraced.
- Effective ***resource recovery and reuse*** is considered.
- Cities demonstrate political will and technical and managerial ***leadership***, and they identify new and ***creative ways of funding*** sanitation.
- ***Both on-site sanitation and sewerage solutions***, in either ***centralized or decentralized systems***, are considered to better respond to realities faced in cities.
- ***Complementary services (including water supply, drainage, greywater, and solid waste)*** are considered.

In its 2019 CBS study, *Evaluating the potential of Container Based Sanitation,*[4] the World Bank presented CBS approaches as being able to play a key role as part of the CWIS portfolio of solutions, expanding the suite of sanitation options available in dense urban areas. Moreover, the individual modules of the CBS value chain can integrate well with existing CWIS systems to strengthen overall sanitation service delivery.

[4] World Bank, Evaluating the Potential of Container-Based Sanitation. 2019

2. Business models

To date, the majority of CBS providers have focused on using business principles to improve service efficiency, reduce costs and improve the user experience. Additionally, because many utilities are unwilling or unable to engage in service provision in informal settlements due to legal issues around land tenure or resource scarcity, a private business model may be the only way to provide services in these areas. There are a number of ways to structure both the legal entity of the CBS provider (for profit, non-profit, or hybrid) as well as the CBS business model in order to achieve these goals.

Typically, CBS providers charge some sort of monthly fee for their service. To be clear, user fees are not always sufficient to cover the cost of service when attempting to provide sanitation to some of the lowest-income communities globally. While an expectation of full cost recovery from user fees is unrealistic, given that the vast majority of sanitation provision around the world is subsidized in some form, user fees provide an important function beyond cost recovery. As a result of relying in part on the customer fees to function, the service provider is more responsive and accountable for providing the highest quality experience for the customer in order to retain their business.

Customers can include individual households, landlords managing multiple units in need of sanitation, schools, and other public infrastructure locations such as bus stops or parks. Most service providers collect fees from toilets installed in individual households. The customer pays a monthly fee for the toilet, cover material and to have their waste collected. Assuming this is the only revenue stream, efficiency in service provision is key to a sustainable business. CBS toilets have also been deployed in public spaces using both humanitarian and franchise models. In the franchise model, franchisees purchase public toilet hardware and subscribe to a waste collection service. They are responsible for operating the toilet and collecting user fees themselves. This model has been particularly effective for providing sanitation to schools and landlords.

A second stream of revenue can be collected from processing treated human waste to produce reuse products that can be sold on the open market (see section 2f for reuse options). The idea is simply that if there is a market for product that can be created from treated human waste, there is an opportunity to increase the revenue available to the CBS service provider. Research has found that operating a reuse facility can be one of the more cost intensive links in the sanitation value chain.[5]

[5] EY (Ernst & Young) and WSUP (Water & Sanitation for the Urban Poor). 2017. The World Can't Wait for Sewers: Advancing Container-Based Sanitation Businesses as a Viable Answer to the Global Sanitation Crisis. London, UK. and EY (Ernst & Young). 2020. How cost analysis dispels myths about container-based sanitation. London, UK

Another way for providers to improve their business model is to form Public Private Partnerships (PPP) with national or municipal governments and utilities. There are a number of ways to structure such PPPs, but two of the more promising include:

1. The utility finances the construction and operation of a waste treatment and reuse facility or the backend of the sanitation value chain while the provider focuses on the frontend service provision.[6]
2. The government, directly or through an international funder, contracts a CBS provider to service a set number of households or treat a specific quantity of waste. Such arrangements can lead to the integration of waste coming from other sources and may be an effective means to achieve CWIS goals.

If we shift to focusing on utilities for providing CBS services, this would allow for water revenues to cross-subsidize CBS services provision.[7] This is currently being explored in the Philippines, in partnership with the local utility. It is also possible for a CBS provider to function as a conventional Non-Governmental Organization (NGO) and completely forgo an entrepreneurial approach.[8]

According to the EY-WSUP analysis in 2017[9], to maximize the efficiency of a CBS business model, the following cost drivers should be studied in depth: payment collection, collection frequency, densification of service area, customer churn, waste-to-resource strategy, and the cost of toilets. All of these aspects are discussed in detail in the following sections of this manual.

The CBS business model can be flexible enough to adjust to numerous contexts and typically relies on a mixture of public, philanthropic and private funding sources to create a sustainable business model. The key is to determine what the proper mix of the sources of funding are in your specific context and then build in contingency plans for unforeseen funding shortfalls such as economic crisis, conflict and pandemics as having to suspend service for any reason can be extremely detrimental to the long-term viability of a provider and the public health of communities. See annex 2 for diagrams of CBS provider business models.

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[6] "Utility Business Model (Piloting Two Portable Toilet Systems (PTS) in Laguna, Philippines)." 2018. Sustainable Sanitation Alliance. Last modified August 9. https://forum.susana.org/161-sanitation-as-a-business -and-business-models/22429-utility-business-model-piloting-the-pts-in-laguna-philippines?setGT=0.

[7] World Bank, Evaluating the Potential of Container-Based Sanitation. 2019.

[8] A good example of this approach is Fondación Sumaj Huasi (La Paz, Bolivia). Read more in World Bank (2019)

[9] EY (Ernst & Young) and WSUP (Water & Sanitation for the Urban Poor). 2017. The World Can't Wait for Sewers:

3. Step by step guide for establishing a Container Based Sanitation service

It will take several months to set up a CBS service and ensure that all partners understand the approach and their role within it. While setting up a CBS system can be done rapidly under emergency conditions, launching a successful and refined system under normal conditions is likely to take a minimum of 12 months to allow sufficient time to establish all the necessary stages, from pre-implementation to evaluation.

The following table provides a step by step guide on how to establish a CBS service using an existing service provider.

Collaborating with an existing service provider		
Stage	**Duration**	**Steps**
1 Pre-implementation	1 month	1. Research: current costs of sanitation per household, undertake an environmental study, investigate legal restrictions and required permissions 2. Develop objectives for system, decide on target population and understand the amount of funding available 3. Solicit service provider
2 Stakeholder consultation and system refinement	5 months	1. Decide on communication plans and which stakeholders need to be involved in decision making process, include community engagement 2. Dedicate and empower a contact representative to work and consult with service provider 3. Undertake pilot
3 Evaluation	3 months	1. Comprehensive evaluation of the system, its operations, and its impact 2. Reporting of key findings, lessons learnt, and recommended steps for project expansion
4 Expansion	3 month	1. Finalize plans for project integration into implementing partner main activities and secure any necessary funds 2. Communicate results and next step plans with upper level management

If an implementing organisation is looking to undertake the work themselves, the following steps can be followed.

Establishing a CBS service to manage directly		
Stage	**Duration**	**Steps**
1 Pre-implementation	1 month	1. Respond to solicitation 2. Create project and management plan
2 Stakeholder consultation and system refinement	7 months	1. Agree on project plan with local stakeholders, particularly community leaders 2. Hold focus group discussions and key informant interviews 3. Conduct skills and materials assessment 4. Evaluate bio-waste supply chains and markets for reuse products 5. Apply for all regulatory approvals required 6. Secure access to water, power, land and any infrastructure needs etc.
3 Rapid Prototyping	2 months	1. Prototype key technologies and reuse products; verify they meet the needs, preferences and challenges of the target population and that reuse products meet legal requirements 2. Develop detailed procurement and capacity development plans 3. Recruit and train local staff 4. Conduct risk analysis and put in place mitigation measures and test monitoring tools 5. Meet with local stakeholders
4 System roll out	2 months	1. Procure all necessary equipment and install toilet, treatment, and reuse technologies 2. Begin operations and implement monitoring and quality control systems 3. Update risk register 4. Decide on pricing and sales strategy for toilet service and reuse products 5. Meet with local stakeholders

5 Expansion	5 months	1. Further toilet deployment and capacity building of operation staff 2. Implement sales approach for reuse products 3. Meet with local stakeholders
6 Evaluation	1 month	1. Comprehensive evaluation of the system, its operations, and its impact 2. Refine and document final systems and processes ready for handover and/or expansion 3. Reporting of key findings, lessons learnt, and recommended steps for project continuation and/or potential hand over

4. Technical specifications

a. Toilet design

CBS toilets vary considerably in price. A 2017 EY report concluded that, to support economics of scalability, CBS providers would need to aim for a target cost of US$40 to US$50 per household for a toilet that can last five years.

CBS toilets tend to be portable. However, some CBS providers service fixed toilets. If an infiltration pit or vent is needed, the toilet will become less portable. The type of toilet used will impact the time it takes to install the toilets. Portable toilets can take a few minutes, while other can take longer, from 45 mins when making some additional adjustments for ventilation, to a day if the toilet is prefabricated and can be assembled on site to over a few days for a fixed toilet with a superstructure using locally sourced materials.

Some key questions to consider when deciding on CBS toilet design include:

Should you design the toilet to cater for seated or squat use?
Most CBS toilets are seated. However, the best choice of design would depend on what is most aspirational in the local context. While seated toilets are often seen as aspiration, if the toilet is either public or shared between multiple households, a squat plate may be preferable due to the reduced of contact by the user.

Sanivation, Kenya

Sanergy, Kenya

Will you need to cater for anal cleansing?
The vast majority of CBS toilet models to date have not been specifically designed for users that practice washing for anal cleansing – although toilets which collect both urine and feces in a combined container could be effective for anal washing. Providers should aim to provide what is both culturally appropriate and aspirational (see annex 1 for a diagram explaining cleansing method and defecation position of current CBSA operators' clients).

How much ventilation will be needed?

This will be affected by the type of climate in which you are operating. Along with cover material, sufficient ventilation, is one of the most important factors in reducing unpleasant odor. In moist environments, air movement is ensuring the fecal sludge does not become too moist and a breeding ground for bacteria, fungi, and parasites.

x-runner, Peru

SOIL, Haiti

What material will you use for constructing the toilet?

CBS toilets are sometimes constructed using locally available materials, from a combination of wood, ferrocement, concrete and/or plastic. Alternatively, proprietary models produced through injection molding are used, in many contexts. The majority of portable toilets on the market are designed for the leisure industry and aren't able to withstand daily use by CBS customers. A robust, low-cost but high-quality product is needed which requires scale and significant demand.

Will you provide a superstructure?

If people do not have space for the toilet in their homes but they do have access to outside space where the toilet can be located, a superstructure may be a better option. However, if a superstructure is provided your toilet cost will inevitably be higher. See annex 5 for examples of super structures.

Loowast, Madagascar,

Mosan, Guatemala

Sanitation First, India

Will you collect waste in containers, bags or both?

Some CBS providers collect and replace the entire waste container while others provide bag liners to collect. When deciding on which approach to take, the costs of bags or other consumable materials such as cover materials must be weighed up against the cost of all other consumables needed for collecting and cleaning containers. Depending on the type of bag used, they may have a higher risk of puncture or leakage but will be more compact and lighter to transport or the container may be easier to clean.

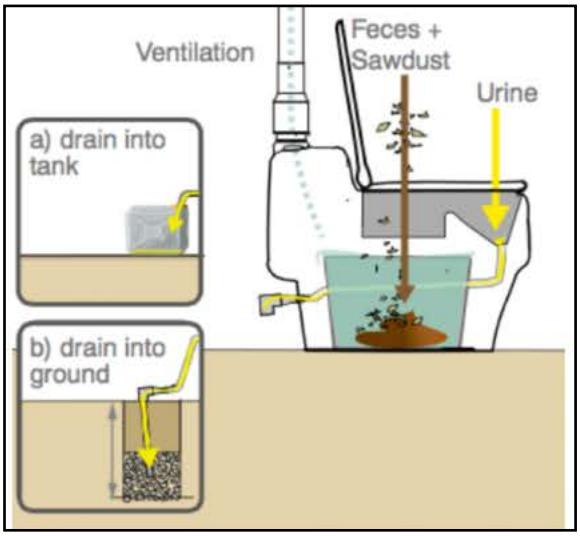
Where bags are used, consideration needs to be given to their ability to withstand weather conditions. For example, in Peru, it is necessary to use bags that have a storage life of six to eight months. During the summer, they start to degrade in the heat so are replaced with standard non-biodegradable bags. Non-biodegradable bags come with an added environmental cost and regulatory issues in countries which have plastic bag bans.

The size of containers will depend on the number of people using the toilet, collection frequency and how soon the toilet is perceived to be full and unpleasant. A simple way to think about this relationship is that as the container in the toilet fills, the distance between the feces and the user decreases and the level of user disgust increases (see graph on next page). The distance to feces-disgust relationship can be made somewhat irrelevant with the use of cover materials or other encasing mechanisms which obstructs any view of feces in the toilet from other users and allows for a more enjoyable experience.

How will you dispose of urine?

Most CBS toilets are urine diverting. Fecal sludge is generally collected in a container and urine is diverted into a second collection container or to soakaway / infiltration pits on site. Many providers are less concerned with the collection of urine as opposed to safely managing it onsite as the majority of pathogenic organisms are in the fecal waste not the urine. How urine is managed will depend on whether the population are washers are wipers, the nature of the soil substrate, whether drinking water is extracted from the groundwater, the height of the water table and the market for urine reuse.

The largest health concern from infiltration of urine is the potential to increase nitrate contamination of groundwater. Obviously, this is not of concern if community water sources are not coming from groundwater. However, elevated nitrate levels in drinking water can lead to some negative health outcome especially if the water is used to mix infant formula.



The primary options for urine management. (x-runner, Peru)

In the cases, where urine is collected in a second container and disposed of separately, the added volume collected can add to the cost of waste removal and waste treatment. A general rule of thumb for the average adult production of human waste per year is 50 kgs of feces and 500 liters of urine. That means there is an order of magnitude more urine to collect and process assuming there is a reuse product market for the urine. See the reuse products section in 2f for more detail on this topic.

There are proponents of mixing the urine and feces together in the same container,[10] however, most providers have found that in hot and humid environments, the most effective way to reduce smell is to separate the feces and urine. Alternatively urine and feces can be mixed if the toilet design also seals the waste in a non-porous material thus significantly reducing smell.[11]

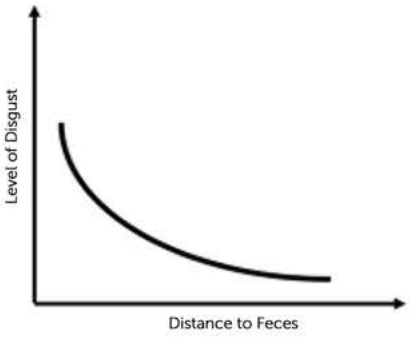
What consumable material will you supply?

The choice of consumable material depends significantly on the context in which the service is being delivered. Sawdust is commonly used as it has good odor-elimination and desiccation properties, though its effectiveness varies with the wood species, dryness, and coarseness and it does not decompose as readily as some other cover materials. Other cover materials include agricultural waste (eg sugarcane bagasse and peanut shells), ash, charcoal dust and even finished compost. Choice of material will depend on local availability and sourcing options. In large cities, with limited forestry or agriculture access, or where these waste streams are already monetized, this type of consumable material is more difficult and costlier to source. A fresh supply of cover material is usually supplied at the time of waste collection or can be sourced by users directly. Additonally, the type of cover material can impact disposal and reuse options. Other consumable materials include polymer bags and film to contain waste.

b. Collection, transport and transfer

Key questions to consider around collection, transport and transfer include:

How often should you collect?



Frequency of collection is a key question and will in many ways inform the choices to follow. Examples of frequency of collection range from daily to once per month. However, the key factors to consider are: 1) How large is your container and how quickly will it fill given the size of the household? 2) How much space is available for container storage? 3) Given local climatic conditions, how long can a container remain in the toilet before producing an unpleasant user experience? 4) Given that increased collection results in decreased efficiency and high operating costs, what is the maximum collection frequency that makes economic sense? 5) Do you have the potential to split the collection process into multiple steps thereby consolidating fecal volumes and number of trips to the treatment facility? 6) Are there any local regulations that may impact how frequently you can collect? For instance, in India where manual scavenging laws prevent frequent collection it may be necessary to developed a multiple container system with four containers on a roller base underneath toilet floor. This allows the feces to age and dry before they are collected, thus abiding by the regulations set down by the government.

[10] Jenkins, Joseph. "The humanure handbook." A guide (2005).

[11] For example, Loowatt's home toilet https://www.loowatt.com/toilets.html

Where will collection take place?

Most CBS service providers collect waste either from within the customer's home or on the doorstep, depending on the environment and customer preference. However in some cases, to work with household schedules and serve hard to access areas, customers can be asked to take their fecal sludge to a pickup point or community locker for customers to drop off their sealed bags and pick up new materials.[12]

Will you provide any other services?

Some CBS organizations also provide a toilet cleaning service. There is a need for research into the market for sanitary products. Specifically, whether it would be beneficial for collectors to sell/supply them alongside the waste collection service and whether this could be welcome/acceptable to customers. The CBS service model provides an established, high-touch network of customers often in neighborhoods rarely visited by established businesses. As such there is potential for add-on products and services, health information, government services to be layered on top. However, CBS providers need to be cautious not to let additional services or products degrade the core service quality.

What type of transport will you use?

CBS providers use a range of different transport types depending on what is available locally and what is best suited to road conditions and distances to be covered. First stage transport can include:

- Wheelbarrows and hand carts – the most maneuverable in narrow, unplanned areas and rough terrains but also the slowest and most physically demanding form of transportation so only suitable for short distances.
- Three-wheeled motorcycles / tuk-tuks – maneuverable and less physically demanding, low investment barrier and operational and maintenance costs, can travel quickly between collection points and the treatment site, provide good weight-bearing capacity, relatively adaptable and maneuverable.

Collected waste is often consolidated and transferred onto larger capacity vehicles such as flatbed or cargo trucks before it is transported to treatment centres. A key consideration when choosing a second-stage transport vehicle is the capacity of waste it can haul in relation to

Handcart used by SOIL, Haiti

Truck used by x-runner, Peru

Tuk tuk used by Clean Team, Ghana

[12] This is the approach taken by x-runner in Peru, read more in World Bank, Evaluating the Potential of Container-Based Sanitation. 2019.

the expected volume of waste collected, fuel efficiency, and whether local regulations require waste haulers to have enclosed cargo holds.

Where will waste be taken in the first instance?
Waste is often brought to a transfer station where it is either stored or loaded onto a second-stage, higher capacity vehicle, such as a large cargo truck, for transport to a treatment centre. This typically depends on the distance to the centre and is intended to reduce number of trips and drivers needed thereby increasing efficiency. In many places, collection is done outside of business hours when treatment centres are closed as the roads are more accessible at those times.

c. Treatment

The CBS approach of separating urine from fecal sludge at source provides a number of benefits for waste treatment. The waste does not need to be dried and is easier to convert into reuse products because it has not sat in a pit and degraded or been diluted in water.

There is also less contamination as high engagement with customers means they can be encouraged not to throw garbage into the toilet. Moreover, if resource recapture and reuse technology are employed during treatment, CBS contribute to reduction in greenhouse gas emissions. See CBS Alliance policy brief, "Supporting the Shift to Climate Positive Sanitation." There are a number of treatment options. Decisions around treatment options are based on land area, environmental conditions, capital and operational budget considerations as well as disposal models and markets for reuse products. Some CBS service providers build and operate resource recovery facilities while others work with partners to implement the waste treatment part of the chain.

Treatment forms currently used by CBS operators include:

- **Pyrolysis:** a type of thermal treatment used to create energy and biochar. Fecal sludge is heated at a high temperature in a low-oxygen chamber to chemically change it into a solids (biochar), liquid (bio-oil) and gas (syngas) products. The type of product produced depends on process conditions.[13]
- **Drying Beds:** fecal sludge is loaded into a drying bed which has a filter media on the bottom which collects liquids for further treatment while leaving behind the solids. The fecal sludge can take several weeks to months to dry, and then be safely disposed or used in agricultural applications.[14]
- **Thermal treatment:** a process in which fecal sludge is heated at temperatures above 65C for a minimum of three hours to kill all the pathogenic material. The decontaminated fecal material can then be used as a binding agent to create biomass fuel. This system can be built off site and assembled in a standard shipping container for ease of transportation and rapid deployment.[15]

[13] Currently undertaken by Mosan in Guatemala.
[14] Currently piloted by Clean Team Ghana.
[15] Currently undertaken by Sanivation in Kenya.

- **Aerobic thermophilic composting:** a composting process that depends on thermophilic (heat loving) bacteria that thrive in an oxygen rich (aerobic) environment to convert human waste into safe, organic, agricultural-grade compost. Temperatures above 122° F (50° C), for at least one week is considered the minimum requirement for assuring safe treatment.[16]
- **Anaerobic digestion:** a process that relies on anaerobic bacteria that grow in the absence of oxygen to process waste in a sealed, oxygen-free environment called an anaerobic digester. This system can produce biogas, electricity and fertilizer.[17]
- **Anaerobic composting:** an anaerobic process as described above that treats waste in the absence of oxygen using anaerobic bacteria specifically to produce compost.
- **Bokashi composting:** The Bokashi system uses a mixture of aerobic and anaerobic bacteria. Fecal sludge is put into large bokashi plastic bags and bags are sealed and left for several months for the anaerobic degradation process to take place. The waste is then placed into a windrow and more Probac is added. The windrow is regularly turned, activating dormant aerobic bacteria, contributing to further pathogen kill.

Thermal treatment

Aerobic thermophilic composting

Anaerobic digestion

e. Safe disposal

If treatment for reuse if not feasible, CBS providers must dispose of waste safely. Many CBS providers dispose of urine on site via infiltration to the ground or soak pits on sites. Fecal waste, on the other hand, would need to be taken away, for example to a landfill site managed by the local municipality.

It may be more feasible to safely dispose of waste as opposed to treatment with reuse. There are a number of factors that could make disposal a more attractive option including a lack of a local market for potential reuse products. In this case the definition of safe disposal according to the JMP is dependent on the national standards that may vary from country to country.[18]

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[16] Currently, undertaken by SOIL in Haiti and Sanergy in Kenya.

[17] In the UK, Loowatt treats waste in a utility-run anaerobic digestion systems that recovers energy and fertiliser. In Madagascar, Loowatt has been piloting a household sanitation service which links to small scale anaerobic digestion treatment systems operated by the city of Antananarivo waste utility.

[18] United Nations (2018). Sustainable Development Goal 6 Synthesis Report 2018 on Water and Sanitation. New York

Given these variations in standards, both the national and local context will be important but a few options include:

- **Municipal waste treatment:** In contexts where municipal waste treatment is available, a partnership with the municipal waste treatment facility to take CBS waste collected may be possible. This is a good approach in a context where there is no reuse product market and there is an existing municipal treatment site that ensures that waste is treated and disposed in accordance with established government standards.[19]
- **Landfill:** In some settings, there may be no capacity for the waste collected by a CBS service to enter a municipal treatment plant or a municipal treatment plant might simply not exist. Assuming the national waste management permits the disposal of human waste at landfill sites, this can be another option for safe disposal.
- **Trenching:** In an emergency situation, or if the government lacks treatment sites and landfill sites, trenching may be an acceptable solution assuming government approval. This disposal method simple entails digging a trench, filling it with waste and covering it with soil. This is not an ideal solution and caution must be taken to avoid contaminating the ground water or other surface sources. However, the US CDC[20] and UNHCR[21] have listed trenching as an option that can be used as a last resort.

f. Reuse products

Fecal sludge can be processed to produce fuel, compost, building materials, protein and animal fodder. Products currently produced by CBS providers include:

- **Biochar:** Biochar is a high-quality charcoal soil amendment which improves the soil by holding nutrients and water in the ground. A key benefit is that when a plant is grown in Biochar, the carbon stays in the ground for up to 1,000 years. It has been recognized by the IPCCC as a viable and scalable carbon sequestration measure.[22]
- **Compost:** Compost is nutrient rich organic matter that can improve poor soils, or to rebuild soils which have been damaged by improper soil management. It can be produced through a number of processes, including aerobic and anaerobic composting as well as black soldier fly biowaste treatment.[23]

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[19] This is the main approach currently undertaken by Clean Team Ghana

[20] cdc.gov. 2020. Potential Sanitation Solutions During An Emergency Response | Global Water, Sanitation And Hygiene | Healthy Water | CDC. [online] Available at: <https://www.cdc.gov/healthywater/global/sanitation/sanitation-emergency-response.html> [Accessed 2 May 2020].

[21] UNHCR WASH Manual: Practical Guidance for Refugee Settings. Seventh Edition January 2020. United Nations High Commissioner for Refugees

[22] Currently produced by Mosan in Guatemala. The US company Biomass Controls also sells a biochar unit that fits in a shipping container.

[23] Currently produced by SOIL in Haiti and Sanergy in Kenya.

- **Briquettes:** Briquettes are a high-energy fuel that can provide an alternative biomass fuel to charcoal and wood. They are made from using thermal treatment to process biomass waste, such as charcoal dust, agricultural residues and carbonized prosopis, and adding fecal sludge to act as a binder.[24]
- **Animal feed -** Black soldier fly larvae: The dried pupae and prepupae of the black soldier fly larvae provide a protein-rich animal feed for chicken, pigs or fish. The larvae feed on a mix of feces and food waste and the remaining waste from the process is turned into an organic fertilizer rich with nitrogen and calcium.[25]

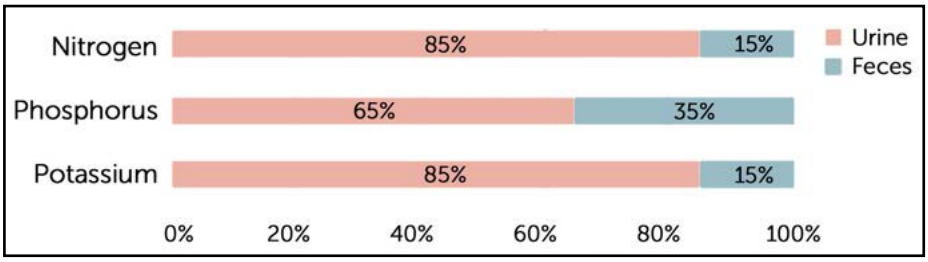
Briquettes

Compost

Animal feed

While no CBS provider has to date focused on recycling urine, there is significant potential in this area. In particular, the majority of the marketable nutrients, NPK (Nitrogen, Phosphorus and Potassium) are found in much higher volumes in the urine than faeces (see diagram below). While the untreated release of nitrogen and phosphorus into water bodies can result in eutrophication and severe environmental degradation, industrial fertilizers globally need sources of nitrogen and phosphorous.

Synthetic nitrogen production using the Haber-Bosch process is energy intensive and a significant source of greenhouse gases. Rock phosphorus is a limited and non-renewable resource mined from a limited number of locations globally. Thus, urine reuse offers a long-term resilient model for human waste management and sustained agricultural production.[26] There has been significant progress on effective methods of processing and reusing urine in recent years including direct application, struvite reactors.[27]



Human urine contains numerous nutrients, requiring extensive treatment at waste water treatment plants. Source data: EAWAG

[24] Briquettes are currently produced by Sanivation in Kenya.

[25] Currently produced by Sanergy in Kenya.

[26] The Rich Earth Institute (2019) Guide to Starting a Community-scale Urine Diversion Program

[27] For example, EAWAG spin-off Vuna Ltd which emerged from its VUNA project: https://www.eawag.ch/en/department/eng/projects/vuna

5. Health and safety

a. WHO Sanitation Safety Planning

CBS Alliance members are working with local government partners to conduct World Health Organization (WHO) Sanitation Safety Planning (SSP), a modular risk assessment process used to understand and mitigate health-related hazards for each link of the sanitation chain.

The SSP process was developed based on the 2006 WHO waste water guidelines and uses the approach of identifying hazards and critical control points widely used in risk management in industrial processes for years but which are new to sanitation. The aim is to minimise the negative health impacts associated with bad sanitation management and maximise the beneficial impacts of sanitation reuse.

SSPs were developed in part due to the realization that all the large-scale reviews of sanitation interventions were showing a limited impact on health, and that much better health gains could be achieved if there was a more systematic approach to cut exposure pathways. Burden of disease assessments showed that moving from unimproved to improved sanitation achieved a 16% reduction in diarrheal diseases, but moving from unimproved to safely managed sanitation showed a 69% reduction.[28] Therefore, there is potential for a much greater health impact through sanitation than is currently being achieved.

While the health department within the local authority are ultimately responsible, as they have the overview of the entire sanitation system, any CBS provider can take responsibility for the elements that they can influence.

Exposure groups, hazards, controls and monitoring are all important. The SSP process is not just about improving technology, but about making incremental improvements through management, behaviour and technology to reduce risk at all steps of the sanitation chain.

The safely managed sanitation (6.2.1) and safely treated wastewater (6.3.1) indicators of the SDGs will be measured using statistically representative, globally comparable data to inform global monitoring processes. The SSP process is an implementation tool to be used at the city or system level to capture the details of each systems and ensure they are safely managed in practice in line with the intent of the indicator.

Extensive guidance can be found in the WHO's Sanitation Safety Planning - a manual for safe use and disposal of wastewater, grey water and excreta. Additionaly, SOIL's Sanitation Safety Plan can be found on the WHO website as well.

[28] WHO, Preventing diarrhoea through better water, sanitation and hygiene - Exposures and impacts in low- and middle-income countries. 2014.

The following tables outline minimum required protocols.

Planning documents

Protocol	Details
Medical protection plans	Staff training, medical immunization, and health checks
Health and safety monitoring plan	Spot checks, incident reporting, and investigations

Operational protocols

Protocol	Details
General safety protocols	General daily activities including heavy lifting, driving vehicles, handling untreated faeces, and operating machinery
Latrine emptying and transfer safety protocol	How to service a toilet safely (set up, toilet emptying, and human waste transfer)
Human waste processing (red zone) safety protocol	Staff induction to biohazard zone, waste transfer to treatment tank, cleaning and disinfecting tools, and Personal Protection Equipment (PPE)
Reuse production safety protocol	Handling of materials, operating machinery, quality control, and equipment maintainance
Emergency spillage protocols	How to manage spillage of hazardous materials

b. Potential risk issues unique to Container-Based Sanitation

While CBS is an effective solution for limiting the spread of fecal contamination within household and community environments, there are some health and safety issues that are unique to the CBS service model. These include:

- Labour-intensive: The labour-intensive nature of CBS service provision can pose a potential health and safety risk during epidemics of infectious diseases as CBS collection staff could face high exposure. Frequent health checks of employees and preventive measures are recommended. In 2020, the global coronavirus pandemic has prompted providers to adopt a number of disease transmission mitigation measures including: enhanced PPE equipment, reducing contact between staff through split shifts and reducing collection frequency. However, the outbreak also highlighted a number of benefits of the CBS model. It highlighted how CBS supports health and was recognized by a number of governments as an essential service that could continue to operate during lockdown periods. In areas where temporary isolation settlements are needed to host infected people, CBS has offered a fast

solution to provide sanitation. Furthermore, through their direct and regular contact with households, CBS providers were able to play a supportive roll to tackle the outbreak, including leveraging their unique networks and relationships with communities to share health messaging and dispel disinformation.

- **Urine and greywater infiltration:** Infiltration of urine and greywater is an acceptable short-term solution. However, in the long-term, large-scale infiltration of urine can lead to elevated nitrate and nitrite levels, as well as pharmaceutical contamination in groundwater. This would also apply to unlined pit latrines as well. However, in places where water tables are high or infiltration is slow, there could be a risk of contamination. More research on how integrating urine and greywater solutions into CBS services is needed.
- **Container cleaning:** Most CBS operators strive to disinfect, rather than sterilize, their containers. Technically, disinfection[29] entails the removal of most pathogenic organisms. This is distinct from cleaning, which typically involves removing visible contamination and solids from surfaces and from sterilization, an extremely high standard of decontamination, which ensures all organisms have been killed or removed. Disinfection is an appropriate level of decontamination that is line with both US EPA and WHO safety standards. See annex 6 for examples of container cleaning SOPs.

c. Testing treated waste

It is important that pathogen inactivation tests for a faecal indicator bacteria (FIB) are carried out on treated waste to make sure it is safe for reuse or disposal. Ascaris is the most robust indicator organism to assure that there is complete destruction of pathogens because Ascaris eggs are the most difficult to eradicate. There have been studies performed by the US CDC in Haiti which indicate that Escherichia coli (E. coli) die off mirrors Ascaris egg die off. Given the difficulty of testing for Ascaris, most CBS providers prefer to test for the FIB, E. Coli, which is more specific to the human gut than thermotolerant/fecal coliforms and less likely to be present due to other sources of contamination. There are a number of tests on the market but the most commonly accepted procedures include using standard membrane filtration methods or IDEXX methods.

Some useful resources for water and wastewater testing information and standards include:

- Standard Methods for the examination of water and wastewater
- US EPA Environmental Regulations and Technology Control of Pathogens and Vector Attraction in Sewage Sludge
- WHO Guidelines on sanitation and health

No matter what method you choose, it should adhere to any standards or regulations already adopted by the country where you are operating.

[29] Engineering science of water treatment unit operations, Seán Moran, in An Applied Guide to Water

6. Promotion

a. Customer acquisition

CBS providers use a range of market-based strategies to increase sales and the density of their services and there is a wealth of resources around sales and marketing that prospective CBS providers will be familiar with and can benefit from. However, as an innovative approach that has yet to be widely adopted, there are a number of aspects that are particular to promoting the CBS service to new customers.

CBS community event promotion in Haiti. Photo: SOIL

As CBS providers tend to operate in low income areas, they have to convince clients who don't necessarily have regular monthly wages that paying a regular fee for a toilet is a worthwhile expense. In areas where there is a history of paying for sanitation services, providers can promote the uptake of their toilets on a pricing structure based on the cost that families were previously spending on the use of paid public toilets.[30]

However, in some areas, there may not be a history of any sanitation service or a familiarity with paying for services at all yet alone for an in-home service. In these contexts the concept of paying for a sanitation service can pose a cultural barrier that needs to be addressed.[31] Business Customer revenue will account for a greater percentage of overall revenue if the residents of an area are familiar with the concept of paying for sanitation and CBS is a cost competitive option.

b. Toilet use

All CBS service providers strive for excellent customer service and user satisfaction has been found to be consistently high.[32] A key component to support user satisfaction is to ensure good hygiene practices and correct use of the toilet. Proper use of the toilet, ensuring cleanliness and

[30] Sanergy in Kenya and Clean Team in Ghana are two providers who have been able to take this approach.

[31] This was the case for SOIL, see User perceptions of and willingness to pay for household container-based sanitation services: experience from Cap Haitien, Haiti (2015).

[32] World Bank, Evaluating the Potential of Container-Based Sanitation. 2019

lack of smell all help to ensure a good customer experience and to ensure maximum health benefits, are key to fostering customer loyalty to the service. To support this CBS providers undertake hygiene training, as part of their customer onboarding process and follow-up visits to reinforce the importance of proper and hygienic use of the toilets.

SOIL's service diagram

Sanivation toilet use diagram

Sanivation toilet servicing form to monitor correct usage every servicing round

Household ID	Smell (1-3)	Cleanliness (1-3)	Toilet Status (1-2)	Notes/client comments
Household 1				
Household 2				
...				

Smell	Cleanliness	Toilet Status
1 . No Smell	1 . Very Clean	1 . OK
2 . Average	2 . Average	2 . Repair
3 .Really bad smell	3 .Very dirty	

c. Reuse products

In areas where market conditions and the legal framework are favourable, there is potential for reuse products to provide a stream of revenue for CBS cost recovery and support environmental sustainability. However, operating a reuse facility can be one of the more cost intensive links in the chain so it is important to ensure the market for your products is well understood before developing this part of your service. Too often the incorporation of reuse into treatment schemes has been an afterthought in the planning process. Due consideration should be made to the local institutions, market demand, and supply chains in order for them to succeed.[33]

Animal feed produced by Sanergy

Unmet demand has been found to be a very important predictor of success, even above attitude, across all reuse products.[34] Where there are existing alternatives, your reuse product will need to be able to compete with and offer an additional benefit that entices consumers to switch (e.g., lower cost, added convenience, better performance).

Another element to consider is the acceptability of reuse products made of human feces in your target market. In many places, there are existing tradition of using human feces and urine as fertilizer. In these areas, where there exists a high level of familiarity with the concept, there would be greater potential to develop a market for reuse products. However, in many places there exist cultural beliefs and taboos around the handling of human waste and these can be difficult, though not impossible, to overcome.[35]

Biochar produced by Mosan

[33] Back-End Users: The Unrecognized Stakeholders in Demand-Driven Sanitation, 2010

[34] By processing waste with black soldier flies to produce animal feed, Sanergy has been able to respond to the huge demand for affordable, protein-rich animal feed in East Africa

[35] An aversion to handling containers of excreta by some members of society was encountered by Clean Team in Kumasi and Oxfam in Nairobi during the early stages of their CBS service development.

A particularly useful tool in working through the different reuse trade-offs is the Outline of Design for Service, a five-step reuse-oriented planning approach that results in site-specific, reuse-oriented sanitation schemes. The approach is locally tailored to specific users and specific economies; therefore it requires domain expertise as well as a significant role for user participation and input.[36]

Compost produced by SOIL

Briquettes produced by Sanivation

[36] Back-End Users: The Unrecognized Stakeholders in Demand-Driven Sanitation, 2010

7. Monitoring

Monitoring is essential for preventing and avoiding malfunctions; for knowing when to adjust course if necessary and for providing excellent customer service. All monitoring tools should be simple enough that staff can master their use within a month.

Some of the most important metrics on which to collect data on include:

d. Payment collection

As a business you want detailed records of payments and which customers are delinquent. If delinquency persists, then it will be necessary to stop service and remove the toilet from the delinquent customer. However, this removal needs to be done under predictable, consistent standards so other customers understand the importance of on time payments. Without detailed payment data this process can be fraught and result in angry customers and mistrust.

e. Collection frequency

It is important to know the frequency and mass of the waste collected from each service area and even at the household level. This does not have to be done by weighing every container which would be time intensive at scale but can be estimated based on assumptions informed by regular (yearly, bi-yearly) weighing of a subset of containers. This will allow the business to tailor their collection frequency for optimal efficiency. Additionally, it is essential to understanding the total Mass of waste collected minus cover materials which is necessary for government, impact and carbon credit reporting.

f. Densification

This can be done by gathering GPS data on where your customers are located and will help the business understand how spread out their customers are. The results in a better understanding of where efforts should be directed to densify customer bases. As a general rule of thumb, the higher your customer density are the more cost efficient your service will be.

g. Customer churn and satisfaction

Customer churn is the percentage of customers that stopped using the service in a given time frame. This is one of the most important metrics for a growing business and is a good indicated of revealed satisfaction with the service. Churn can be both voluntary (related to customer satisfaction) and involuntary churn (dependant on external factors). Businesses want to keep churn to a minimum because it uses up additional resources to bring new customers just to remain at the same level instead of growing. Peer reviewed research on the drivers of customer churn in CBS services is ongoing and should be available in the near future.

CBS providers must be committed to excellent customer service and satisfaction. If customers will likely be forced to wait for sewerage or other adequate sanitation services (as is the case in

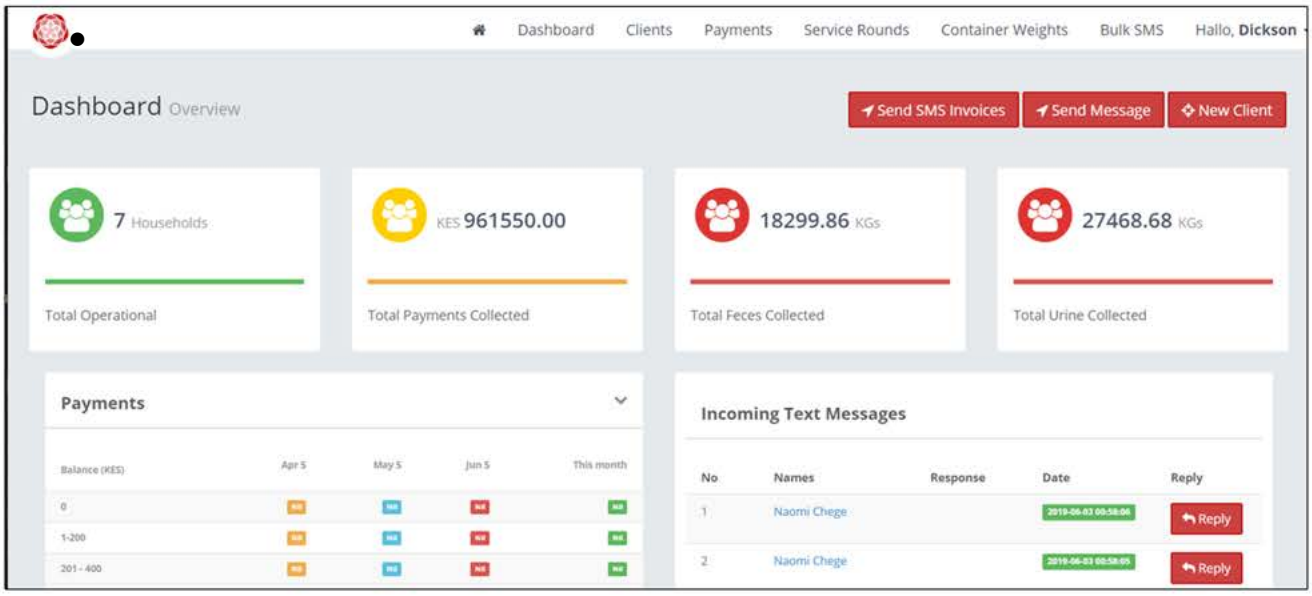
informal settlements) then they are far less likely to view CBS services as transitional. While CBS is a valuable transitional solution, thinking of it as a long-term, reliable solution may be helpful for setting the bar for customer service that should be on par with sewerage.

h. Waste-to-resource

Assuming the business is engaged in resource recovery it is essential to know the amount of waste being collected and the amount of reuse product being created. This will help determine if you need to make your process more efficient, how you can reduce costs while increasing revenue. Like collection data, treatment data will be essential for government, impact and carbon credit reporting.

i. Cost of toilets

It is important to keep track of the cost of different toilet models and their usable life as this can be a significant cost driver. Maintaining high standard of toilet quality are essential to the user experience and customer retention. If the toilet is failing or not operating correctly households will likely report this and such data is essential to improving the service and driving costs down. Additionally, if a customer is abusing the toilet it may become necessary for the CBS service provider to remove the toilet and discontinue service. Lastly it should be noted that maintaining a high quality, clean and function toilet is essential for maintaining safely managed sanitation and you will want to document that you are in fact providing this level of service.



Sanivation's monitoring dashboard

i. Digital tracking tools

One of the challenging aspects of collecting data is how to store it and analyse it in a way that does not place a huge work burden on the business staff. Paper data collection is only really feasible up to around 100 toilet installations and, while there are numerous software options on the market, few, if any, are optimized for CBS. As a result, many providers have previously,

built their own software platforms at great expense and maintenance cost. Additionally, this has created incompatible data sets within the CBS sector and can lead to a lack of comparability.

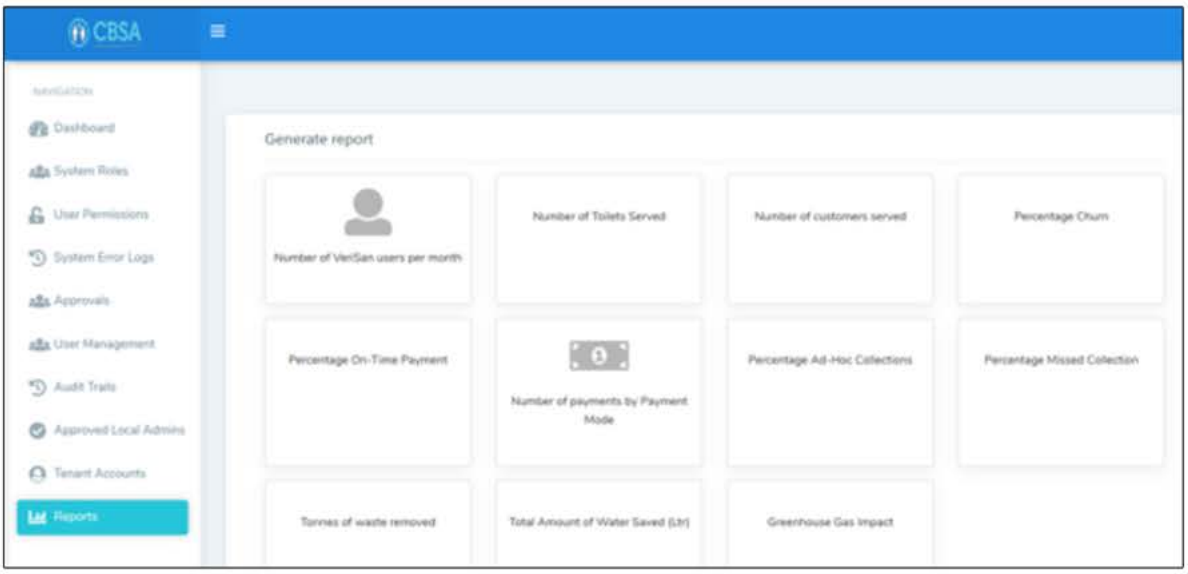
To address these issues, the CBSA is developing common service standards to support consistent service quality in CBS implementation. The Alliance also collects common data on performance indicators from members to demonstrate effectiveness, impact and reach in order to fulfill its end goal of increasing access to and uptake of CBS.

This work is supported by VeriSan, a digital customer and operations management tool recently developed by the Alliance. The common platform enables the collections of data and impact metrics and allows new CBS providers to adopt established best practices and processes drastically increasing their learning and ability to deliver high-quality services from day one.

VeriSan mobile app user interface

The system can serve multiple CBS entities and allows each entity to manage their own data and also includes a super-admin access to non-proprietary aggregated data. It includes modules to manage the entire customer and sanitation value chain from lead generation, through customer conversion and toilet installation, toilet servicing and waste collection. It also supports billing and payments (including mobile payments). The potential for monitoring carbons offsets is being explored.

For customers, it allows them to benefit from a tried and tested customer experience and journey. For governments and other external stakeholders, it can provide common CBS data and impact metrics from an organisation and system working at arm's length from the service provider. To find out more, contact CBSA at:
contact@cbsa.global



VeriSan desktop user interface

8. CBS in humanitarian contexts

Thanks to its non-permanent nature and its ability to be deployed in new areas and quickly scaled, CBS is ideally suited to humanitarian response settings such as refugee, emergency and disaster displaced people camps.

To date CBS has been deployed in response to natural disasters[37] and refugee crises[38] and this early work has demonstrated CBS as an effective approach in these settings. The approach proved itself as well suited to the difficult environmental conditions found in displaced people's camps including rocky ground, high water tables and limited space for construction. Moreover, the intervention was delivered at comparatively lower cost than other options and ensured complete and safe treatment of wastes.

In the case of Kakuma refugee camp In Kenya, the intervention demonstrated that a market based solution such as CBS can help to fill funding gaps for public services in humanitarian settings and contributed to supporting livelihoods by employing refugees to provide the service. In Haiti, where the approach was rolled out throughout the dense urban setting of Port-au-Prince in response to the 2010 earthquake, the approach was deemed acceptable by landlords who rejected more permanent installations.

While the approach was recommended, funding in these contexts is not guaranteed, sustainable or traditionally done with private sector and political dynamics can make it difficult to set up. Further work to raise awareness of the CBS approach as an effective solution in humanitarian contexts among relevant stakeholders.

Sanivation's shipping container waste processing system used in Kakuma refugee

[37] See Piloting ecological sanitation (EcoSan) in the emergency context of Port-au-Prince, Haiti, after the 2010 earthquake and Thermophilic composting of human wastes in uncertain urban environments: a case study from Haiti

[38] See Waste-to-Value Sanitation in Kakuma Refugee Camp, Analysis from the piloting of a business model involving container-based sanitation and a domestic energy reuse product

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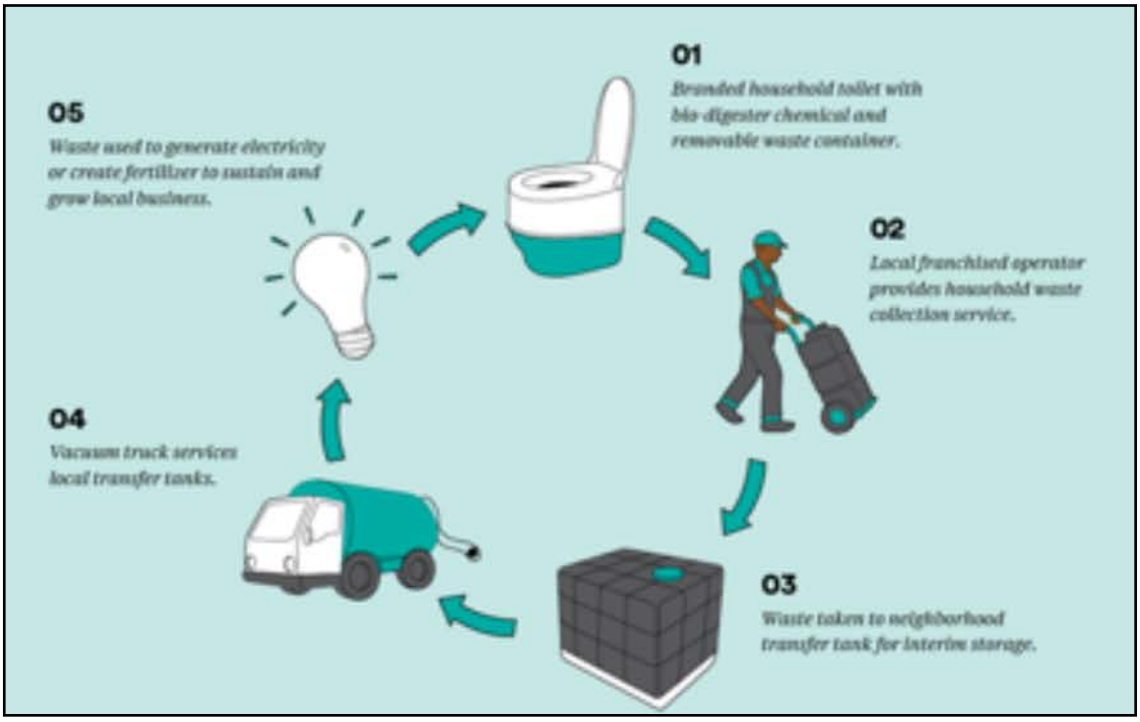
Annexes

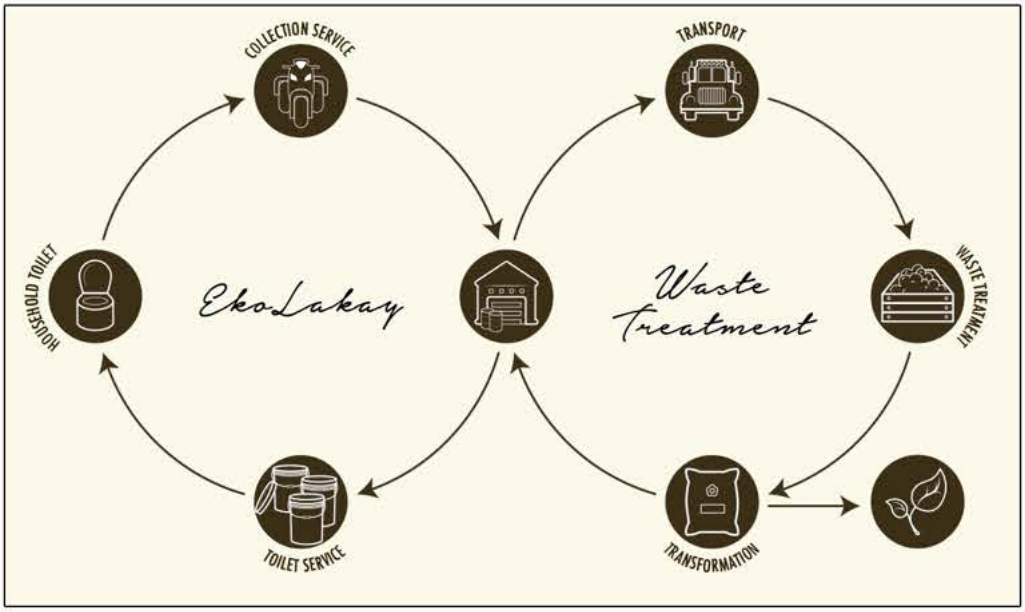
Annex 1 – Further examples of CBS operator service models



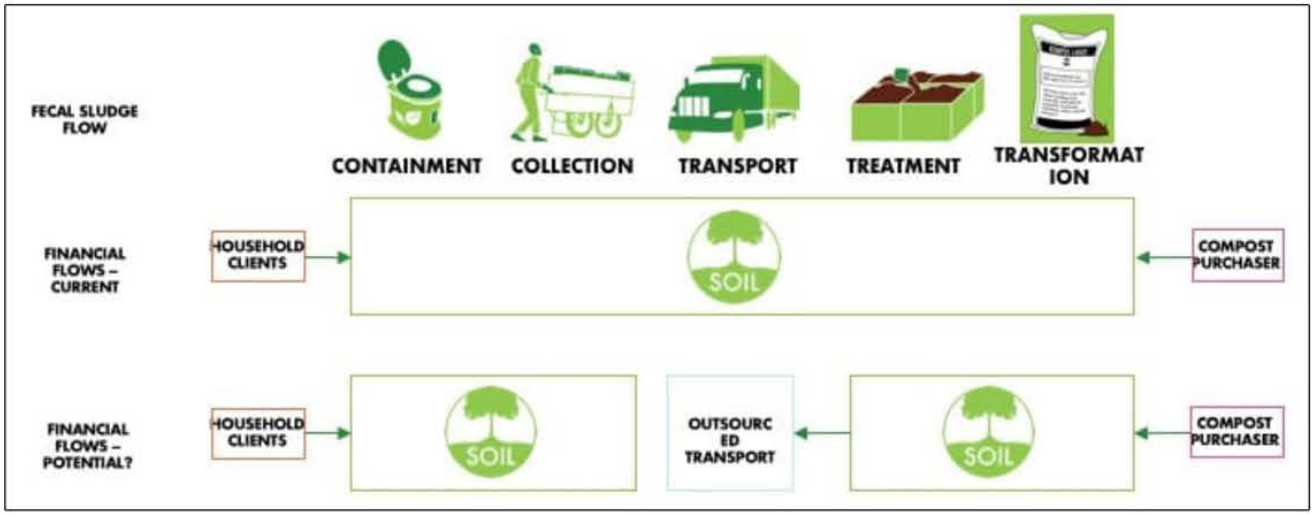
Clean Team Ghana's service model

Loowatt's service model

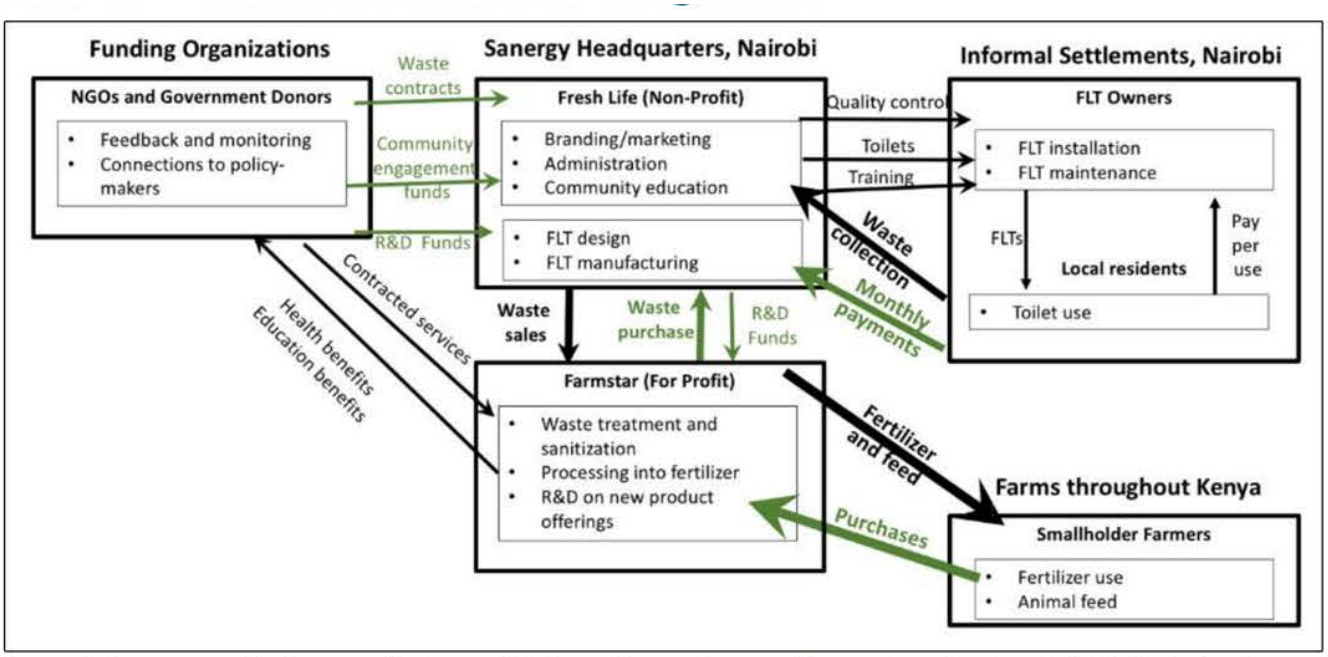
Annex 2 – Business model diagrams



This diagram illustrates how SOIL has divided their business model into two distinct sections. Ekolakay is the frontend service that costumers interact with while the back end treatment and reuse is seen as a different business model, but they are reliant on each other.

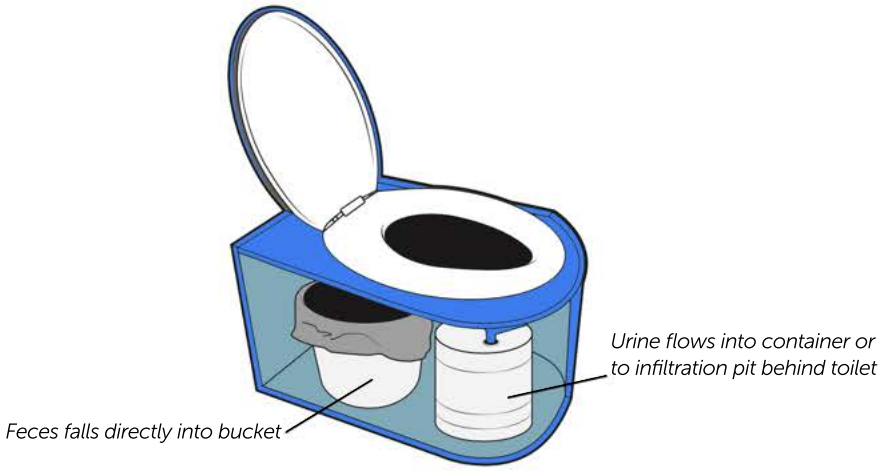


This diagram shows SOIL fecal sludge flows, financial flows and ways in which different parts of these chains could be adjusted to increase efficiency and cost effectiveness.



Sanergy's two-pronged business model Source: Waldman-Brown, Anna and Flatter, Georgina Campbell. 2018. Scaling Sanergy: Growing a Promising Sanitation Startup. The Legatum Center, MIT Sloan.

Annex 3 – Further examples of CBS toilet design



In Kenya, Sanivation uses the "Blue Box" toilet

In Haiti, SOIL's toilets, which are constructed by Haitian contractors, use either ferro-cement or wood

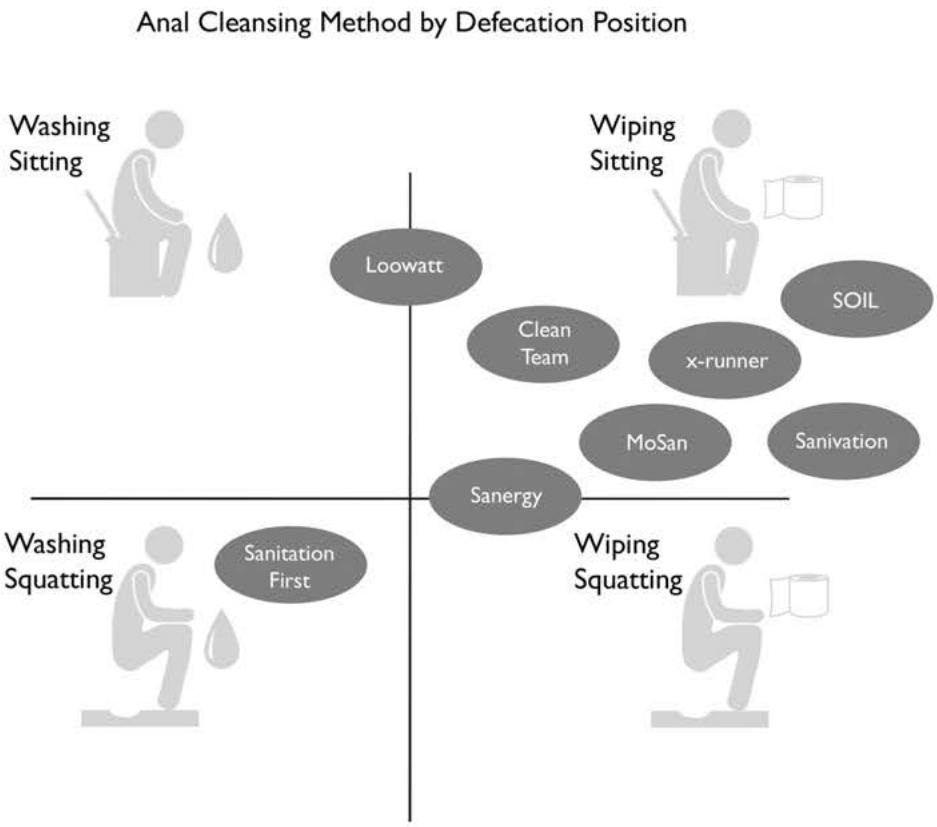
In Peru, x-runner uses the Separett toilet model, sold to x-runner by its foreign producer at a discounted price

In Kenya, Sanergy's "Fresh Life" toilets use a urine-diverting squat plate

In Madagascar, Loowatt provides waterless-flush sanitation systems that seals waste into a portable cartridge using biodegradable film, which prevents odors and does not require any cover material

In Guatemala, Mosan toilets are light-weight and contain two removable containers and an anti-smell-valve. Mosan produces their toilets with contracted producers.

Annex 4 – Cleansing method and defecation position of current CBSA operator clients



Source: Russel K., K. Hughes, M. Roach, D. Auerbach, A. Foote, S. Kramer, & R. Briceño, Taking Container-Based Sanitation to Scale: Opportunities and Challenges. Frontiers in Environmental Science 2019, 7, 190

Annex 5 – Examples of superstructure materials

A superstructure refers to the housing around the toilet, typically super structures are a standalone structure in a yard or alleyway outside of a main house. Superstructures typically increase the cost of the toilet set up significantly. They can be constructed from numerous different materials but there are a couple features that are essential to positive user experiences.

1) Well-lit but with sufficient privacy.
2) Sufficient air flow to reduce any odour.
3) A washable floor, this is key to reducing contamination and transmission of Helminths (parasitic worms). Typically, this is a cement, tile, or wood floor with some sort of waterproof covering.

Examples of different superstructure materials:

Grass – low cost but not very durable. Photo: SOIL

Wooden frame with plastic sheeting or rice bag walls – design for an IDP camp post disaster. Photo: SOIL

Metal frame, walls and roof. Photo: Sanitation First

Metal frame with woven plastic walls. Photo: Loowat

Concrete frame and walls with frosted roof. Photo: Sanergy

Annex 6 – Cleaning standard operating practice examples

Sanivation SOP for Washing Urine and Feces Containers

Version control			
Version	**Author**	**Date**	**Comment**
0.1			

Function	Toilets Servicing
Process	Red zone
Activity	Cleaning bucket and urine barrels
Scope	To show how cleaning of buckets and urine barrels is done
H+S	PPE:- Arm-length gloves, face masks, overall, mackintosh apron, gumboots, head wrap.
Personnel	Onsite Toilets Servicing Representatives
Equipment	Scrubbing brush, chlorine, scrubbing cloth
Procedure	1. Soak the barrels in chlorinated water for 15-20 minutes 2. Using the scrubbing brush, thoroughly scrub the interior of the barrels 3. Using the scrubbing cloth, thoroughly scrub the exterior of the barrels 4. Rinse with clean water 5. Hang on the drying rack to dry in direct sunlight for 45minutes to 1 hour. 6. Unhang and store them in a cool aired dry storage area.
Data	Any bucket or barrel breakages

CONTAINER EMPTYING

Objective	Ensure that the process of emptying the containers arriving on the composting site is done according to the thermophilic composting process, in a way that protects both workers health and the environment.
Frame	This protocol applies to each container emptied on a composting site.
Responsibility	The composting team is responsible for executing the protocol. The site supervisor is in charge of verifying the correct application of the protocol.
Necessary Equipment	• Gloves • Overalls • Boots • Mask

Activity 1: Before containers arrival

Step	Action
1	The composting team must wear the full equipment: overalls, boots, mask and gloves.
2	Ensure that the hand washing fountains, the container disinfection tank and the tire disinfection tank are full of chlorinated water according to the **disinfection protocol**.
3	Ensure that there is enough water available in the storage tank.
4	Before emptying in a new bin, make sure the walls are properly filled with bagasse and that they are solid.
5	Prepare a 6 inches layer of compost heads at the bottom of the bin that will be used for emptying.
6	Ensure that enough compost heads are available to cover the pile once emptying is finished.
7	Count the number of emptied containers as well as the quantity of compost heads added to the pile. Communicate data to supervisor.
8	If containers need to be weighed, remember to prepare the scale. Make sure to have a sheet of paper and a pen to write the data.

Activity 2: When the containers arrive

Step	Action
9	Unload the containers near the bin where they will be emptied.
10	If needed, weigh each container and record data on the datasheet.
11	Start emptying in the bin designated by the supervisor.
12	Add compost heads to cover the waste and prevent smell and flies if necessary.
13	Close each container with its lid and place it on the floor immediately after emptying it, before it can be transferred to the washing area (**container washing protocol**)
14	Make sure that every person present in the area during emptying is wearing the full protective equipment.
15	Make sure that no one is eating, drinking or smoking inside the "red" zone.
16	Make sure that every person involved in emptying follows the **disinfection protocol** before entering another bin or another zone.
17	When all the containers are empty, cover the pile with a 10cm layer of compost heads.
18	Finally, make sure the net is down to cover the pile and protect it from vectors.

Activity 3: When emptying is finished

Step	Action
19	Make sure that all the tools used during emptying are disinfected according to the **disinfection protocol**.
20	Make sure that each team member involved in emptying cleans themselves completely according to the **disinfection protocol.**
21	Make sure that all the containers, closed with their lids, are transferred to the designated washing area.
22	Store all the dirty overalls and protective equipment in a specific container so they can be washed and disinfected appropriately later on, following the **disinfection protocol**.
23	If the containers were weighed, give the datasheet to the site supervisor.

CONTAINER WASHING	
Objective	Ensure that all dirty containers are washed in the reserved area, using a pressure washer, then disinfected with chlorinated water according to the **disinfection protocol** in order to protect both workers health and the environment.
Frame	This protocol must be followed after each dumping session.
Responsibility	The composting team is responsible for executing the protocol. The site supervisor is in charge of verifying the correct application of the protocol.
Necessary Equipment	• Gloves • Overalls • Boots • Mask • Pressure washer • Chlorine (HTH)

Activity 1: Before container washing

Step	Action
1	Make sure that the water drain is not clogged.
2	The composting team must wear the full equipment: overalls, boots, mask and gloves.
3	Ensure that the hand washing fountains, the container disinfection tank and the tire disinfection tank are full of chlorinated water according to the **disinfection protocol**.
4	Make sure that all the dirty containers are organized in the washing area and closed with their lids.

Activity 2: During container washing

5	Use the pressure washer to wash the containers and lids thoroughly and remove all remaining solids.
6	Place the clean containers and lids in the disinfection tank. Leave them for at least one minute before taking them out.
7	Place the disinfected containers and lids on the drying bed to let them sundry.
8	Repeat steps 5 to 7 for each container and lid.

Activity 3: After container washing

Step	Action
10	Make sure the washing area and all tools that were used in the process are cleaned according to the **disinfection protocol**.
11	Make sure that each team member involved in washing cleans themselves completely according to the **disinfection protocol.**
12	Store all the dirty overalls and protective equipment in a specific container so they can be washed and disinfected appropriately later on, following the **disinfection protocol**.
13	Make sure all the clean containers and lids are stored in a clean area (hangar for example)

DISINFECTION	
Objective	Make sure each person, equipment or vehicule entering and leaving the red zone is disinfected appropriately to avoid contamination of people or the environment.
Frame	This protocol applies to all people, equipments and vehicules leaving the site's red zone.
Responsibility	Each person entering the red zone and using one or more pieces of equipment in the zone is in charge of following this protocol. The site supervisor is in charge of verifying the correct application of the protocol.

Necessary Equipment	• Water • HTH (65%) • Mixing tool (stick) • Brush • Pressure washer or hose • Gloves

Activity 1 : Preparation of the chlorinated solutions

Step	Action
	I. Preparation of the Disinfection Tank solution (0.2 %)
1	Check if the tank is full and if chlorine has to be added. If the tank is ready, go directly to « II. Preparation of the Hand Washing solution (0.05%)». If not, go to the next step.
2	Fill the tank with water (8 drums = 456 liters)
3	Wear gloves and add 1.4 kilo of HTH in the full tank.
4	Stir with a stick for at least 2 minutes to ensure complete dilution of the chlorine in water.
	II. Preparation of the Hand Washing solution (0.05%)
5	Check if the tank is full and if chlorine has to be added. If the tank is ready, go directly to « II. Preparation of the Tire Disinfection Basin solution (0.05%)». If not, go to the next step.
6	Fill the tank with water (5 gallons)
7	Wear gloves and add 15 grams of HTH in the full tank.
8	Stir with a stick for at least 30 seconds to ensure complete dilution of the chlorine in water.
	III. Preparation of the Tire Disinfection Basin solution (0.05%)
9	Check if the basin if full and if chlorine has to be added. If the basin is ready, go directly to « What do I need? ». If not, go to the next step.
10	Fill the basin by the main gate with 6 drums of water (342 liters). Fill the basin by the carwash with 7 drums of water (399 liters).

11	Wear gloves and add: - 263 grams of HTH in the basin by the main gate - 307 grams of HTH in the basin by the carwash
12	Stir with a stick for at least 2 minutes to ensure complete dilution of the chlorine in water.

What do I need?

- For disinfection of **People**, go to **Activity 2**
- For disinfection of **Equipment and Tools**, go to **Activity 3**
- For disinfection of **Vehicles**, go to **Activity 4**
- For disinfection of **Clothing**, go to **Activity 5**
- For disinfection of **Surfaces**, go to **Activity 6**

Activity 2 : Disinfection of People

Everyone has to disinfect themselves before leaving the red zone.

Step	Action
1	Before leaving the red zone, each person has to rinse their shoes and hands with a **0.05% chlorinated water solution**.
2	Anyone taking part in dumping has to take a shower and dispose of dirty work clothes in a specific container before it can be washed and disinfected. The container needs to remain closed.

Activity 3 : Disinfection of Equipment and Tools

All equipment and tools have to be disinfected before leaving the red zone or being used for another activity (in the red zone or anywhere else).

Step	Action
1	After being used in the red zone, all equipment and tools have to be disinfected using a **0.2 % chlorinated water solution.**
2	After washing, sundry the equipment.
3	After drying, store the equipment and tools in their usual place.

Activity 4 : Disinfection of Vehicles

All vehicles have to be disinfected before leaving the red zone.

Step	Action
1	Park the vehicle in the washing area (« car wash »)

2	Use a hose or a pressure washer to clean the vehicle with water. Ensure that all solids are removed.
3	If the vehicle was carrying contaminated matter (waste containers for example), disinfect the bed with a **0.2% chlorinated water solution**.
4	When leaving the red zone, make sure that the vehicle drives through the tire disinfection basin.

Activity 5 : Disinfection of Clothing

Each item of clothing worn during dumping must be stored in a specific sealed container befoı being washed and reused.

Step	Action
1	Once dumping is finished, ensure that all worn items of clothing are stored in a specific sealed container.
2	Soak the clothes in a **0.2% chlorinated water solution**.
3	Spin, then wash with water and soap.
4	Sundry.

Activity 6 : Disinfection of Surfaces

All surfaces used for « risky » activities (such as the washing area for example) must be disinfected after use.

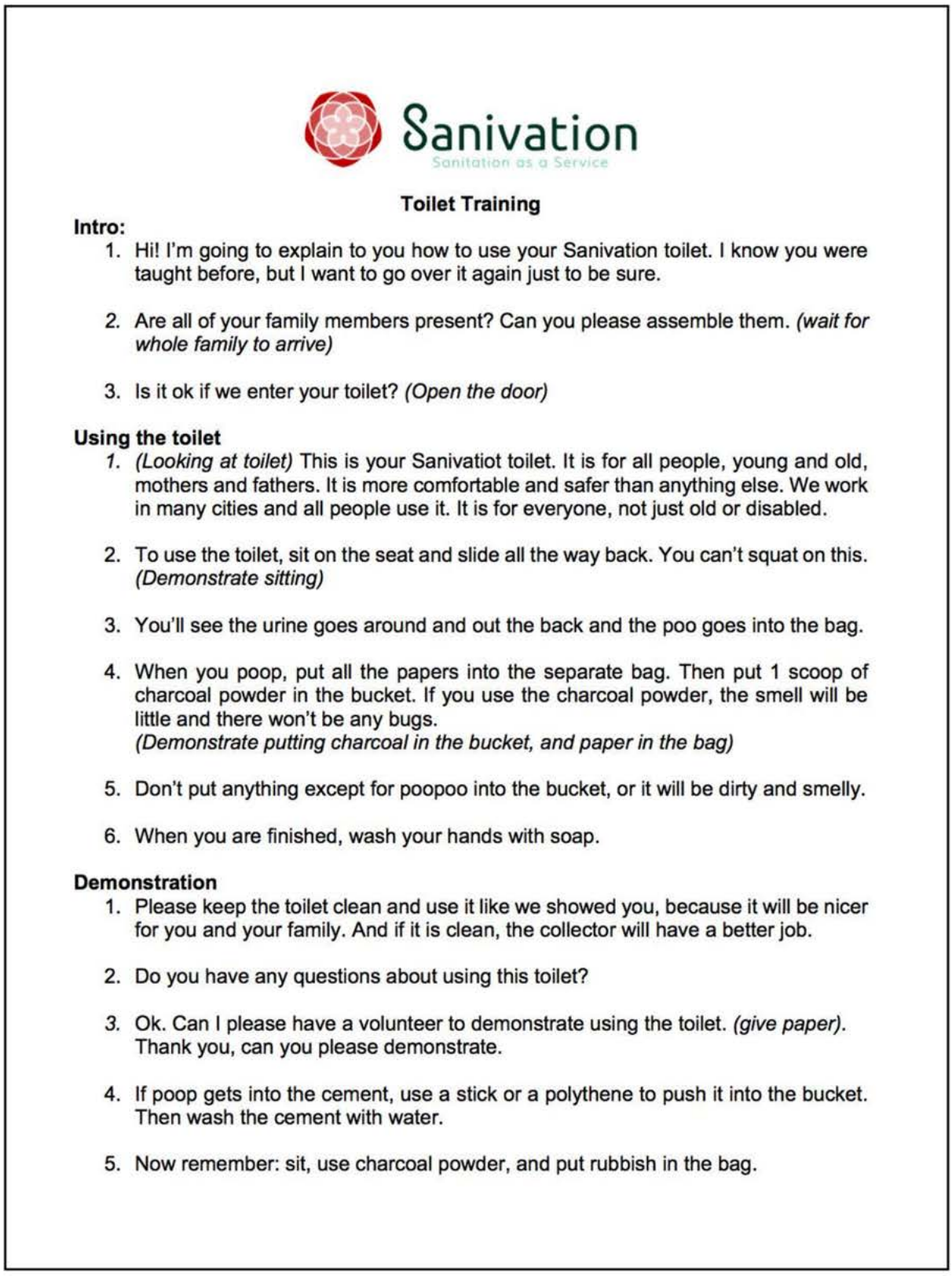
Step	Action
1	Use a hose or pressure washer to clean the chosen area with a **0.2% chlorinated water solution**. Ensure that all solids are removed.
2	Sundry.

Annex 7 – Example promotional materials

SOIL toilet promotional flyer

Loowatt behaviour change campaign flyers

Annex 8 – Further example toilet use training materials



Sanivation
Sanitation as a Service

Toilet Training

Intro:

1. Hi! I'm going to explain to you how to use your Sanivation toilet. I know you were taught before, but I want to go over it again just to be sure.

2. Are all of your family members present? Can you please assemble them. *(wait for whole family to arrive)*

3. Is it ok if we enter your toilet? *(Open the door)*

Using the toilet

1. *(Looking at toilet)* This is your Sanivatiot toilet. It is for all people, young and old, mothers and fathers. It is more comfortable and safer than anything else. We work in many cities and all people use it. It is for everyone, not just old or disabled.

2. To use the toilet, sit on the seat and slide all the way back. You can't squat on this. *(Demonstrate sitting)*

3. You'll see the urine goes around and out the back and the poo goes into the bag.

4. When you poop, put all the papers into the separate bag. Then put 1 scoop of charcoal powder in the bucket. If you use the charcoal powder, the smell will be little and there won't be any bugs.
   (Demonstrate putting charcoal in the bucket, and paper in the bag)

5. Don't put anything except for poopoo into the bucket, or it will be dirty and smelly.

6. When you are finished, wash your hands with soap.

Demonstration

1. Please keep the toilet clean and use it like we showed you, because it will be nicer for you and your family. And if it is clean, the collector will have a better job.

2. Do you have any questions about using this toilet?

3. Ok. Can I please have a volunteer to demonstrate using the toilet. *(give paper).* Thank you, can you please demonstrate.

4. If poop gets into the cement, use a stick or a polythene to push it into the bucket. Then wash the cement with water.

5. Now remember: sit, use charcoal powder, and put rubbish in the bag.

Sanivation toilet training script

backside of last page

inside of back cover

outside of back cover