

Evaluating the Potential of

Container-Based Sanitation



x-runner in Lima, Peru

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EVALUATING THE POTENTIAL OF CONTAINER-BASED SANITATION: AN OVERVIEW

The World Bank Water Global Practice (WGP) has developed an approach to urban sanitation based on citywide inclusive sanitation (CWIS) principles, which have been developed in conjunction with sector partners (Bill & Melinda Gates Foundation et al., 2017). This approach aims to shift the paradigm around urban sanitation approaches in World Bank engagements, promoting 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.

As part of the implementation of these principles, the WGP is developing a suite of tools and other material

to support Bank teams and their clients when engaging in CWIS. One of the aims of this work is to explore innovative approaches to provide safely managed sanitation services along the whole service chain and to support clients in identifying when such options might make sense. The study “Evaluating the Potential for Container-Based Sanitation” aims to answer some of these questions for container-based sanitation (CBS), an emerging sanitation approach.

The objective of this study is to document and assess existing CBS approaches, with a particular focus on evaluating their safety, reliability, affordability, and financial viability. The report also seeks to identify the circumstances in which CBS approaches are most appropriate and whether they could be considered as part of a portfolio of options for CWIS. The study was motivated by growing interest in the emerging CBS experiences and by the fact that many governments, city authorities, and financing entities are often not familiar with the approach.

The study builds on four case studies (Sanergy, Nairobi, Kenya; Sustainable Organic Integrated Livelihoods [SOIL], Cap-Haitien, Haiti; Clean Team, Kumasi, Ghana; and x-runner, Lima, Peru) to provide insights into these questions. The present document is one of these four case studies. The full suite of documents is available at www.worldbank.org/cbs.

Reference

Bill & Melinda Gates Foundation, Emory University, The University of Leeds, WaterAid, Plan International, and World Bank. 2017. *Citywide Inclusive Sanitation: A Call to Action*.

EXECUTIVE SUMMARY

This case study, along with three others, is a component of a wider study by the World Bank of container-based sanitation (CBS) models. CBS consists of an end-to-end service—that is, one provided along the whole sanitation service chain—that collects excreta hygienically from toilets designed with sealable, removable containers and strives to ensure that the excreta is safely treated, disposed of, and reused.¹ Rather than having to build a sanitation facility, households (or public toilet operators) can sign up for the service. The CBS service provider then installs a toilet with sealable excreta receptacles (also referred to as *cartridges*) and commits to emptying them (that is, removing and replacing them with clean ones) on a regular basis.

The objective of this study is to document and assess existing CBS approaches with a particular focus on evaluating their safety, reliability, affordability, and financial viability. The report also seeks to identify the circumstances in which CBS approaches are most appropriate and whether they could be considered as part of a portfolio of options for citywide inclusive sanitation (CWIS).

This case study examines the CBS service provided by x-runner in the low-income formal and informal settlements in peri-urban Lima. The objective of this case study is to better understand how x-runner's CBS business model fits in the overall context of the low-income settlements in which it operates. x-runner was established in 2011 and provides portable in-home toilets and a weekly collection system. It is the only CBS model where the customers conduct the emptying and primary transport themselves, bringing the feces to a pickup point, where it is gathered and transported by truck. The study took place in May and June 2017 and involved interviews with x-runner staff, national and local government officials, donors, and customers/users. It also involved visits to x-runner's service area and treatment site and the collection and analysis of relevant data and reports.

Overview of the x-runner Business Model

x-runner provides a safe sanitation service along the whole sanitation chain in poor nonsewered neighborhoods in the hills of the outskirts of southwest Lima for a population that does not have (and probably will not have for some years) any safe or hygienic alternative. x-runner installs portable toilets in people's homes that are lined with either plastic or biodegradable bags and emptied on a weekly basis. The bags are sealed in a separate bucket and deposited to a drop-off point (lockers) by users on their way out of the neighborhood. Buckets are collected by x-runner staff at the drop-off point and then transported through a leased service provided by a registered enterprise, EcoCentury. x-runner also treats the excreta through an innovative process that minimizes the land requirement for disposal, but it is currently not allowed to sell the resulting compost due to regulatory constraints.

Over time, x-runner has developed a model that builds on the strengths of its suppliers. By relying on these partnerships, x-runner has been able to simplify its business and focus on specific aspects of the sanitation service chain. The Swedish company Separett provides a high-quality containment solution at a significantly discounted price to x-runner (to its credit and x-runner's ability to develop and market its solution). As a result, x-runner has not had to build a toilet manufacturing line. Further down the service chain, EcoCentury provides a robust and scalable transport solution, removing the need to obtain accreditations and the extra overhead that comes with monitoring and complying with regulatory standards, which EcoCentury does on x-runner's behalf.

x-runner's collection process is the only one among the case studies in which customers carry their feces

themselves to a pickup point. This approach allows them to align better with households' schedules and to serve areas where access is difficult. x-runner also installs custom-made community lockers in some areas depending on the timing of pickup (for example, if the truck arrives late in the morning, some customers may have already left their houses) so customers can drop off sealed bags and pick up new materials on their own schedule. It is not currently clear how transferable this approach is to other contexts and whether there are specific factors that make it work in this one. Good-quality cover material is obviously essential to make CBS work, reducing smells and making the feces seem more innocuous. The use of plain, regular buckets to transport the feces probably also makes the process of carrying one's feces in the street more acceptable.

Sourcing cover material is becoming a challenge. Sawdust is supplied by a range of small carpentry enterprises from whom the available quantity is unpredictable. For each purchase, the quality of the sawdust needs to be evaluated and the price negotiated. Customers resisted attempts to mix/dilute the sawdust with compost, though x-runner staff believe that the resulting cover material is at least as good as pure sawdust. Improving the supply of cover material is crucial to expansion, given its importance for minimizing smells and flies.²

The treatment and composting process x-runner uses is an accelerated process that involves the purchase of effective microorganisms. Although a significant expense, this reduces the amount of land required for disposal and removes the need for co-waste (other than for cover material). Current indications are that further process efficiency improvements would be needed to make this process cost-competitive against traditional co-composting with other organic waste sources. However, with such improvements, this process could be of interest for sprawling conurbations where land is extremely scarce.

x-runner's Operating Context

Despite having more than 90 percent sewerage coverage, only a little more than half of Lima's feces is safely managed. In the nonsewered areas, this goes down to about 1 percent due to the lack of fecal sludge emptying and transport services. Most pits are unlined and, therefore, leach excreta into the soil. Emptying services are expensive and rely on vacuum trucks, which cannot reach households located far from the roads. When pits fill up, households have few options other than to dig a new pit, despite space constraints.

A significant population of Lima's urban poor—about 800,000 people—live in nonsewered peri-urban areas. Many are informal and hence do not have legal status to demand access to municipal sanitation. Topography and congestion impede the construction of sewerage lines for other areas that have obtained legal status.

The national sanitation policy of 2017 calls for 100 percent sanitation coverage for urban populations by 2021. Although sewerage remains the default solution for urban populations, recognition is growing of the need for alternative solutions in areas where topography and space constraints make sewerage expansion more difficult. Servicio de Alcantarillado y Agua Potable de Lima (Lima Sewerage and Water Supply Service; SEDAPAL), the water supply and sanitation (WSS) utility responsible for service provision in Lima, is calling for policy change to allow public funds to be invested in in-house facilities such as flush toilets, but this has not happened yet. There are no fecal sludge treatment facilities and very little desludging capacity.

Although the policy and institutional framework in Peru permits the CBS approach, it does not enable it. Sanitation investment decisions are made on the basis of comparing available options, but this system presupposes a project-based approach with rapid implementation at scale in a defined geographical area. A small company such as x-runner does not have the

resources to bid for such projects or to scale up so quickly. Currently, the predictability of x-runner's market assumes that the public sector will not come up with and subsidize an alternative and competing solution for its area of operation.

Assessment of x-runner's Services

The level of satisfaction with the service for x-runner customers is high. The high-quality experience appears to be driven by x-runner's strong customer focus, dedicated team of employees, and deployment of a high-quality toilet. The Separett toilet does, however, constitute a significant risk as the model is provided to x-runner at a highly subsidized price and could impact customer satisfaction were the supply chain to be interrupted. The customer service and teamwork are ingrained in the organization and would likely stand up to the challenges that come with scaling up.

The number of customers has been growing steadily, with an average of around 24 new households per month.³ This is a little more than half the sales target of 42 sales per month. The sales and marketing process is refocusing to build more on spreading awareness about incentives/promotions for successfully referring non-customers to the service. x-runner's operations appear to be facing some bottlenecks in the near term, including limitations in the sawdust supply chain, a need to start scaling up collection service capacity while avoiding idle capacity, and constraints on the sale of compost and the resulting maxing out of storage capacity at the treatment site. Robust solutions to these issues are needed to unlock the expansion capacity of x-runner's operation.

Although some customers expressed the view that the price for the service is high, they appear to be willing to pay it. In a 2015 satisfaction survey by x-runner, only 15 percent of respondents raised issues with the price of the service.⁴ The CBS service provider's customer base

is steadily growing and its *precio comunal* discount for customers in communities where x-runner achieves 50 percent or more market penetration results in a significant price reduction (25 percent).

The x-runner toilet service had a total annual cost of a little less than US\$336,458 in 2017, with an estimated 18 percent (a little less than US\$60,000) recovered via fees from users. Revenues from the fees charged to service users covered about 38 percent of the costs of providing the collection and transport service. However, reuse activities generated some operating costs that did not generate corresponding revenues due to regulatory restrictions on the sale of reuse products.

Key Lessons

x-runner is providing a much-needed service in peri-urban areas of Lima, where there are no other reliable options. Despite the government's policy to provide improved sanitation solutions to all the urban population by 2021, there are an estimated 800,000 people who are not connected to sewers, and less than 1 percent of the fecal waste flow is safely managed in these areas (including a substantial contribution from x-runner services).

Customers appear willing to pay for x-runner services. Though some customers have expressed a feeling that the price is high, this has not posed a payment issue and surveys show they are satisfied with the service. x-runner's CBS service appears to be cheaper, or at least not more expensive, than operating a pit latrine (with periodic maintenance and emptying).

x-runner's collection process, which is the only one in which customers carry their waste to a pickup point, appears to be acceptable to customers and the wider community. Two benefits of this approach are that it enables users to drop off sealed bags and pick up new materials when it is convenient for them and it allows x-runner to serve difficult-to-access areas.

The transferability of this approach to other contexts has not been assessed. The overall hygienic safety of this approach would also need to be confirmed as it appears to be highly reliant on customer education and on customers adopting hygienic practices for handling the waste. There have been cases where customers have lost access to the service due to poor hygienic practices.

x-runner is leveraging the capacities of suppliers to reduce the complexity of its business to a manageable level. Separett's provision of a high-quality containment solution at a discounted price removes the need for x-runner to build a toilet manufacturing line. Outsourcing the transport portion to EcoCentury means x-runner does not have to procure accreditations and can avoid the overhead associated with monitoring and complying with regulatory standards. It remains to be seen whether this will impact x-runner's ability to improve its cost-efficiency.

Customer growth is somewhat slow (and below targets) but steady, and the potential market is large. x-runner now has to work on increasing cost-efficiency and addressing potential bottlenecks. Similarly to their approach in refocusing their sales and marketing process and looking for new storage space, x-runner must continue to seek robust solutions to promote the expansion of their operation.

An explicit recognition of CBS—or a category into which CBS clearly falls—as a viable sanitation system for the urban poor, would be an important

factor for enabling public sector support. This would open the door for policies and procedures to determine which areas and populations it is appropriate for and the development of service standards. In addition, regulation of fecal sludge reuse (currently not allowed) would allow x-runner to collect revenues from the production of compost, which is currently carried out with a highly efficient process simply to minimize land use associated with waste disposal, and generates costs but no revenues.

Notes

- 1 In this report, the term *excreta* is used instead of *waste* to avoid any potential confusion with solid waste. Tilley et al. (2014) define excreta as “urine and feces that is not mixed with any flushwater.” Note that for the four CBS case studies and the main report, the feces and urine are separated using urine-diverting toilet technologies. In cases where only feces are collected by the CBS service provider, this is referred to accordingly as feces. Also note that cover material (for example, sawdust or carbon cover) is added to the excreta in all cases.
- 2 As of May 2018, x-runner had entered into working agreements with three larger sawdust suppliers, which had alleviated this pressure on the supply of sawdust.
- 3 As of May 2018, that number has increased to 35 new households per month. Each household has an average of five people.
- 4 x-runner surveys 30 percent of its costumers at the end of each year through a combination of face-to-face questions and phone calls. Questions focus on the quality of the toilet, the quality of the collection service, ease of payment through local banking agents, and comfort with the overall system, among others. In the latest survey conducted by x-runner at the end of 2017, customer satisfaction rate was as high as 95 percent (with a sample size of approximately 200 households).

Reference

Tilley, E., L. Ulrich, C. Lüthi, P. Reymond, and C. Zurbrügg. 2014. *Compendium of Sanitation Systems and Technologies*. 2nd rev. ed. Duebendorf, Switzerland: Swiss Federal Institute of Aquatic Science and Technology (Eawag).

ABBREVIATIONS

avg.	average (mean)
CBS	container-based sanitation
CFO	chief financial officer
CWIS	citywide inclusive sanitation
ECLA	Entrepreneurship and Competitiveness in Latin America (Columbia University Business School)
EPS	entidad prestadora de servicios de saneamiento (sanitation service provider)
FSM	fecal sludge management
GDP	gross domestic product
GoP	government of Peru
kg	kilogram
MHCS	Ministry of Housing, Construction and Sanitation
m²	square meters
m³	cubic meters
min.	minimum
NGO	nongovernmental organization
OSS	on-site sanitation
OTASS	Organismo Técnico de la Administración de los Servicios de Saneamiento (Technical Organism for the Management of Sanitation Services)
SEDAPAL	Servicio de Alcantarillado y Agua Potable de Lima (Lima Sewerage and Water Supply Service)
SFD	fecal waste flow diagram
SUNASS	Superintendencia Nacional de Servicios de Saneamiento (National Superintendent of Sanitation Services)
t	ton
UDDT	urine-diverting dry toilet
US\$	United States dollar
WHO	World Health Organization
WSS	water supply and sanitation
WWT	wastewater treatment

Exchange rate: US\$1 = S/. 3.27 as of June 2017

INTRODUCTION

Background

This case study, along with three others, is a component of a wider study by the World Bank of container-based sanitation (CBS) models. CBS models have emerged over the past 10 years as an alternative model to network-based sanitation or on-site sanitation (OSS) services. This case study focuses on x-runner, a CBS service provider operating in Lima, Peru, since 2011.

CBS consists of an end-to-end service—that is, one provided along the whole sanitation service chain—that collects excreta hygienically from toilets designed with sealable, removable containers and strives to ensure that the excreta is safely treated, disposed of, and reused.¹ Rather than having to build a sanitation facility, households (or public toilet operators) can sign up for the service. The CBS service provider then installs a toilet with sealable excreta receptacles (also referred to as *cartridges*) and commits to emptying them (that is, removing and replacing them with clean ones) on a regular basis. Transport methods can vary (and may involve *tuk tuks*, motorcycles, hand carts, and donkey carts) and adapt to a variety of space and logistical constraints. Some CBS entrepreneurs build and operate resource recovery facilities, taking advantage of the high-nutrient content of the relatively “fresh” and undiluted excreta, to produce biogas, fertilizers, or protein for animal feeds. Some CBS operators manage the entire cycle themselves, whereas some partner with other groups or local authorities to implement parts of the sanitation service chain.

Study Objectives

The objectives of the overall study are to document and assess existing CBS solutions with a particular focus on evaluating their safety, reliability, affordability, and

financial viability. The study also seeks to identify the circumstances in which CBS approaches are most appropriate. The ultimate objective is to identify whether these solutions could be considered as part of a mix of options for citywide inclusive sanitation (CWIS).

The objective of this case study is to better understand how x-runner’s CBS business model fits in the overall context of the formal and informal low-income settlements in peri-urban Lima in which it operates.

x-runner provides portable in-home toilets and a weekly collection system. x-runner is the only CBS model where the customers conduct the emptying and primary transport themselves, bringing the feces to a pickup point from where it is transported by truck.

Study Methodology

The field work for this case study was carried out in early 2017 based on interviews with key x-runner staff, covering the range of activities and functions of the organization at x-runner’s main office and customer support center, and local stakeholders. Relevant data and documents were collected and analyzed until May 2017, though major developments and updates through May 2018 are reflected. The case study began with a meeting with x-runner’s chairperson and the water and sanitation specialist of the World Bank Lima office, who supported the study through the facilitation of meetings with government and water supply and sanitation (WSS) utility officials. This was followed by a guided tour of x-runner’s treatment site and observation of the collection operation.

An initial round of interviews with a community leader and four customers (one of whom was an ex-leader) was conducted in their homes.² The interviewees were

selected by x-runner based on criteria laid out by the consultant, including:

- A customer that had made a substantial complaint to x-runner;
- A household with vulnerable member (that is, disabled); and
- A female head of household.

To solicit additional opinions, impromptu brief interviews were held with five customers and four non-customers during a collection round. The interviews focused on satisfaction levels and suggestions for improvement to the service. People were generally busy with their morning routines and, therefore, a number declined to be interviewed.

Representatives of the national government, sanitation regulator, and the water and sewerage utility for Lima—Servicio de Alcantarillado y Agua Potable de Lima (Lima Sewerage and Water Supply Service; SEDAPAL)—were interviewed with the assistance of the water and sanitation specialist of the World Bank. Donors had been interviewed prior to the case study, during Stage 1 of the CBS review, to which these case studies are contributing.

A list of all interviewees is available in appendix A.

Report Structure

Chapter 1 describes the CBS operation's service area and the basic geographic, economic, and demographic

characteristics of the Lima city and its low-income areas. Chapter 2 provides an overview of the CBS operation, with a technical description of the different components of the operation as well as the management strategies, systems, and processes behind them. The impact of the policy and regulatory environment is briefly examined, followed by an assessment of service performance from the customers' and the CBS service providers' points of view. Chapter 3 assesses the performance of the service from the customers' points of view and reviews customer growth. Chapter 4 presents a financial analysis of the operation and briefly discusses main cost drivers. Chapter 5 summarizes key lessons.

Notes

- 1 In this report, the term *excreta* is used instead of *waste* to avoid any potential confusion with solid waste. Tilley et al. (2014) define excreta as "urine and feces that is not mixed with any flushwater." Note that for the four CBS case studies prepared for this report, the feces and urine are separated using urine-diverting toilet technologies. In cases where only feces are collected by the CBS service provider, this is referred to accordingly as feces. Also note that cover material (for example, sawdust or carbon cover) is added to the excreta in all cases.
- 2 The sample size was limited by their availability at home (Sunday mornings only, as Saturdays are taken up with labor on community projects). Although interviews with eight customers and two leaders were planned, due to time constraints and last-minute unavailability, the actual sample achieved was less.

Reference

Tilley, E., L. Ulrich, C. Lüthi, P. Reymond, and C. Zurbrügg. 2014. *Compendium of Sanitation Systems and Technologies*. 2nd rev. ed. Dübendorf, Switzerland: Swiss Federal Institute of Aquatic Science and Technology (Eawag).

CHAPTER 1 • CBS SERVICE AREA CONTEXT

Location

Peru is a middle-income country with gross domestic product (GDP) per capita a little more than US\$6,000 (International Monetary Fund [IMF] 2016). There is strong rural-urban migration, resulting in an urban growth rate of 2.9 percent per annum (Government of Peru [GoP] 2014). Lima, the capital city on the central Peruvian coast, is home to a population of a little less than 10 million in 2017. Lima Metropolitan is composed of the two contiguous municipalities

of Callao and Lima, which have a combined total of 49 districts.

Urban development planning in Lima has been limited, and a large part of the population lives in “human settlements” characterized by poor access to services such as water, electricity, and sanitation. These include both formal settlements with titled properties and informal settlements, which are generally located on steep slopes and accessible via steep concrete staircases (Photo 1.1) that connect to roads, which contour around the hillsides.

Photo 1.1 • The Steep Hillsides and Stairways (inset) of Peri-Urban Lima



Source: Julian Parker.

x-runner provides container-based sanitation (CBS) services in such peri-urban settlements in the areas shown in Map 1.1. The core service area is in Pamplona in the San Juan de Miraflores district, but x-runner has identified a wider potential service area in the surrounding districts, including Villa el Salvador and Villa María del Triunfo.

Water and Sanitation Services in Lima

Water supply and sanitation (WSS) coverage for Peru as a whole stands at 89.2 percent and 74.5 percent,

respectively, whereas for the urban population, the figures are 94.7 percent and 89.5 percent (GoP 2017). Overall, it is estimated that a little more than 8 million Peruvians do not have adequate sanitation.

The government of Peru (GoP) estimated that a little more than 800,000 people in metropolitan Lima are not connected to the sewer network (2017).¹

When this is the case, households rely on cisterns and pour-flush toilets connected to septic tanks, various types of pit latrines, CBS toilets, and open defecation (see tables 1.1 and 1.2). In the areas where x-runner operates, pit latrines are the most common type of

Map 1.1 • Map of Lima, Showing x-runner’s Current and Potential Service Area



Source: Google Maps.

Table 1.1 • Frequency of Different Sanitation Types in Lima

	Sewer into home	Sewer to property	Latrine	Septic tank	River/channel	None
Percentage	87.4	4.3	1.3	2.7	0.4	1.3

Source: Mujica and Uriarte 2016.

Table 1.2 • Frequency of Different Sanitation Types for Nonsewered Households in Lima

	Cistern flush	Pour-flush	VIP latrine	Pit latrine (with slab)	Pit latrine (no slab)	CBS toilet	Bucket	None
Percentage	15.6	56.9	2.8	8.1	16.1	0.6	0	0

Source: Mujica and Uriarte 2016.

sanitation. In the current national sanitation policy, the GoP aims to achieve universal access to safe sanitation for urban populations by 2021 (and by 2030 for rural populations).

Despite the relatively high percentage of sanitation coverage, about only half of the feces is safely disposed of in Lima as a whole, as shown in the fecal waste flow diagram (SFD) in figure 1.1. This is because almost half of the sewage is not properly treated due to inadequate treatment capacity: Some is released untreated to the environment, whereas a slightly smaller fraction reaches the treatment plant but still is not properly treated.

For nonsewered areas, only 1 percent of feces is safely disposed (see Figure 1.2), of which two-thirds are linked to x-runner’s services. Most households in the nonsewered areas rely on pit latrines, which are often unlined and, therefore, leach excreta into the soil. Emptying services are expensive and rely on vacuum trucks that cannot reach the majority of households not located next to the roads. As a result, when pits fill, households have to dig a new pit, despite significant space constraints.

Dry systems have been tried in the past but have usually failed. These systems relied on users having time and interest to manage the toilets and the excreta produced.

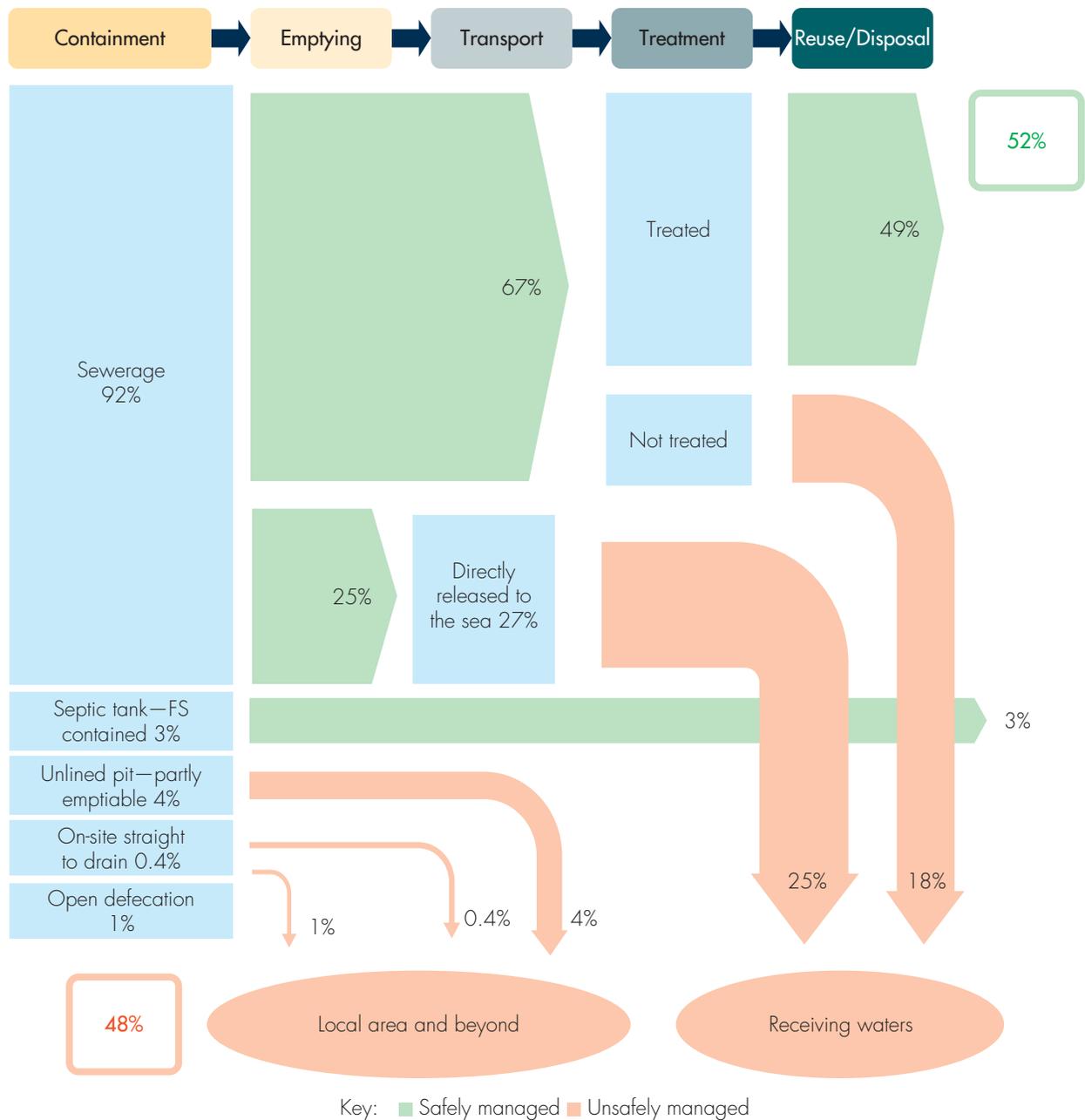
This did not happen, either because users were too busy or they had not been sufficiently sensitized and trained on how to do this. Users were also reportedly hoping to have flush toilets in the future (Oswald and Hoffman 2007).

Lima lies in the desert coastal strip of Peru, which is facing increasing water stress. It is in the valleys of three major rivers—the Rímac, Chillón, and Lurín—which are the city’s main water sources. The climate is mild, warm, and humid, yet Lima is the second-driest capital in the world in terms of average annual rainfall (after Cairo, Egypt). Dry sanitation systems are, therefore, an important proposition for Lima’s population. Combined with water efficiency improvements, a reduction in nonrevenue water,² and new source development, this could help save precious water resources. Sewerage has been brought to at least one suburb of Lima where people could not use their flush toilets due to lack of a water connection (Platzer, Hoffman, and Ticona 2008).

Policy and Regulatory Environment for Sanitation Services

The Ministry of Housing, Construction and Sanitation (MHCS) is the lead agency for the water and sanitation

Figure 1.1 • Fecal Waste Flow Diagram for Lima (Citywide)



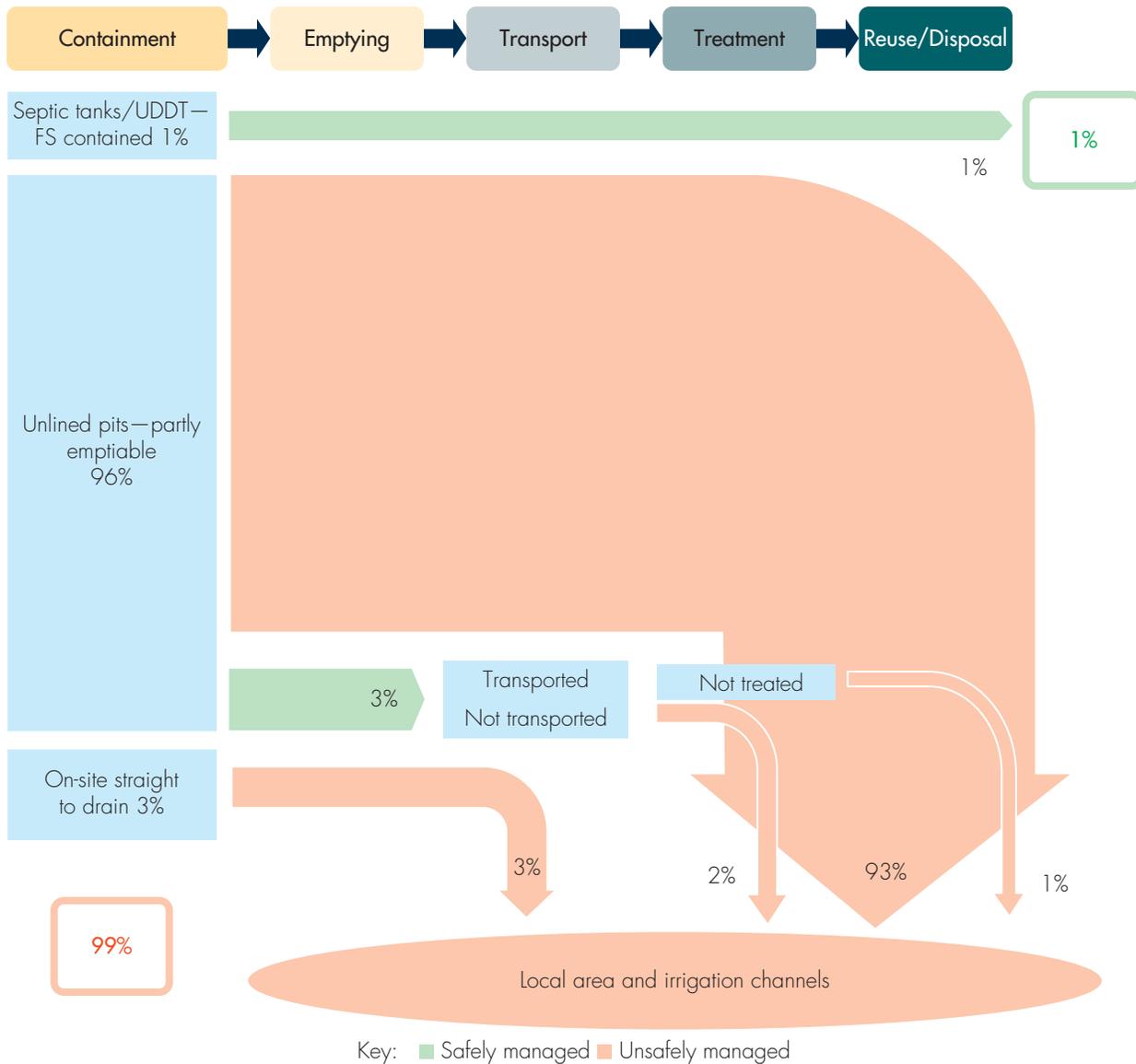
Source: Mujica and Uriarte 2016.

Note: Percentages indicate associated portion of fecal sludge (FS).

sector and is responsible for policymaking and coordination through its Directorate of Sanitation (of the Vice Ministry of Construction and Sanitation). MHCS's Environmental Unit is in charge of coordinating sanitation regulation with other ministries.

In the current national sanitation policy, the GoP aims to achieve universal access to safe sanitation for urban populations by 2021 (and by 2030 for rural populations). The policy objectives are focused on expanding coverage for universal access and achieving high-quality and sustainable

Figure 1.2 • Fecal Waste Flow Diagram for Nonsewered Areas in Lima



Source: Mujica and Uriarte 2016.

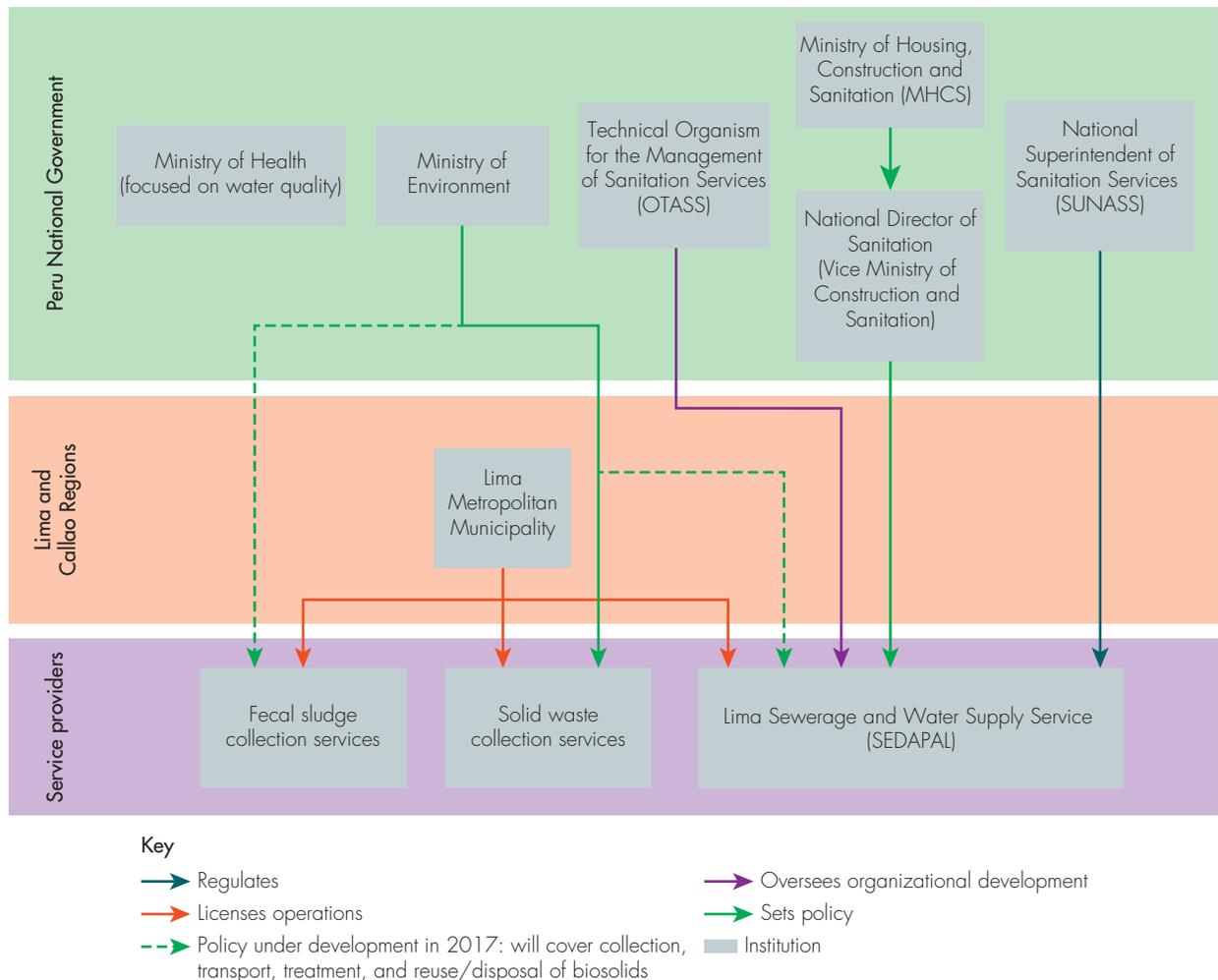
Note: Percentages indicate associated portion of fecal sludge (FS). UDDT = urine-diverting dry toilet.

service provision via autonomous enterprises with full cost recovery. When it comes to determining technical solutions, the policy states that decisions should be made on the basis of minimum economic cost, a point emphasized by a senior official of the MHCS.

The institutional setup for the sanitation sector is shown in figure 1.3.

Water and sanitation services in Peru are to be delivered by private, public, or mixed organizations whose exclusive purpose is to provide sanitation services. These organizations are known as entidades prestadoras de servicios de saneamiento (EPSs)—literally translated as “entities providing [water and] sanitation services.” The national water and sanitation regulator, Superintendencia Nacional de Servicios de

Figure 1.3 • Key Institutional Relationships for Sanitation Services in Peru



Saneamiento (National Superintendent of Sanitation Services; SUNASS), must approve service providers and their service regulations before they can be contracted by local authorities.

Servicio de Alcantarillado y Agua Potable de Lima (Lima Sewerage and Water Supply Service; SEDAPAL) is the municipal water and sanitation utility for Lima and Callao, the largest EPS in Peru. The Technical Organism for the Management of Sanitation Services (OTASS) regulates the administration and management of EPSs to ensure their financial efficiency and sustainability.

Local governments are the main source of funds for investments in sanitation infrastructure, followed by regional governments and service providers, with a small percentage coming from the national government. WSS service providers in Peru have limitations in their capacity to effectively utilize the funds that they receive from central, regional, and local government budgets, spending on average only 65 percent of said funds between the years 2011 and 2016. At the same time, willingness to pay for sanitation services is low even among higher-income households, leading the GoP to include the development of a culture of valuing

sanitation among citizens as the sixth area in its latest sanitation policy (GoP 2017).

Households may use any sanitation facility that provides for safe disposal of excreta if they do not have access to sewerage. Containment (that is, the toilet part of the sanitation service chain) is the responsibility of house owners, who are obligated, per the Law for the Modernization of Water and Sanitation Services (GoP 2015), to connect to water and sewerage services where they are provided, with any exceptional cases requiring the approval of the relevant EPS and still complying with regulations. In the absence of sewers, households are allowed to use any system that provides for sanitary disposal, though the 2016 legal framework refers to on-site disposal.

SUNASS's regulatory mandate is limited to the core of the sanitation service chain: emptying, transport, and treatment. Containment is the household's responsibility, whereas excreta reuse is under the remit of the ministry responsible for the reuse sector (which is the Ministry of Agriculture for reuse of wastewater treatment [WWT] biosolids as organic fertilizer or soil conditioner). As of 2016, the responsibility for rural WSS services was added to SUNASS's jurisdiction, which had previously been limited to urban areas (GoP 2016).

The GoP aims to achieve 100 percent adequate treatment of wastewater in urban areas by 2021, with reuse of 50 percent of the treated solid portion (GoP 2014). The plans do not state which technology will be used to achieve these targets, though sewers and WWT were to estimate costs and appear to be the technology of choice. Intermediate targets for treatment and reuse of wastewater, respectively, were 30 percent and 15 percent for 2012 and 50 percent and 30 percent for 2017. Of the current gap in urban sanitation, 30 percent is represented by the city of Lima. The only reported reuse to date, however, is unsafe use of raw fecal sludge to illegally irrigate farmland—for

example, from leaking sewers (Platzer, Hoffman, and Ticona 2008).

Peruvian law currently does not explicitly cover the reuse of fecal sludge or excreta.³ The 2015 water and sanitation law fills a gap in the previous water law passed in 1994 by permitting service providers to commercialize reuse products from wastewater, such as biosolids, or transfer the solid portion to third parties who have the resources to provide adequate treatment. There is no framework for the reuse of excreta, however, which is classified as toxic waste and can, therefore, only be sent to a landfill.⁴ There are no fecal sludge treatment facilities in Lima at present.

SEDAPAL estimates that there are 300,000 people in peri-urban Lima who cannot be reached with sewerage due to legal barriers and local conditions. Formal land rights are often lacking, creating an additional legal impediment, though a process exists for communities and plot dwellers to (eventually) get legal recognition. It has also been requesting MHCS to get the law changed to allow public investment in infrastructure components inside people's houses, as the urban poor are unable to afford the flush toilets required for a sewer connection. As of early June 2017, the law did not allow this. SEDAPAL's technical staff has been looking for alternative solutions for the hilly peri-urban areas and is open to dry sanitation options. Even in those peri-urban areas where sewers are technically feasible (with favorable soil and access conditions), SEDAPAL's sewerage network may not reach the population for the next five to 10 years. This is due to the length of the project planning process and the need to sequence investments despite of limited resources.

Septic tank emptying services in Lima are focused on institutions as few households can afford the service. Two prominent and professional companies that provide this service are Megapack and Disal. They serve public institutions (schools, hospitals, and government buildings) and industrial facilities. Given the

lack of a legal framework for fecal sludge management (FSM) and the perception that households would not be able to afford them, they have no incentive to provide services to poor households in peri-urban Lima. Solid waste management services, which also require EPS status, are also carried out by these companies but as informal services that do not adhere with regulations and may result in dumping of waste (fecal and solid) outside legal landfills.

Notes

- 1 In the Lima province as a whole, this figure reaches 2 million people not connected to the sewer network.
- 2 Nonrevenue water is around 40 percent, according to SUNASS, the regulator of water and sewerage services.
- 3 Here, fecal sludge refers to the product of on-site sanitation (OSS) solutions.
- 4 A new law for solid waste management adopted in December 2017 prioritizes the prevention and minimization of waste generation at source and incentivizes the recovery, material, and energy recovery of the waste through reuse, recycling, composting, co-processing, among other alternatives, provided that the protection of health and the environment is guaranteed. However, there remains a legal gap for the reuse of human excreta.

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CHAPTER 2 • OVERVIEW OF EXISTING CBS SERVICE PROVISION

Background: Brief History of x-runner

The concept for x-runner began with two industrial designers, one of whom was developing a design for a portable toilet for slums as part of her master's degree thesis. Austrian investors offered some money in exchange for equity in a company based on the concept. Thus, in 2011, “x-runner Venture” was incorporated in Germany with a third co-founder and the current chairperson, who has a business and microfinance background.¹ The investors each paid €10,000 for a 1 percent shareholding.

The portable toilet concept was first trialed in India, but the founders concluded that the market there was too complicated and turned their attention to Peru. They focused on Lima, a desert city with a large population of urban poor that they believed had more tools and resources to invest in an improved sanitation service. In addition, x-runner's current chairperson is half-Peruvian and already had established connections there to help facilitate a startup.

After initially producing its own toilets, x-runner soon switched to an imported off-the-shelf toilet. In Lima, it trialed a new design of a urine-diverting dry toilet (UDDT) that it had developed with a local designer. After 30 to 40 toilets were installed, x-runner was offered a highly discounted price on high-quality urine-diverting toilets produced by Separett. A family-owned Swedish company founded in 1976, Separett was inspired by x-runner's attempt to reach the urban poor and its ability to offer them a superior solution.

x-runner developed a fee-paying collection service focused on the poor living in the steep peri-urban

hillsides of Lima. The pilot community was located in an accessible and relatively flat area, and the service was later introduced into the settlements in the steep hillsides where sanitation is a bigger problem due to the difficulty in constructing latrines on the sloped rocky soil. x-runner's leadership studied the truck-based solid waste collection system and decided to improve on it by taking a more customer-oriented approach. They provided a free collection service for a month, after which a monthly fee was introduced. The fee was introduced early to ensure accountability of the company toward the customers.

x-runner's activities are executed by a nongovernmental organization (NGO) called Sanisol.² The service is branded as Family's (that is, the English term is used). An organigram for x-runner/Sanisol is shown in Appendix B. The main teams are operations, sales, and solutions. Operations covers the toilet installation, collection service, and the composting/treatment process. The sales team consists of three pairs of sales agents (including the manager) and conducts all community marketing events, door-to-door sales, and follow-up calls. The solutions team is the most recent addition and was created in early 2017 to provide a customer relations mechanism, as previously the principal point of contact with customers after toilet installation and service commencement was the collection service team. Although this team was able to interact with customers during the collection process, it distracted them from their objective of collecting feces in as short a time as possible. Supply chain is the responsibility of the chief financial officer (CFO).

x-runner has an egalitarian culture, in which input is continually sought from all staff members and

responsibility for achieving the various targets is broadly shared. The sales and solutions teams operate out of a customer service center (Centro de Family's) in central San Juan de Miraflores and have regular joint meetings. The sales team has a combined monthly target rather than individual targets; staff do not have individual targets and follow up on one another's leads.

Overview of Services Provided

Figure 2.1 illustrates the sanitation service chain for x-runner and the two prominent alternatives in the same locality: unlined pit latrines (manually desludged or replaced) and flush toilets connected to the sewer system.

Sales and Marketing

The sales strategy initially relied heavily on door-to-door sales but shifted in 2015 to promoting referrals and reaching out through community meetings and community leaders. However, door-to-door sales visits remain a key activity to follow up on interest expressed at community meetings and to reach people that do not attend these meetings when service is introduced to a new neighborhood. The six people on the sales team conduct household visits in pairs. They have a team sales target of 42 per month, which is not broken down into individual targets because they rotate around geographic areas, hence they follow up on one another's earlier sales efforts.

x-runner has introduced an array of promotions and continues to introduce new ones. Promotions can include the following:

- The initial S/. 99 (US\$30) installation fee is removed.
- The S/. 39 (US\$12) monthly fee is reduced to S/. 29 (US\$9) when 50 percent or more of a community is using the service (precio comunal).³

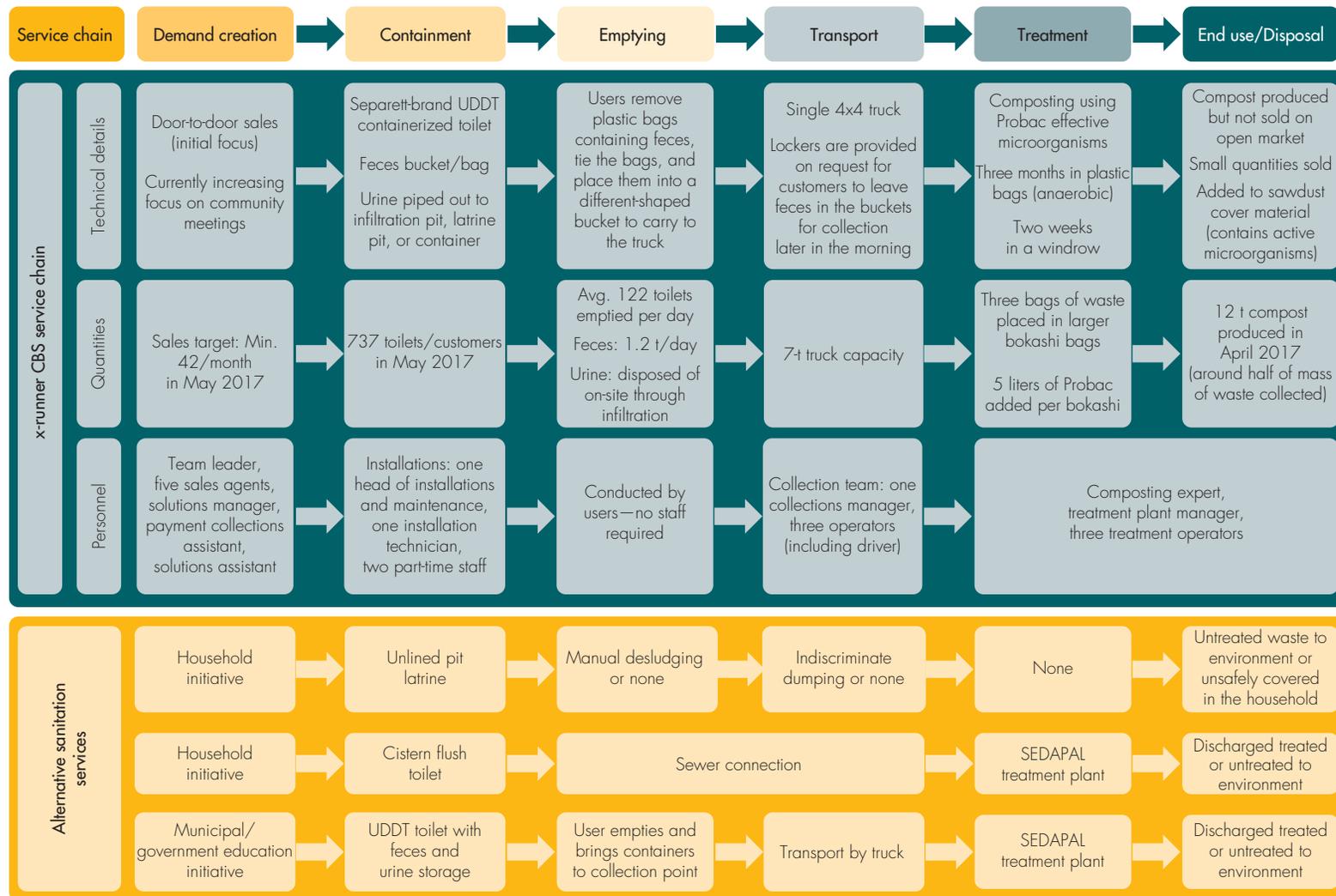
- A S/. 30 (US\$9) one-time discount is given to existing customers for each referred customer that signs up for the service.
- A second toilet in the same house results in reduction of the monthly fee to S/. 29 per each toilet in perpetuity.

The precio comunal promotion was introduced to promote density of users in a given area so that they would benefit from the impact of a sanitized community. This promotion has required a lot of follow-up in the form of community meetings to get the word out. To date, three communities benefit from this tariff, including one with 80 percent coverage. x-runner has also designed an initiative to raise awareness and promote its service through ambassadors—customers who will be trained to provide ongoing promotion of the benefits of the service in their community. Given their central role in community customs and communication, and the fact that they spend more time around the community physically, ambassadors tend to be women.

Going forward, x-runner is planning to focus on incentivizing and following up on referrals. In a satisfaction survey conducted at the end of 2017, the solutions team included questions to determine the level of awareness users had regarding referral incentives.

The preferred and main method of payment is through bank agents. Customers need to go to a shop affiliated with Peru's largest retail bank to pay their monthly fee. Many Peruvians already pay their electricity, TV, and other bills via the same system. This system reduces the cost (and risk) of payment collection and allows x-runner to formalize a service in an entirely informal area, thereby generating trust. It also creates a first link between these people and the banking system, which they are not always a part of yet. Some customers have reported problems paying at times because the bank agents have a daily limit for overall bill payments (once it is exceeded, they are not able to receive payments until the next day) or because customers have difficulties connecting due to the remoteness

Figure 2.1 • Sanitation Service Chain for Sanitation Options in x-runner Catchment Area (as of April 2017)



Note: Avg. = average; min. = minimum; SEDAPAL = Servicio de Alcantarillado y Agua Potable de Lima (Lima Sewerage and Water Supply Service); t = ton; UDDT = urine-diverting dry toilet.

of the area. x-runner has established a customer service phone line so that customers can report issues, and payment can also be made at the Family's customer service center in San Juan de Miraflores.

Containment

Once a customer has signed a contract for x-runner's service, the installation team conducts an inspection of the house to make a plan for installation, noting whether the floor is soil or cement, how urine will be disposed of, and where the vent pipe will exit the wall. In older properties, the space available can be limited, and in a few cases, walls or floors need to be rebuilt with improved materials or a second floor added. x-runner's toilet installation can easily be adapted in line with these upgrades. Installation takes 45 minutes to one hour, and

the two-person team can install as many as six toilets in a day. Mototaxis (rickshaws) transport the team for installations, but x-runner is hoping to purchase a van for this purpose.

x-runner imports an off-the-shelf UDDT, having had an unsatisfactory experience with manufacturing its own model. This earlier model was twice as expensive as the discounted price it pays for the Villa model of the Separett toilet, which is currently used (see Photo 2.1). It also required intensive supervision for a (slow) manual manufacturing process, and the attempt at local factory fabrication did not work out when the manufacturer could not deliver the promised service.

The Separett toilet has a fixed urine-diversion mechanism, with a connection for a narrow diameter pipe to carry the urine away. A plastic flap covers the feces

Photo 2.1a • Separett Toilet Installed



Source: Julian Parker.

Photo 2.1b • Toilet Inner Workings



hole and opens when weight is applied to the toilet seat. Inside the toilet, a 23-liter plastic bucket lined with a plastic bag lies below the feces hole. The bag itself is lined with sawdust and is usually biodegradable. These bags are purchased from a Peruvian company that imports them from the United States and have a storage life of six to eight months. However, during the summer (mid-January to March), they start to degrade in the heat and may break, so they are replaced with standard non-biodegradable bags. In previous summers, x-runner had provided households with extra biodegradable bags so that they could change the bags before they got too heavy or full.

There are several options for urine disposal. Most households in the area accumulate the urine in a bucket and dispose of it on the street. In other cases, they dispose of it in either an existing latrine pit (when they have one, though the pit is often full or unhygienic) or an infiltration/soak pit filled with stones, constructed by x-runner prior to toilet installation.

Obtaining sufficient quantities of sawdust was becoming a problem for x-runner in early 2017. It was obtaining sawdust from a range of relatively small-scale furniture makers, none of whom could reliably supply predictable quantities. Obtaining the cover material, therefore, involved inquiring as to the amount available, checking the quality (that is, texture), and then negotiating a price. In May 2017, x-runner had concerns that it might be approaching a bottleneck in its ability to source increasing quantities of sawdust for an expanding operation. It experimented for a time in mixing its compost with the sawdust, as the former has good physical properties for absorbing water from feces, as well as a range of good microorganisms that prevent smells from developing. This approach was dropped, however, due to unpopularity with the customers, who seemed to view it as a cynical cost-cutting measure, rather than as a necessary one.⁴ As of May 2018, x-runner had entered into working agreements with three larger sawdust suppliers, which has alleviated this pressure.

Emptying

Feces is transferred from the feces container in the toilet to a sealable bucket for carrying to the collection point. The bucket that comes with the Separett toilet does not have a handle and has a relatively wide diameter and low profile, which makes it inconvenient for carrying. Therefore, customers are provided with two additional 22-liter buckets with handles, a narrower diameter, and greater depth to carry full bags of feces/sawdust to collection points. These buckets are off-the-shelf, ordinary-looking buckets with lids that seal. The bags of feces are sealed again before being transferred in order to maintain a safe transportation chain (that is, during transportation, the feces is double-sealed).

Collection and Transport

Collections are conducted once a week for each customer, area by area, over five days (Monday to Friday). The collections start at 6 a.m. and last for as long as five hours. Customers carry their sealed buckets of feces to the collection truck as it passes by, or they drop them off at a locker when leaving their houses. The buckets are handed to one of the collection staff, who passes it to a colleague in the truck (see Photo 2.2), who then removes the bag of feces and drops it into a 240-liter wheelie bin before placing a sack of fresh sawdust and two toilet bags into the bucket.

When observed on two occasions in different areas, the collection process had all the appearance of being a normal, everyday activity, as if the feces being moved was relatively innocuous, like garbage. There was practically no smell (less than a solid waste collection truck), and the collection crew noted that smell emanating from the buckets would signal improper use of the toilet. The truck plays a jingle to alert people of its arrival. When customers have to leave their houses very early in the morning, before the arrival of the collection truck, they may leave their buckets in front of their houses. Where several neighboring households are in this situation, x-runner provides wooden lockers for them, which have

Photo 2.2 • Swapping out Bags of Feces for Fresh Sawdust and Empty Bags



Source: Julian Parker.

capacities of as many as 10 full buckets. Each customer has a key for the locker and places their bucket of feces in it when leaving home then collects the emptied bucket, which has been filled with new bags and sawdust, when they return. Cleaning the buckets is the responsibility of the customer, which raises a potential health risk.

The collection truck is a leased service that, since September 2016, has been outsourced to a Peruvian waste management company, EcoCentury,

which is fully licensed as an entidad prestadora de servicios de saneamiento (sanitation service provider; EPS) in Peru. The Peruvian EPS licensing regime covers the drivers, who are EcoCentury staff and must receive regular training plus have the required insurance. EcoCentury has the capacity to provide replacement trucks in case of breakdown and to conduct maintenance during the night. Therefore, its service significantly reduces the potential logistical and regulatory risks for the collection service.

A 7-ton, four-wheel-drive truck is used for the collection and transport service. It is fitted with 11 240-liter wheelie bins, into which bags of feces are deposited. At the start of the collection service, the wheelie bins are loaded with the bags of sawdust that are to be distributed during that day. For this reason, the larger 1,000-liter wheelie bins available from the company are not used as the collection staff cannot reach into the bottom of those containers to remove sawdust bags. Optimization of the usage of the vehicle space would require a redesign of the wheelie bin–container system and would allow the collection capacity to increase from about 200 households to about 230 (a 15 percent increase). As of May 2018, x-runner is looking into doing this.

Once the capacity of the existing truck is exceeded, there are various options for increasing the collection capacity. One would be to introduce collection rounds on the weekend. This would incur additional labor costs as labor rates must be increased (50 percent extra on Sundays) in accordance with Peruvian law. On the other hand, it does allow a small-step increase in capacity without a major jump in operational costs. A second truck could also be introduced. To avoid major overcapacity, two smaller trucks might be a better option, though these would need to be outfitted with an optimized storage system. A third option would be to introduce a second rotation of collections per day.

As its customer base expands, x-runner is considering various options for increasing the transport capacity and eliminating underutilization of the space inside the truck. An approximate timeline for the collection service is illustrated in figure 2.2. The travel times between

the treatment plant and the area of collections are fixed, unless a new treatment site were to be obtained, in which case they would very likely get longer. The efficiency of the collections service could be improved if one truck and crew could do two rounds of collections in a day and collect more feces per round of collection. This would require changes in the personnel structure and physical equipment for the collections as well as changes in the density and behavior of customers, including:

- Refitting the trucks to increase capacity;
- Introducing a system that allows trucks to be loaded with containers that are prepared with bags of sawdust and empty toilet bags by a separate team (for example, having containers that can be rapidly swapped out with those in the truck);
- Densifying customers to allow more feces to be collected per stop; and
- Minimizing the wait time at stops by expanding the system of lockers so that all customers can leave their feces ahead of time.

In November 2017, x-runner was accepted into a one-year program at Columbia University Business School’s Entrepreneurship and Competitiveness in Latin America (ECLA) program. As a result, the x-runner CEO has been receiving classes and mentorship to improve the operational efficiency of the collection service and reduce the cost per household.

The collection service had been the main interface between the customers and x-runner, with collection staff fielding questions and issues raised by customers to the rest of the team. This slowed collections down, hence

Figure 2.2 • Timeline for a Single Rotation of the Collection Service

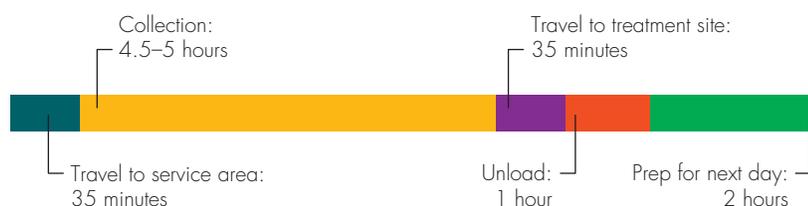


Photo 2.3 • Customer Services Center in San Juan de Miraflores



Source: Julian Parker.

the solutions team has taken on the role of interfacing with the customers. A customer service center has been opened in central San Juan de Miraflores (see photo 2.3), where people can visit to talk with x-runner staff; view the toilet, compost, and other products; and get more information. This has facilitated the collection team's work but has not significantly reduced collection times. Through the ECLA program mentioned, x-runner is analyzing some of the factors that could further impact the time spent in providing this service.

Treatment

At the end of a day's collection run, the truck delivers the feces to x-runner's treatment site (see photo 2.4), a 1,000-square-meter (m²) fenced-off piece of land. The first stage of the treatment process is an anaerobic composting system called bokashi. The bags of collected feces are placed into larger plastic bags (240-liter-capacity bokashi bags), three bags of waste per black bag, where they are slashed open and 5 liters of activated Probac effective microorganisms are added as a liquid.

Probac contains a mixture of anaerobic, aerobic, and facultative (anaerobic or aerobic) bacteria. Unlike some formulations, it does not require preactivation or refrigeration in storage. The black bags are sealed and left for several months (previously six months but now three) for the anaerobic degradation process to take place. This process breaks down the complex materials in the waste to simpler materials, while the proliferation of anaerobic bacteria leads the fecal pathogens to die.

The bokashi bags are stored in batches of 1,200, or about 35 tons (each bag weighs around 30 kilograms [kg]). When a batch of bags is opened, the waste is placed into a windrow,⁵ where another dose of Probac is added. The windrow is turned manually on a daily basis (three to four hours work per day) for one week and then left for a week to rest. Facultative and dormant aerobic bacteria in the waste become highly active at this point, helping to outcompete pathogens for nutrients and raising the temperature in the windrow, thus contributing to further pathogen kill. Ten tons of feces (mixed with sawdust) produces approximately five tons of compost. x-runner

Photo 2.4 • Composting Site



Source: Julian Parker.

piloted using boxes instead of the black bags for the treatment process but found that they took up too much space.

Reuse

x-runner is not able to sell the compost on the open market as it does not have a license to do so and the current legal framework does not currently support it. Getting a license would require an environmental impact

assessment and the chances of being granted a license are low as the law currently does not cover reuse of excreta for agricultural purposes. Superintendencia Nacional de Servicios de Saneamiento (National Superintendent of Sanitation Services; SUNASS), the regulator, has no mandate to regulate reuse of fecal sludge. After the aerobic process in the windrow is complete, the compost is placed into sacks and stored. Due to the high cost of the production and storage of compost, x-runner has

been sending the waste to a landfill since May 2017 and was expecting to do so up to December 2018. (During this time, it plans to conduct research and development on the treatment process and on the legal requirements needed to meet to treat and commercialize with pro bono support from Estudio Ehecopar, an established law firm.) The waste is stored in a shipping container at the treatment site, and every nine days, a contractor transports it to the landfill.

x-runner sells small quantities of the compost at US\$3 for a 20-kg bag and estimates the price for larger quantities to be US\$75 per ton. As of April 2017, x-runner was producing about 12 tons of compost. The estimated 2016 compost production from collected waste was 120 tons for the year. At US\$75 per ton, this has an approximate value of US\$9,000. The amount spent on consumables was about US\$6,650, and the total cost of the reuse operation was about US\$24,000 (ignoring any overheads that should be allocated to this activity). In other words, the cost of the additional inputs for the bokashi composting process are valued at a little less than 75 percent of the current estimated market price of the compost. (This would decrease to 45 percent if the compost could be sold at the highest price reported for other container-based sanitation [CBS] service providers of US\$400 per ton.) Therefore, at this time, it does not look likely that the additional cost of consumables for the bokashi composting process will yield sufficient returns to bring the reuse product to profitability. Even if the land cost could be reduced to virtually zero with the increased land efficiency of the bokashi process, the cost of the consumables, labor, and maintenance would exceed the value of the compost sold.

The bokashi composting process still remains of interest, however, for three reasons. First, there is likely to be ample room for further process efficiency improvements, and second, reuse products do not need to be profitable to be economically viable—rather, the net loss should be less than the cost of alternative treatment and disposal. The third and perhaps most important reason

is that the small land footprint of the bokashi composting process makes it amenable to a decentralized approach and/or sprawling conurbations where land is extremely scarce and the distance from the service area to the peri-urban area (where land is available) is large.

Legal and Policy Environment and Impact on CBS Services

x-runner presents a significant advance in terms of well-managed on-site sanitation (OSS) services for the urban poor in low-income neighborhoods in Lima, but this has not translated into active support from policymakers or from the main service provider, Servicio de Alcantarillado y Agua Potable de Lima (Lima Sewerage and Water Supply Service; SEDAPAL). A city sanitation service delivery assessment by the World Bank gave poor ratings and a score of zero to the city for all but four of the 45 indicators. One of the four non-zero scores—for containment—was “due to x-runner’s provision of on-site sanitation facilities in urban poor areas” (Mujica and Uriarte 2016). SEDAPAL has an interest in alternative solutions for areas that are difficult to sewer and has been considering the inclusion of dry toilets in its plans. At the time of the study, it was still analyzing options and working through policy issues with the Ministry of Housing, Construction and Sanitation (MHCS).

As a result of this policy vacuum, there is no way for a small sanitation service provider such as x-runner to delineate a catchment area with a predictable market size. Sanitation investment decisions are made by comparing the options available, but this system presupposes a project-based approach with rapid implementation at scale in a defined geographical area. A small company such as x-runner does not have the resources to compete/bid for such projects or scale up so quickly.

This suggests that an explicit recognition of CBS—or a category into which CBS clearly falls—as a viable sanitation system for the urban poor would be

an important advance. This would open the door for policies and procedures to determine which areas and populations such services are appropriate for, as well as the development of standards. Currently, the predictability of x-runner's market assumes that the public sector will not come up with and subsidize an alternative and competing solution for its area of operation.

On the reuse side, Peruvian law allows the reuse of wastewater but not of fecal sludge. This appears to be linked to a current low demand and usage of fecal sludge management (FSM) services. There are no fecal sludge treatment plants in Peru, and fecal sludge from septic tanks is reported to be illegally disposed in landfill sites, SEDAPAL sewers, or open areas. Septic tanks are relatively rare in Peru, including in Lima, and are used mostly by institutions. Households that have pit latrines rarely have them desludged, hence the demand for FSM has been low. This could change in the medium to long term as low-income households fill their latrines and run out of space to replace them and/or if water stress continues to increase. In such an event, allowing reuse of treated fecal sludge would open the possibility for x-runner to market its reuse products for agricultural

use, for example. Reviewing legislation to redefine fecal sludge and its potential for reuse—instead of its current classification as toxic waste that can only be sent to landfill—would also be an important step forward.

Notes

- 1 x-runner has since reregistered in Switzerland, where the company is now domiciled.
- 2 For simplicity, Sanisol is simply referred to as x-runner in the remainder of this case study.
- 3 Communities develop spontaneously as people settle on the hill-sides, self-organize, and later seek legal recognition. A typical community size is about 60 households, according to x-runner.
- 4 Customers generally believe that x-runner is making handsome profits from its CBS service. This perception is in part due to the belief that sanitation service provision is the government's responsibility—and for a private actor to be providing the service means that it is a profitable one. In other cases, the presence of NGOs distributing materials and conducting programs for free has led to a negative comparison with x-runner's fee-for-service approach.
- 5 Windrows are long rows of (mixed) materials piled together to compost aerobically. They are turned periodically to ensure that, over time, all parts of the pile are exposed to the required conditions (aeration and high temperature) for pathogen destruction and breakdown of the material.

Reference

Mujica, A., and Z. S. Uriarte. 2016. *Fecal Sludge Management: Diagnostics for Service Delivery in Urban Areas*. Case Study in Lima, Peru.

CHAPTER 3 • CBS SERVICE PERFORMANCE

This section examines customer progression, the factors affecting this progression, as well as customer perceptions concerning the service.

Customer Growth

x-runner's customer base has grown relatively slowly but steadily during the period from January 2015 to May 2017, at which time x-runner had 739 toilets in operation.¹ Growth has been more or less linear during this period, with on average 24 new customers per month (ignoring the data for March and April 2017, which were anomalously low), or around 290 per year. This is illustrated in figure 3.1.

Until 2016, x-runner was relying on spreadsheets, documents, and Google Earth maps to manage information and organize its processes. Hence, some key data such as customer numbers prior to 2015 were not available. In the second half of 2016, it began using Salesforce, a cloud-based customer relations management software, and finished migrating the data by early 2017.

The number of 24 new customers added per month is significantly below the current sales target of 42, and x-runner has higher targets in its projections for the future. x-runner faces a number of logistical challenges as it continues to expand, including increasing installations capacity (without increasing costs), sourcing sufficient quantities of sawdust, and increasing collection capacity. Therefore, it may face headwinds for a while that constrain its ability to increase its growth rate. A linear growth model continuing the current trend might be more realistic.

Figure 3.2 shows the growth in sales, installations, and the customer base for the period for which data is

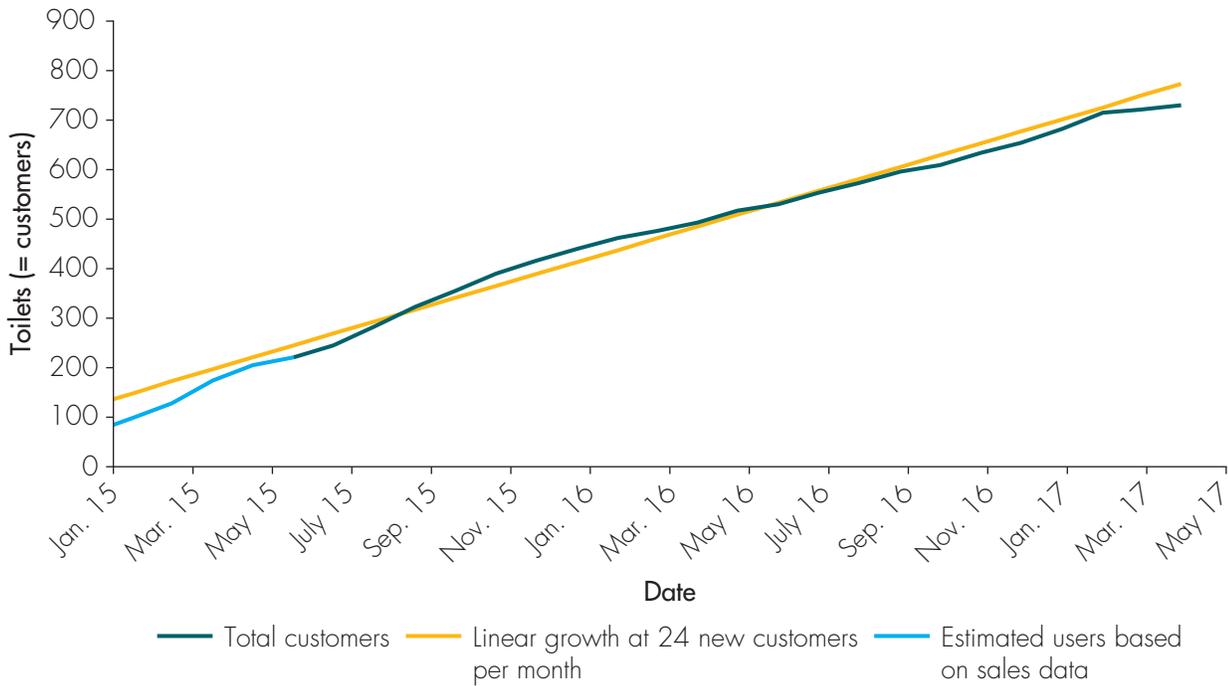
available, between June 2015 (January 2015 for sales) and April 2017. The new users added each month would be expected to track installations closely, and the difference between the two represents uninstalls, which are mostly due to people moving (with a few due to customers who failed to observe adequate standards of hygiene and who did not respond to hygiene promotion visits from x-runner staff). Installations would be expected to track sales, with a short lag time for the preinstallation survey and potential dropout of a few customers who did not have a suitable space for installation. Data from x-runner show a growing gap between cumulative sales and cumulative installations.

Uninstalls between January 2016 and February 2017 totaled 84 (ranging between three and 15 per month with an average of six per month). The reasons for service termination or toilet removal were:

- People moving away;
- Family emergencies that severely disrupted their personal finances so that they could no longer afford x-runner's service;
- Consistent failure to meet expected standards of usage despite several attempts by x-runner to encourage/demand change; and
- Debts—unmanaged missed payments of x-runner service fees.

x-runner will work with customers to reschedule payments, but sustained debts result in termination of service. From January 2016 to February 2017, an average of 17 percent of customers were more than one month late with payments (ranging between 16 and 26 percent), which could indicate an issue with the affordability of the service. If customers have not paid for more than one month, x-runner staff discusses the

Figure 3.1 • Customer Growth since January 2015



Source: Author elaboration based on x-runner data.

Note: The lighter dashed blue line represents an estimate based on sales data from January to May 2015, for which actual figures for total users and installations are not available. The figures for this period were derived by subtracting the previous months sales from the June total and then progressively subtracting the sales data for May, April, and so on until January. As the sales data generally exceed the new users added, the dashed line will overestimate new users each month and therefore underestimate the total users (as the sales were subtracted). This explains the apparently steeper curve here.

situation with them and offers the opportunity to create a payment plan. If a payment plan cannot be agreed upon, or if debts accumulate for two months or more, x-runner terminates the service. x-runner’s solutions team is tasked with developing mechanisms for managing and minimizing debts.²

Assessing the Value of x-runner Service to Customers

This analysis shows that CBS services provided by x-runner are appreciated by customers and offer a sound alternative to other forms of sanitation in informal settlements where difficult access and restrictions on water availability currently create challenges for these alternatives.

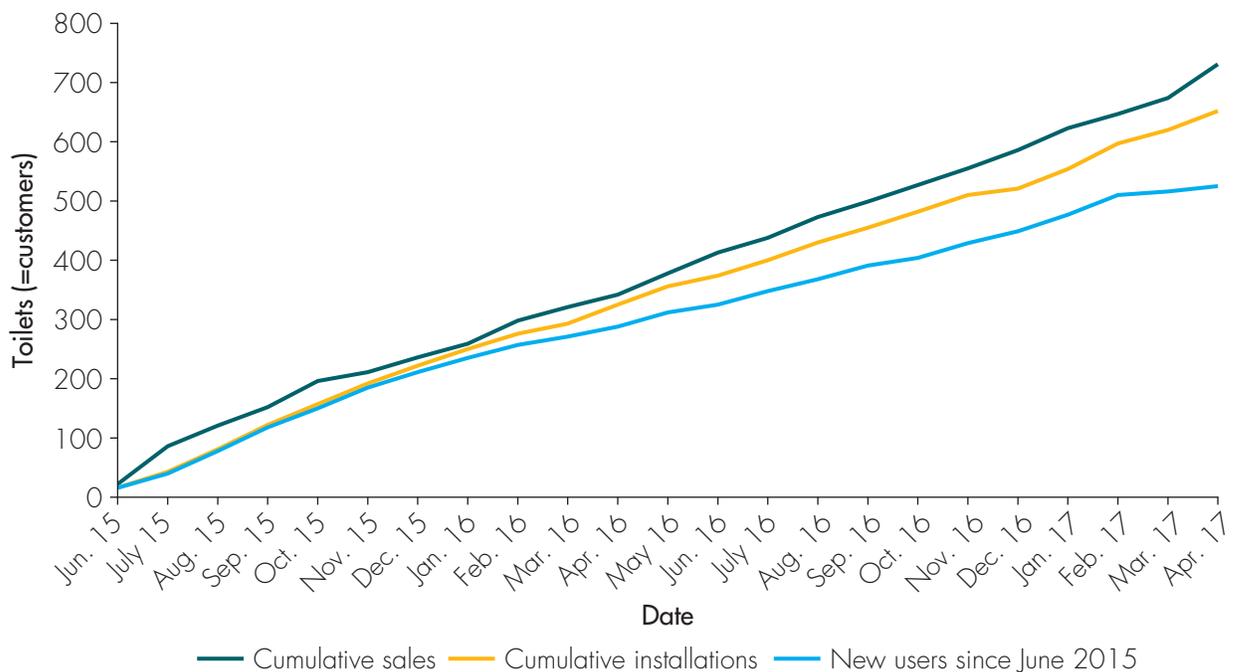
Quality and Reliability of Services

Customers were motivated to adopt x-runner’s service after problems with smells and flies with their household pit latrines, as well as the embarrassment they felt when guests would need to use these facilities.

The people interviewed were introduced to the x-runner service through recommendations from relatives, marketing events by the x-runner sales team at community meetings, and, in one case, a visit to the Family’s center in San Juan de Miraflores. x-runner’s solutions team also conducts random phone calls to customers to verify proper use of the system and inquire about their satisfaction with the service.

All users expressed satisfaction with the x-runner toilets due to the reduction or elimination of smells and

Figure 3.2 • Cumulative Sales, Installations, and New Customers Added, by Month



Source: Author elaboration based on x-runner data.

flies and improved perceived hygiene. However, a few complaints were raised:

- Two users reported that plastic bags had broken. According to x-runner, the issue was that biodegradable bags become weak in summer's high temperatures. As a result, non-biodegradable plastic bags are now used from mid-January to March. At the time of this case study, x-runner was still using normal bags in early June as summer had lasted longer than usual but was soon to revert to biodegradable ones.
- One of the community leaders mentioned that customers in his community believed that the mixing of compost into the sawdust was resulting in a poorer-quality cover material.
- Several people thought that the price of service was too high, notably those with only one or two people in the household. All conceded, however,

that they accepted the price and were willing to keep paying it. By comparison, households interviewed were generally paying between S/. 35 (US\$11) and S/. 45 (US\$14) per month for water, so the S/. 39 (US\$13) standard monthly price of the x-runner service for a household of one to six people is comparable to that.

- The bank agents through which customers generally make their service payments are not always able to accept payments.

Most customers interviewed were satisfied with the collection service. The collection service was observed on two occasions in different locations and appeared to run smoothly. One leader remarked that sometimes there is not enough time to prepare even though the music is heard ahead of time (the acoustics of the hillsides seem to be fairly good for transmitting sound). Another person interviewed mentioned that

the collection service was late once due to heavy rains. The dynamics of the collection are different from those of other container-based sanitation (CBS) service providers in that it is the customer's responsibility to get the waste to the collection point and the collection route is more straightforward. x-runner has customer lists for each stop to check that everyone has dropped off their waste, as well as the phone numbers of customers in case it misses a collection. It is worth noting that the contract for services is clear on collection times, and usually missed collections are due to the absence of a customer at the agreed-upon pickup time and therefore not linked to a complaint. As of May 2018, the percentage of missed collections was 4 to 5 percent on a daily basis.

Currently, customers view x-runner's service as the only solution that works—that is, one that provides them with a hygienic solution that removes their waste without undue inconvenience or effort on their part (flush and forget). The five customers (of which two are also current or past leaders) interviewed in-depth were asked whether they considered x-runner's service to be a transitional or long-term solution. Currently, they do not see a better alternative. Most mentioned that the government/Servicio de Alcantarillado y Agua Potable de Lima (Lima Sewerage and Water Supply Service; SEDAPAL) plan for sewerage, but they also said that they have waited for many years for such a long-term solution and construction of infrastructure takes time. So for one ex-leader, there is no long-term solution.

In Lima, the concept of having a complete bathroom with toilet and shower facilities is strong at the policy-, service provider-, and household-level, but it does not appear to obstruct the acceptance of dry toilet solutions. A community leader raised this issue, without prompting, during an interview. The others, when prompted on this issue, focused on how unrealistic this was for them. All would desire it, but none had sufficient space for such a setup; they currently bathe using a tub in the bedroom. Limited

water availability was also seen as another impediment to this.

Cost to Service Users

The majority of households are paying US\$12 per month (US\$144 per year) for x-runner's service, but this drops to US\$9 per month (US\$108 per year) once 50 percent or more of a community has subscribed.

In the medium to long term, therefore, a rate of US\$9 per household could be realistic for most people if x-runner continues to grow and increase market penetration in each community. Larger households (more than six people) pay US\$15 per month. These fees are similar to what households pay on a monthly basis for water provided by water tanker. For households that have a connection to the SEDAPAL piped network (which are very few in x-runner's service area), the price of water can be lower.

Operating and maintaining a pit latrine appears to be marginally more expensive for users than x-runner's service, even ignoring the upfront capital cost. Mujica and Uriarte (2016) provided average costs for latrines and latrine maintenance and emptying, based on a sample of 360 households in nonsewered areas of Lima: The average cost of constructing an improved (lined) pit latrine was US\$283 versus US\$48 for an unimproved pit latrine. The average cost of repairs (to the toilet, superstructure, and drainage) was US\$110 for the year prior to the study (hence an approximation of the annual average). The average cost of emptying was US\$136.50, and from a small subsample of eight households that had emptied their latrines (others had not experienced pits filling or had constructed new ones), the average period between emptying events came to 2.9 years. This produced an average emptying cost of US\$49 per year. Therefore, the operational cost alone of a latrine—if operated properly with regular emptying—was estimated at approximately US\$159 per year. Annual costs to x-runner's users fell between US\$108 (with the community discount) and US\$144.

If water and sewerage could be brought to households, monthly fees would be cheaper than what residents of peri-urban settlements are currently paying for water alone, for pit latrines, or for container-based sanitation (CBS). The social tariff for sewerage (that is, for 0 to 10 cubic meters (m³) per month) is US\$0.17 per m³. A monthly fixed charge of US\$1.60 is added. The social tariff for water is US\$0.38/m³ (SUNASS 2015). Households interviewed were using about 1 to 3 m³ per month without flush toilets. Even if water consumption increased to 10 m³ per month, the total water and sewerage cost would be around US\$7 per month (US\$84 per year). This is less than the amount people are currently paying for water alone in informal settlements without piping, where they need to purchase water from tanker trucks for about US\$10 to US\$15 per month.

x-runner Services vs. Available Alternatives in the Service Area

The only current alternatives for x-runner's areas of operation that provide a full sanitation service chain solution are public pour-flush toilets connected to sewers or lined pits whose waste is safely emptied, transported, treated, and disposed. Public pour-flush toilets connected to sewers would mostly be limited to peripheral areas of the settlements, to which they could provide a safe sanitation service if the wastewater treatment (WWT) plant was functioning properly 100 percent of the time (which it currently is not). Lined pits with manual emptying do not provide a safe sanitation chain, as the emptying is unsafe for the operators and there is insufficient space to construct them in some places (and excavation of pits is not possible in some areas).

Sewerage provision is seen as the most effective sanitation solution by government and utility officials

and the majority of the population of x-runner's service area, but this solution may not reach many peri-urban settlements in the foreseeable future. The sewer network would need to be extended uphill from its upstream peripheries, and new trunk mains would be required. The populations of many peri-urban hillside settlements have been waiting as long as 20 years for sewerage, which will be more difficult and expensive to construct in the informal settlements.

Urine-diverting dry toilets (UDDTs), with three-month storage capacity, receiving municipal emptying and transport services have been identified as a potentially effective and cost-conscious solution.³ However, the actual implementation of the solution is still pending. The required storage identified (600 liters for urine and 90 liters for feces) would be difficult to construct in the context of the human settlements on the steep peri-urban hillsides around Lima, though urine could probably be infiltrated into the ground in some areas. The emptying process would prove to be the biggest challenge as most houses are between 10 and 50 meters from the nearest drivable road, so significant hand cartage would be required for the first step in the collection chain. Therefore, this solution would not work for most of the population targeted by x-runner.

Table 3.1 compares the safety of the x-runner's CBS service with the alternatives at each point in the sanitation chain, as well as their potential reach—that is, how well they can penetrate the informal settlements.

As shown in Table 3.1 and throughout this section, CBS services provided by x-runner offer a sound alternative to other forms of sanitation in areas where difficult access and restrictions on water availability render the roll-out of these alternatives complex and/or unlikely in the near future.

Table 3.1 • Qualitative Comparison of CBS and Alternatives

Safety of sanitation service chain						
	Containment	Emptying	Transport	Treatment	Disposal/reuse	Potential reach
x-runner CBS	CBS	In sealed containers (double-sealed with plastic bag)		Composting—if regulation can be established		Extensive
Sewer-based	Household flush toilet	Sewer		WWT plant	River	Difficult to reach all areas
Municipal UDDT	UDDT with three-month storage	Manual	Truck	Composting—if regulation can be established		Medium—requires space and access

Note: Green = safe; yellow = partially safe; UDDT = urine-diverting dry toilet; WWT = wastewater treatment.

Note on potential reach: Potential to provide defined sanitation service to all households in specific targeted geographical area.

Notes

- 1 The number of customers had risen to 800 by December 2017.
- 2 As of May 2018, it had reduced the percentage of customers late in their payments to 11 percent by applying various payment strategies. The team is also conducting different activities to increase customer satisfaction and monitor more frequently, and in a more personalized way, how costumers experience the toilet and the collection service.
- 3 Proposed as a suitable fecal sludge management (FSM) system for low-income areas of Lima by Platzer, Hoffman, and Ticona (2008) and later by Mujica and Uriarte (2016).

References

- Mujica, A., and Z. S. Uriarte. 2016. *Fecal Sludge Management: Diagnostics for Service Delivery in Urban Areas*. Case Study in Lima, Peru.
- Platzer, C., H. Hoffman, and E. Ticona. 2008. “Alternatives to Waterborne Sanitation—A Comparative Study: Limits and Potentials.” Presented at the IRC Symposium: Sanitation for the Urban Poor Partnerships and Governance, Delft, The Netherlands.
- SUNASS. 2015. “Management Goals, Tariff Formula, and Tariff Structures for 2015–2020 for Potable Water and Sewerage Services Provided by SEPADAL: *Metas de Gestión, Fórmula Tarifaria y Estructuras Tarifarias en el Quinquenio Regulatorio 2015–2020, Para los Servicios de Agua Potable y Alcantarillado Que Brinda SEPADAL S. A.*” Resolución de Consejo Directivo No 022-2015-SUNASS-CD.

CHAPTER 4 • FINANCIAL PERFORMANCE

This section reviews the financial performance of x-runner using available data and analysis provided by x-runner.

Current Costs and Financing Sources

The x-runner toilet service had a total estimated annual cost of a little less than US\$336,458 in 2017, with 18 percent (a little less than US\$60,000) recovered via fees from users. Revenues from the fees charged to service users covered about 38 percent of the costs of providing the collection and transport service. However, reuse activities generated some operating costs that did not generate corresponding revenues due to regulatory restrictions on the sale of reuse products.

x-runner's operation has been funded by private and government foundations with approximately US\$300,000 to US\$400,000 per year. Financing has largely been provided from two types of foundations: those linked to private companies (mostly Swiss companies) and government-backed foundations (such as Grand Challenges Canada). The former provide more flexible funding as they do not have restrictions on the funding of staff salaries, whereas the latter do. Private donations and, at one point in 2015, a crowdfunding campaign have provided funding injections that—though smaller than those of foundations—have bridged critical gaps for x-runner's operations.

This level of funding has been sufficient for x-runner to get by, and x-runner has restructured with a view to focus more on optimizing its processes. In order to achieve a more sustainable expansion and innovate for a more sustainable financial structure, higher funding levels are needed to support the changes and experimentation required. x-runner does not have commercial debt.

Improving the Efficiency of Its Operations

The main cost drivers—that is, the items that most influence the total costs—are the toilet purchase and installation and the consumables for the toilet service. The larger list of main cost drivers and their percentage contribution are given in table 4.1.

The purchase and installation of toilets is the most expensive part of the operation at 19.4 percent (US\$70,077), of which 66 percent (US\$46,447) is the cost of purchasing and importing the toilet. The toilet price is already heavily discounted from the U.S. retail price. x-runner pays US\$80 plus about US\$35 for importation costs compared to a retail price of US\$1,389 in the United States, though the model provided to x-runner is a stripped-down version with several parts removed, including the electric fan. Still, the customer base for x-runner is used to this high-quality product, and there would be a high chance of rejection were it to be replaced with a product of a similar price at market rates. x-runner's own fiber-glass precursor toilet cost around twice as much as the Separett one. Although there is no reason at this time to assume that anything will change in the supply relationship that x-runner has with Separett, it does constitute a risk for the company.

The consumables for the x-runner toilets represent 12.6 percent of the total costs. The biodegradable bags (and plastic bags for three to four months in the summer) used to line the toilets and hold the waste represent 64 percent of this cost center, and sawdust makes up most of the rest. Given that x-runner has faced challenges with getting adequate quantities of sawdust, and the fact that the biodegradable bags cannot be used year-round, there is a case for researching and testing alternatives. For example, x-runner could look at reusable (that is, washable—if the water supply and economics work)

Table 4.1 • Main Cost Drivers for x-runner Operations

Cost categories	Amount (US\$)	Percentage of total 2016 budget
Toilet purchase and installation (including payroll)	70,077	19.4
Consumables for toilet service (sawdust and plastic bags)	45,420	12.6
Sales and marketing (mainly sales team payroll)	37,619	10.4
Composting operation	24,763	6.9
Leasing of transport service for collections	22,632	6.3

liners, and it should carry out additional research into the option of mixing the sawdust with other materials and how to win acceptance of this through awareness/promotional campaigns or incentives. Sawdust supply could potentially be outsourced in different ways—for example, experimenting with a franchise to multiple suppliers to reduce x-runner’s overhead for this activity.

The sales and marketing cost is largely composed of payroll for the six-person sales team. Increased focus on incentives such as the referral scheme and the women’s networking initiative could prevent the sales and marketing cost from rising as quickly as the customer base and revenue, thereby reducing the cost per capita. Improving the efficiency and effectiveness of the sales and marketing operation appeared to be a principal focus at the time of the field study in May 2017.

The composting process represents a relatively small percentage of the overall costs. The land-related costs and consumables (bokashi bags and Probac effective microorganisms) together form a little less than 60 percent of the treatment costs. The use of Probac reduces the land required for disposal; therefore, it would appear that reducing one of these cost components would result in the other increasing. Given the relatively small proportion of the costs represented by the treatment process overall, it does not appear that there are opportunities for significant cost-cutting here. From a regulatory perspective, however, authorizing sales of fecal sludge byproduct

reuse would generate revenues from this activity, which is currently merely a cost center. At present, the commercialization of fecal sludge byproducts is not prohibited or illegal per se, but it is not specifically covered in the regulatory framework. This complicates the possibility of selling compost, fuel briquettes, or biogas to any large organization as it would limit opportunities for exports.

The transport leasing increased significantly in 2017 from 2016 following a change of service provider to EcoCentury. As of May 2018, x-runner has been able to improve its efficiency significantly with careful optimization of truck capacity, the number of trucks, number of rotations per week, daily schedule, and organization of the preparation process. However, it still sees potential for improvements in optimizing the added space in the trucks with the placing and distribution of the containers.

Plans for Expansion

For the foreseeable future, x-runner plans to limit itself to the low-income areas of southern Lima, despite ad hoc requests to bring its service to the northern part of the city (where the context is quite different). It is planning to focus on further market penetration in the area of Pamplona in the San Juan de Miraflores district, while expanding out also into the Villa María del Triunfo and Villa el Salvador districts.

The strategy for expansion is to improve the effectiveness and reach of its sales processes while working on the efficiency of operations and sales. Its major costs are all variable, including its main capital costs—the toilet units. Therefore, x-runner is able to expand its operation without any major hurdles to overcome—there is no new toilet factory to build at a particular scale, for example. There are also no plans to purchase a truck as transport services are currently leased to a regulatory approved entidad prestadora de servicios de saneamiento (sanitation service provider; EPS) and x-runner does not have the funds and was not planning to invest in the approval process as of June 2017.

A big question over the future operation is whether the current treatment process will be maintained.

Without an explicit legal or policy framework for the sale of reuse products from fecal sludge, x-runner cannot sell its compost on a commercial scale. The storage capacity for the bagged compost product at its treatment site is full, and at the time of the case study (June 2017), it is paying for the waste to be collected for final disposal at a landfill. Should x-runner be able to start selling compost commercially in the future, it would need a larger composting site. Initially, it could expand by about 50 percent into the land adjacent to its current site (owned by the same landlord), but it would soon need to move to a larger site that would likely be farther away from its toilet service area. In this case, unit land prices would likely be a bit lower, but the transport time and distance would go up, altering the cost structure, but probably only marginally.

CHAPTER 5 • KEY LESSONS

x-runner is providing a much-needed service in peri-urban areas of Lima, where there are no other reliable options. Despite the government’s policy to provide improved sanitation solutions to all the urban population by 2021, there are an estimated 800,000 people who are not connected to sewers, and less than 1 percent of the fecal waste flow is safely managed in Lima’s nonsewered areas (including a substantial contribution from x-runner services).

Although there seems to be a feeling among some customers that the price for x-runner services is rather high, they appear to be willing to pay it. x-runner’s container-based sanitation (CBS) service appears to be cheaper, or at least not more expensive, than operating a pit latrine (with periodic maintenance and emptying). The CBS service provider’s customer base is steadily growing and its precio comunal discount for customers in communities where x-runner achieves 50 percent or more market penetration results in a significant (25 percent) price reduction.

x-runner’s collection process, which is the only one in which customers carry their waste to a pickup point, appears to be acceptable to customers and the wider community. This approach allows x-runner to better align with household schedules, as users can drop off sealed bags and pick up new materials on their own time, and to serve areas where access is difficult. It is not clear how transferable this approach is to other contexts and whether there are specific factors that make it work in this one. The overall hygienic safety of this approach would also need to be confirmed, as it appears to be highly reliant on customer education and on customers adopting hygienic practices for handling the waste. There have been cases where customers have lost access to the service due to poor hygienic practices.

x-runner is leveraging the capacities of suppliers to reduce the complexity of its business to a manageable level. Separett provides a high-quality containment solution at a very discounted price (to its credit and to x-runner’s ability to develop and market its solution). This removes the need for x-runner to build a toilet manufacturing line. In addition, EcoCentury provides a robust and scalable transport solution, removing the need to obtain accreditations and the extra overhead that comes with monitoring and complying with regulatory standards, which EcoCentury does on x-runner’s behalf. It remains to be seen whether this will impact on x-runner’s ability to improve its cost-efficiency.

Customer growth is somewhat slow (and below targets) but steady, and the potential market is large. x-runner now has to work on increasing cost-efficiency and addressing potential bottlenecks. x-runner has averaged 24 new customers per month since 2015. This is a little more than half the sales target of 42 sales per month. The sales and marketing process is being refocused toward spreading awareness about available incentives and promotions for successfully referring non-customers to the service. x-runner’s operations appear to be facing a number of bottlenecks in the near term, including limitations in the sawdust supply chain, a need to start scaling up collection service capacity while avoiding idle capacity, and constraints on the sale of compost and the resulting maxing out of storage capacity at the treatment site. Robust solutions to these issues are needed to unlock the expansion of x-runner’s operation.

An explicit recognition of CBS—or a category into which CBS clearly falls—as a viable sanitation system for the urban poor would be an important factor for enabling public sector support. Although the policy and institutional framework in Peru permits

the CBS approach, it does not enable it. Currently, the predictability of x-runner's market assumes that the public sector will not come up with and subsidize an alternative and competing solution for its area of operation. A recognized CBS category would open the door for policies and procedures to determine which areas and populations it is appropriate for and the

development of service standards. In addition, regulation of fecal sludge reuse (currently not allowed) would allow x-runner to collect revenues from the production of compost, which is currently carried out with a highly efficient process simply to minimize land use associated with waste disposal and generates costs but no revenues.

APPENDIX A • PEOPLE INTERVIEWED

Organization	Designation	Name
x-runner	Chairperson	Isabel Medem
x-runner	Chief executive officer	Raúl Briceño
x-runner	Chief financial officer	Mónica Ramos
x-runner	Chief operating officer	Maria Pia Quiroz
x-runner	Customer relationship manager	Natalia Benavides
x-runner	Head of installations	Celi Sedano
x-runner	Head of sales	Esther Calderón
x-runner	Waste treatment plant manager	Nemecio Córdor
World Bank Lima Office	Water and sanitation specialist	Malva Rosa Baskovich
Vía San Juan	Community leader	Rogelio
Servicio de Alcantarillado y Agua Potable de Lima (Lima Sewerage and Water Supply Service; SEDAPAL)	Head of Investigations, Innovation and Standardization Team	Oswaldo Hernán Vargas Cuellar
Ministry of Housing, Construction and Sanitation	National sanitation director	Oscar Pastor
Superintendencia Nacional de Servicios de Saneamiento (National Superintendence of Sanitation Services; SUNASS)	Tariff Regulation Management Supervisor II	Ana Vergara
SUNASS	Tariff Regulation Management	Luis Acosta
SUNASS	Tariff Regulation Management	Arturo Lázaro
SUNASS	Tariff Regulation Management	Gretelina Castañeda
Grand Challenges Canada	Consultant	Alyse Schrecongost

APPENDIX B • X-RUNNER/SANISOL ORGANOGRAM

