



Addressing Sanitation Services in Dense Urban Slums: A Container-Based Model

By moving from permanent infrastructure to subscription services, we can create flexible sanitation models that are more effective at managing waste, enhancing sustainability and providing services in informal urban settlements.

Background

As of 2010, 2.5 billion people either relied on sanitation facilities that did not meet basic hygienic standards (21% of the world's population), or had no facility at all (15%)¹.

This service gap contributes to morbidity and mortality from diarrheal disease, still the second leading cause of death for children under the age of 5².

Although the international development community sought to close this critical gap in access through the Millennium Development Goals, which are set to expire at the end of 2015, there is recognition that much work remains to be done. A new set of Sustainable Development Goals (SDGs) have been proposed for the post-2015 period, including a specific goal for water supply and sanitation service provision. SDG Goal 6—"Ensure availability and the sustainable management of water and sanitation for all"—includes targets for ending open defecation and full-supply chain management of waste. Rapidly growing, dense urban populations present considerable challenges to achieving these targets.

1 Joint Monitoring Program (2014), "Progress on Drinking Water and Sanitation: 2014 Update", WHO UNICEF, 28 pages.

2 Walker CLF, I Rudan, L Liu, H Nair, E Theodoratou, ZA Bhutta, KL O'Brien, et al. (2013), "Global burden of childhood pneumonia and diarrhoea", *The Lancet* Vol 381, No 9875, pages 1405–1416.

About the Researchers

The research was led by Kory Russel and Sebastien Tilmans, members of the re.source project team associated with Stanford's program on Water, Health and Development, in collaboration with co-authors Rachel Sklar, Leah Page, Sasha Kramer, Daniel Tillias and Jenna Davis (Associate Professor, Civil & Environmental Engineering, and Higgins-Magid Senior Fellow at the Stanford Woods Institute).

This brief is based on the papers "Container-based sanitation: assessing costs and effectiveness of excreta management in Cap Haitien, Haiti" (Environment and Urbanization, April 2015) and "User perceptions of and willingness to pay for household container-based sanitation services: experience from Cap Haitien, Haiti" (Environment and Urbanization, October 2015).

Simply put, there is a looming sanitation crisis in cities. Slum populations are expected to double from the current 1 billion by 2030, as the world's population continues to urbanize at a rapid pace³. Cities are struggling to expand critical infrastructure to accommodate this unprecedented growth.

3 UN-Habitat UNHSP (2003), "The Challenge of Slums: Global Report on Human Settlements", United Nations, pages 1–345.

As a result, the percentage of city households that have a sewer connection in the United Nations' group of Least Developed Countries (including Haiti) has actually declined since 1990. The challenges to sewerage provision are not just financial and logistical, however. Many urban communities are informal or illegal. Governments are often reluctant to legitimize these settlements by installing piped infrastructure. With sewer systems a remote possibility for the majority of urban residents in the developing world, there is a dire need to develop viable alternatives.

The two predominant approaches to sanitation in low-income urban areas today are public toilets, and private "on-site" facilities such as pit latrines and pour-flush toilets with septic tanks. Each approach has critical flaws. Public toilets are often poorly maintained and are usually inaccessible at night. Private on-site facilities require substantial up-front investment from the household, which can be prohibitive for poor families and for those who are renting their homes. Equally important, latrine pits and septic tanks eventually fill with waste. Roads in low-income areas of developing cities are often inaccessible by emptying vehicles. Pits and tanks are thus

often emptied manually, exposing community members to human wastes.

A small number of groups around the world are developing a different approach to excreta management, termed container-based sanitation (CBS). This approach is uniquely suited to the challenges of dense cities. CBS consists of a service that provides waterless toilets built around sealable, removable containers. The sealed containers are removed from the community without exposing residents or workers to the waste, and are brought to treatment or resource recovery centers where the material can be safely managed. The toilets can be compact enough to fit within very small homes. CBS toilets can also be portable, reducing investment risk for households by enabling new subscription-based service models. The portability and modularity of the system also may enable governments to help finance it in informal settlements without the political liabilities of piped infrastructure. Finally, CBS has built-in end-to-end management of the waste, facilitating improved monitoring of service performance throughout its supply chain.

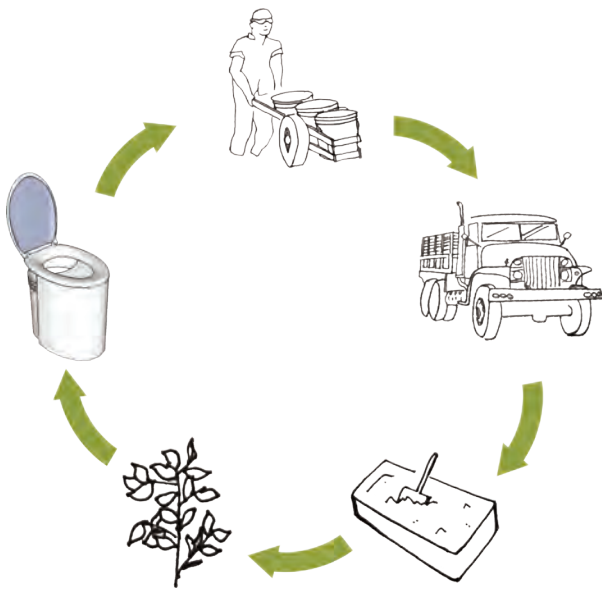


Photo Credit: SOIL

In collaboration with the non-governmental organization SOIL (oursoil.org), a team of researchers at Stanford developed a CBS service in the city of Cap Haïtien, Haiti. New studies led by Stanford Civil and Environmental Engineering researchers Sebastien Tilmans and Kory Russel provide initial results from the piloting of this service. The authors found that CBS has the potential to dramatically improve the management of human waste in dense urban communities while at the same time satisfying residents' desire for safe, convenient and modern sanitation services.

Key Research Findings

Management of Human Waste



CBS services provide end-to-end management of waste from initial capture in a toilet to final treatment or resource recovery

One of the principal challenges of urban sanitation is to capture, isolate and convey human waste away from dense areas to a place where it can be properly managed.

Even high-quality public toilets in the study community could not meet this objective. Whereas half of study participants reported using the public toilets for their daytime needs, only a third did so at night. The remainder typically defecated in the open, or used “flying toilets,” plastic bags that are later tossed into alleyways.

The CBS service reduced reported open defecation and use of flying toilets to less than 1%, and achieved a 3.5-fold reduction in the share of feces that was unmanaged in the study group. The researchers found that CBS has tremendous potential to improve management of waste in the areas where previous solutions have been unsuccessful.

System Costs

Whereas CBS is an effective system for managing waste, its implementation costs at pilot scale remain high relative to the costs of full-scale sewer systems. Nevertheless, there is considerable potential to reduce the costs of CBS through service efficiency improvements, new learning, and economies of scale.

User Perceptions and Demand for Service

A lack of demand for improved sanitation services is often cited as reason to avoid addressing sanitation in low-income urban settings. It appears, however, that in many locations this lack of interest reflects the undesirable nature of the current sanitation options as opposed to a general resistance to sanitation.

Based on before-and-after interviews, Russel et al. found significant changes in reported perceptions of respondents' sanitation situation.

- Individuals using the CBS service were significantly more likely than ones in control cohorts to report that their household's sanitation situation conferred feelings of pride and modernity. They were also significantly less likely to report feeling ashamed by their household's sanitation situation.
- Among all respondents, approximately three-quarters said they were likely to pay US \$5 per month for CBS services. Following the service pilot, 71 percent of participating households opted to continue with the CBS service as paying subscribers.
- Feelings of safety among users of the CBS toilet increased to 92 percent.

The researchers found that CBS not only inspired a high willingness to pay but also converted those individuals into consistent paying customers.

Water Quality

A key concern for in-home sanitation services is the possibility of increasing fecal contamination within the household environment. While the study was not designed to evaluate the magnitude of change in stored water contamination, it nonetheless showed no increased fecal contamination of the household environment associated with the introduction of CBS toilets.

Considerations for Policymakers

1. Container-based sanitation is an effective option for sanitation service provision in urban communities with limited alternatives
2. Larger implementations of CBS services are necessary to verify and demonstrate their viability at scale
3. Municipal governments and donor agencies can play a key role in helping fledgling CBS services scale up, by providing an enabling regulatory environment and facilitating financing.

Conclusions

The findings by Tilmans et al. and Russel et al. indicate that CBS can dramatically improve management of waste in otherwise hard-to-serve areas of developing countries while satisfying residents' desire for safe, convenient and modern sanitation services. The costs must be further optimized, but there is great potential for improvements and cost reductions.

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