WSUP | Water & Sanitation for the Urban Poor

Are Simplified Sewer Systems a viable option for informal settlements in Kenya?

Results of a pilot project in Mukuru, Nairobi

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Quick read...

- Simplified Sewer Systems (SSS) are widely used in Brazil and other Latin American countries, and have also been trialled in Tanzania and Namibia
- Relative to conventional sewers, these systems cost less, use smaller-diametre, flexible pipes, and can be laid at shallower depths and closer to households, easing the connection process
- This Practice Note presents the results of a SSS pilot in the informal settlement of Mukuru, Kenya, as part of a wider slum development initiative. Findings are based on two independent evaluations of the pilot scheme
- While SSS is not suitable for all contexts, initial findings suggest that these systems can provide a viable sanitation option in densely populated, low-income settlements with existing trunk sewer infrastructure

Introduction: sanitation in Nairobi

With an urbanisation rate of 4.5% per annum, Kenya is one of the most rapidly urbanising countries in the world. Access to improved sanitation facilities remains low at 31% in urban areas, with 84% of the Kenyan population depending on onsite sanitation. Nairobi, Kenya's capital city, has been experiencing particularly rapid urbanisation. This growth is skewed towards the city's densely populated informal settlements, which occupy 2.6% of Nairobi's land, but host 60% of Nairobi's population.

Informal settlements in Nairobi have historically lacked key infrastructure and basic services, including water and sewer connections, and solid waste management. Under the leadership of the utility, Nairobi City Water and Sewerage Company, and Nairobi Metropolitan Services, there is a recognised and urgent need to develop context-specific sanitation options tailored to the technical and social challenges posed by informal settlements.

Image: Connecting a pipe to a trunk sewer line, Nakuru, Kenya.
Credit: Brian Otieno

Why simplified sewers?

Simplified sewer systems provide one such sanitation option. Relative to conventional sewers, these systems use smaller-diametre, flexible pipes, which can bend and be laid at a shallower depth. These systems cost less, and can be laid in very close proximity to the property of the users, enabling higher household connection rates to be achieved. This negates a common challenge associated with investment in conventional trunk sewer infrastructure, including in Kenya, which frequently fail at the point of "the last mile", because households are unwilling to pay high connection charges. Simplified sewer systems are used widely in Brazil and other Latin American countries, and have also been trialled in Tanzania and Namibia, underpinned by the rationale that these systems can enable major cost savings without affecting the performance of the system.

In WSUP's view, simplified sewer systems can provide a number of benefits in the context of informal settlements, see Table 1. But how would these systems perform if piloted? WSUP proposed trialling the model in the informal settlement of Mukuru as part of wider slum upgrading activities, detailed below.

Table 1: Summary of key benefits of Simplified Sewers.

BENEFITS OF SIMPLIFIED SEWERS
Suited to densely populated but well-structured settlements.
Inspection chambers are provided every 30 Metres to support network maintenance
Easily adapted to low-income area (LIA) sanitation governance systems e.g. CBOs
Easily adapted to LIA technologies e.g. pour-flush latrines
Provide incentives for CBOs and communities who may be engaged as caretaker managers
Enable improvisation and the use of locally available materials, unlike conventional sewers
Enhance utility and government visibility through comprehensive participatory approaches
Reduced connection costs relative to conventional sewers
Facilitate local innovation and skills transfer, providing easy integration of FSM options

Piloting the SSS model in Mukuru, Nairobi

The informal settlement of Mukuru, Nairobi, was declared a Special Planning Area in 2017, leading to the development of Mukuru Integrated Development Plan (MIDP). The MIDP consists of multiple sector plans to upgrade living standards and provide basic services in the settlement, which is home to approximately 650,000 people. As part of the Mukuru SPA, a pilot project was implemented to improve water and sanitation services, involving a partnership between Nairobi City Water and Sewerage Company (NCWSC), Nairobi Metropolitan Services (NMS), WSUP, Akiba Mashinani Trust (AMT), and the community. The project aimed to pilot alternative, complementary solutions for safe water and sanitation: the installation of pre-paid water dispensers (PPDs) and simplified sewer systems (SSS).

Supported by The One Foundation, WSUP developed plans to support PPD and SSS systems in the Mosque Road area of Mukuru. Prior to the intervention, sanitation access for the residents of Mukuru was generally poor: half the households depended on shared pit latrines, and 62% of shared pour-flush toilets connected to open drainage systems which channelled waste directly into the nearby river. The SSS intervention involved extending existing sewer networks to the plot level; supporting the upgrade of toilets to pour-flush standards; and supporting the connection to the network. Despite unforeseen challenges — including difficulties in mobilising communities as a result of COVID-19 restrictions — the project was implemented successfully, exceeding targets. A total of 1,008 metres of simplified sewer service lines were laid, 72 manhole chambers constructed, 100 households connected and more than 4,000 beneficiaries reached, surpassing the target of 3,000 beneficiaries.

Evaluating the model

The SSS pilot was conceived to improve sanitation for low-income residents of Mukuru, but also to test the viability of the model for replication in wider settlements in Nairobi and other cities in Kenya. To assess the viability of the model, WSUP commissioned two evaluations of the pilot project:

Figure 1: Map of the Mosque Road area of Mukuru. The green line represents sewer network extensions constructed under the project.

- A before-after assessment, with Mombasa zone, an area of Mukuru, as a control area not receiving the intervention
- A qualitative assessment of stakeholder perspectives on the model, involving focus group discussions with tenants and landlords; and key-informant interviews with key stakeholders NCWSC, NMS, WSUP, AMT and Sanergy

Through these assessments, WSUP and partners aimed to understand the effectiveness of the SSS model, with a particular focus on suitability for informal settlements (incorporating sustainability and affordability); and scalability, in Nairobi and elsewhere. Findings from the assessments are synthesised overleaf.

Evaluating the SSS model: suitability for informal settlements

Densely populated informal settlements can pose unique challenges to sanitation service provision. According to stakeholders interviewed as part of the evaluation, the SSS model is well-adapted to a number of these challenges. Key benefits cited included the lower wayleave requirements (access requirements for pipes laid in private land), enabling the sewer lines to be laid at a shallower depth and reducing infiltration of ground water; the use of smaller-diametre flexible pipes (HDPE or composite), which allow manoeuvrability along footpaths; the use of inspection chambers for maintenance, as opposed to large diametre manholes; and the minimal displacement of residents.

Sustainability

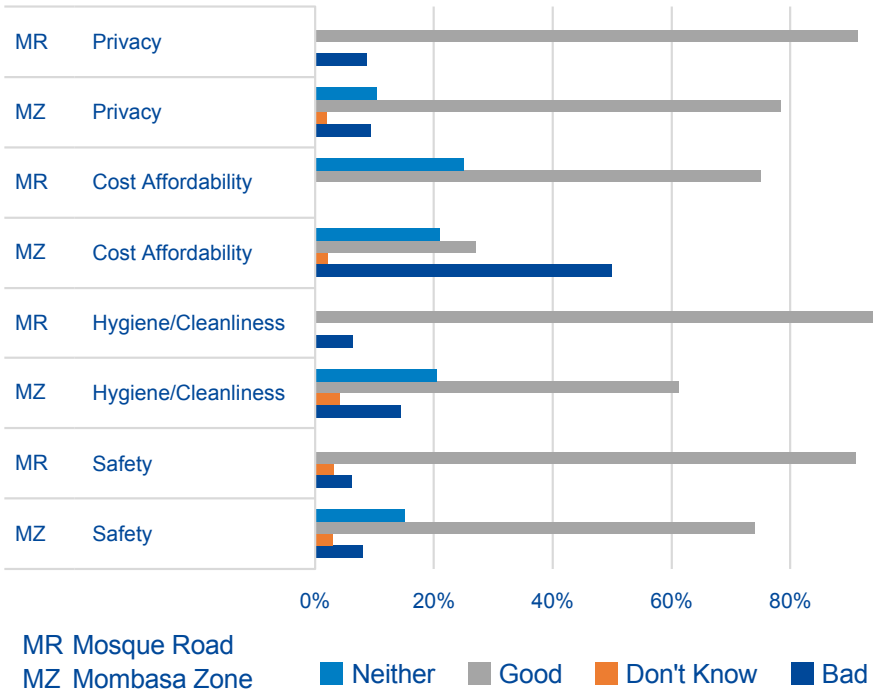
In WSUP's experience, the provision of citywide sanitation services involves a menu of services. Like other sanitation options, SSS is not appropriate to all contexts: for example, it is generally not suitable for riparian reserves or low-lying areas where topography does not allow connection to the sewers. Blockage of pipes due to the disposal of solid waste and diversion of stormwater into the system are also key challenges, as highlighted by NMS respondents. Accordingly, SSS requires the community to be on-boarded early in the project, supported by public awareness campaigns and further measures to ensure functional solid waste management and stormwater drainage. Feedback in this area was positive, with landlords interviewed for the evaluation perceiving their responsibilities relating to toilet and sewer maintenance were well-explained to them prior to connection; and rating their overall awareness level relating to the model as high.

Pour-flush toilets connected to SSS also use less water than conventional sewer connections. However, they require water availability on a continuous basis to avoid blockages. This requires a coordinated approach to improving water supply where SSS connections are being established. As noted by NCWSC staff, this was addressed in the current intervention through the commissioning of 15 PPDs to offer reliable water supply within easy reach.

Affordability

Affordability of the model is yet to be rigorously tested in Mukuru, owing to the unique circumstances of the COVID-19 pandemic, as a result of which NCWSC initiated a moratorium on connection charges. However, affordability of the model relative to conventional sewer connections is viewed to be a major strength: the cost of construction for SSS is estimated at 5,000 KES per metre (approx. US$ 41), compared to between 10,000 and 15,000 per metre for conventional sewers, due to savings in pipings, manholes and earthworks. Approximately 83% of landlords reported that the costs of connecting to the SSS networks were affordable or very affordable; with 81% reporting they would be willing to upgrade their toilets to pour-flush standards. The majority of tenants interviewed thought that user charges of KES 200 per month (approx. $US 1.6) per connection proposed by NCWSC was affordable, and stated willingness to pay higher rents for properties with toilets upgraded to pour-flush standard.

Figure 2: Ratings of toilet facility in the intervention area (Mosque Road) and control area (Mombasa Zone).



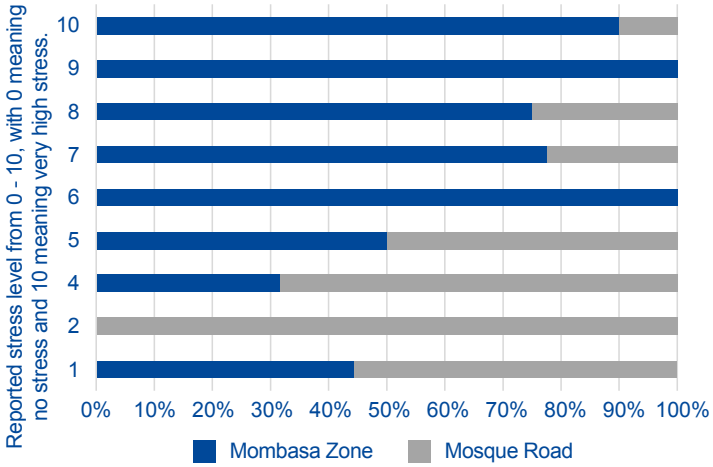
Notwithstanding the requirement to further test affordability once the moratorium on levies is lifted, there is a strong basis to view the affordability of SSS services as comparing favourably to

alternative sanitation options. For example, residents of Mukuru pay between KES 5-10 for single use of public latrines, amounting to KES 900 (approx. $US 7.4) per month for a family of three; compared to KES 20 (approx. $US 0.16) per month for SSS services, assuming a plot of ten households. Potential measures to enhance affordability could include subsidy provision for connection fees from the social connection fund managed by NCWSC; and the option to pay connection fees by instalment over a longer period.

Customer satisfaction

Assessments of the model indicated high levels of user satisfaction, further testifying to suitability. These satisfaction levels related to the facility overall, which included improvements to the superstructure and upgrading to pour-flush toilets. Figure 2 above outlines how residents of the intervention area, Mosque Road, reported higher levels of satisfaction with their toilet facility for all key metrics. The impact of these toilet improvements on levels of stress resulting from poor sanitation has been particularly pronounced, as illustrated in Figure 3.

Figure 3: Reported stress levels of respondents resulting from poor sanitation in the intervention area (Mosque Road) and control area (Mombasa Zone).



% = proportion of respondents selecting each score from Mosque Road and Mombasa Zone respectively (i.e. 90% of all respondents who scored 10 resided in Mombasa Zone).

Scalability of the SSS model in Nairobi and other Kenyan cities

A significant feature of informal settlements in Kenya is the prevalence of trunk sewers running along settlement peripheries (or in some cases, through the heart of the settlement). Despite the existence of this primary infrastructure, there is generally little, if any, off-site sanitation in these areas. In WSUP's view, the prevalence of trunk sewer networks provides abundant untapped potential for scale-up of the SSS model. A mapping of the spatial and demographic characteristics of all informal settlements in Kenya found the SSS model could be suitable for over 50% of these settlements. Importantly, scale-up of the model would be aligned with a pro-poor indicator developed by the national regulator WASREB (KPI-10), which requires all utilities to report levels of service improvement to informal settlements.

There are clearly barriers to scale-up which will need to be addressed. The greatest barrier is finance mobilisation, including to ensure appropriate infrastructure for sewage treatment. These financial challenges are currently unresolved; however, one proposal supported by NCWSC and WSUP is the inclusion of budget allocations to support customer connections in all future capital developments of sewer works. Wider measures to support scale-up include policy change at the national level, to anchor public infrastructure investment to informal settlements in policy and statutory documents; and the integration of SSS into utility design codes, policies and manuals.

Conclusion

In WSUP's experience, achieving citywide sanitation coverage requires a menu of services, including sewered and onsite. The most appropriate technology and service delivery model may vary based on the characteristics of each settlement, or even within settlements. Conceptually, Simplified Sewer Systems (SSS) have a number of strengths which can make them well-suited to densely populated informal settlements. These include relatively low costs, flexible pipes to enable manoeuvrability, and ease of connection. It must be emphasised that SSS requires specific conditions in place to be effective, including adequate water supply to support pour-flush toilets; strong community engagement to support effective system maintenance; and the existence of trunk sewer networks, to which these systems can be connected (in Mukuru, affordability of the SSS model is also still to be fully tested, owing to the circumstances of the pilot which took place during COVID-19). However, customer satisfaction with the model was found to be high, and the model is viewed as both sustainable and scalable by the mandated city authorities. In particular, the prevalence of trunk sewer networks in informal settlements in Nairobi and other Kenyan cities provides genuine potential for scale-up.

Credits

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