Developing business models for fecal sludge management in Maputo

Peter Hawkins and Odete Muxímpua

June 2015





wsp water and sanitation program

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The Water and Sanitation Program is a multi-donor partnership, part of the World Bank Group's Water Global Practice, supporting poor people in obtaining affordable, safe, and sustainable access to water and sanitation services. WSP's donors include Australia, Austria, Denmark, Finland, France, the Bill & Melinda Gates Foundation, Luxembourg, Netherlands, Norway, Sweden, Switzerland, United Kingdom, United States, and the World Bank.

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Acronyms and Abbreviations

AIAS	Water and Sanitation Infrastructure Board
AMMEPS	Mozambican Association of Micro-Enterprise Service Providers
CBO	Community-Based Organization
CRA	Water Regulatory Council (urban water and sanitation sector regulatory agency)
FSM	Fecal Sludge Management
GPS	Global Positioning System
HIV/AIDS	Human Immunodeficiency Virus infection and Acquired Immune Deficiency Syndrome
IE	Individual Manual Bucket Emptier
IHE	Institute of Hydraulic Engineering (Delft, Netherlands)
JSDF	Japan Social Development Fund (World Bank Trust Fund)
MMC	Maputo Municipal Council
MOPH	Ministry of Public Works and Housing
NGO	Non-Governmental Organization
PDA	Personal Digital Assistant
PPIAF	Public-Private Infrastructure Advisory Facility (World Bank Trust Fund)
UNICEF	The United Nations Children's Fund
USSI	Urban Sanitation Status Index
WC	Water Closet (flush toilet)
WHO	World Health Organization
WSP	Water and Sanitation Program
WSUP	Water and Sanitation for the Urban Poor

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Executive Summary

Context

Only 9% of households in Maputo are connected to a sewerage system, whilst 41% rely on pit latrines and 49% use septic tanks and pour-flush toilets. Although almost 90% of Maputo residents have access to a hygienic excreta disposal facility as defined by the World Health Organization/ The United Nations Children's Fund (WHO/UNICEF) Joint Monitoring Program, this ignores the fact that most of them are not emptied hygienically, with obvious and extremely negative implications for public health and the environment. An analysis of fecal waste flows in Maputo shows that only 3% of the total fecal waste produced actually passes through the treatment plant, whilst more than 50% contaminates backyards, the drainage system and Maputo Bay. It is also clear that the biggest problem area is with on-site systems, with much fecal waste being unsafely dumped by local burial or in ditches and unoccupied ground, and even that which is safely removed being partly dumped into the environment or inadequately treated.

This problem of Fecal Sludge Management (FSM) is particularly acute in the city's older unplanned settlements, typified by Nhlamankulu, which is one of five Municipal Districts that comprise the mainland (urban) portion of Maputo city, and has a population of about 150,000 people distributed across 11 neighborhoods. In order to develop a scalable intervention strategy, a project targeting the whole of Nhlamankulu District was undertaken, comprising the improvement of toilets in low-income rental compounds, building technical capacity in the municipal sanitation department, and promotion of improved sanitary practices at household level, as well as the development of sustainable private sector capacity to provide FSM services adapted to the physical and economic conditions in these peri-urban communities, which is the subject of this document.

The Project

The project originated through a request from the Maputo Municipal Council (MMC) to Water and Sanitation Program (WSP) to define and develop a basic level service model for sanitation in peri-urban areas not served by the sewerage system, focusing on improved pit emptying services to replace the existing unhygienic manual services widely used in the District. It was decided to carry out the work in Nhlamankulu District which was regarded by MMC as having the most severe sanitation problems in the city, and to work at the level of an entire Municipal District so as to be at a scale that would contain all the various administrative elements necessary for a subsequent city-wide roll-out. The project was led by WSP and implemented with four principal partners, namely:

- **Water and Sanitation for the Urban Poor (WSUP),** an international Non-Governmental Organization (NGO), which was already working in Maputo, providing tertiary water networks, standpipes and house connections, and improved sanitation for low-rental compound housing. WSP obtained US$1.8 million from the Japan Social Development Fund (JSDF – a World Bank Trust Fund) to enable WSUP to continue with providing sanitation facilities for compound housing, promoting sanitation among the population at large, and developing FSM services adapted to peri-urban realities.
- **The Second Maputo Municipal Development Project** (ProMaputo), funded by the World Bank, which has the objective of strengthening the capacity of MMC to develop, manage and maintain quality service delivery to its citizens. In support of this objective, entrepreneurial training and market analysis were provided to the private sector FSM operators equipped using the JSDF funds. This component was funded by the Public-Private Infrastructure Advisory Facility (PPIAF – a World Bank Trust Funded program).
- **The Maputo Municipal Council's Water and Sanitation Department,** under which were developed the beginnings of a neighborhood-based sanitation monitoring system, a plan for building up the sanitation function, a new sanitation byelaw, as well as obtaining funding of about US$ 500,000 from ProMaputo for basic equipment that was lacking.
- **The Mozambican Association of Micro-Enterprise Service Providers (AMMEPS),** a trade association bringing together the 25 micro-enterprises which provide primary solid waste collection services in the peri-urban neighborhoods of Maputo – although the scope of the Association is national, it only exists in Maputo at present. They took the initiative in seeking to expand the scope of their businesses to include FSM, and assisted in the selection and oversight of the firms participating in this project.

Based on a survey carried out with WSP support by the Maputo Municipal Council in 2011, an average demand of 2,300 emptyings per year in Nhlamankulu District was estimated, with a ratio of about 3 pit latrines to one septic tank. Drawing on current international experience, the service model was designed with transfer facilities, to allow for primary collection with small equipment capable of accessing narrow alleyways and secondary transport to the treatment plant with larger, more economical and roadworthy equipment. Eight private service providers (5 equipped only for primary collection and 3 for both primary collection and secondary transport) were selected as partners for the development of improved FSM services. The primary operators were equipped to provide services from collection to the transfer station, using a 0.5m^3 plastic water tank mounted on a handcart, while the secondary operators also had a 2m^3 plastic tank which could be mounted on a small truck and taken directly to the treatment works. Emptying equipment issued to all operators consisted of buckets and appropriate hand tools and a Gulper (handpump designed for desludging), intended for use on pit latrines, and a 100mm diesel-powered trash pump for use on the more liquid sludge from septic tanks, as well as personal protective equipment for the workers. Following difficulties with siting the transfer stations (sites were made available by the Maputo Municipal Council, but could not be used due to resistance from nearby residents), 6m^3 vacuum tank trailers were procured and issued to the secondary operators as a substitute.

Initial Results

Effect of Water Supply on Sanitation

The urban environment has the potential to change rapidly over time, which was the case in Nhlamankulu District. Although the 2011 survey showed that 68% of households in the project area used improved and traditional pit latrines and 32% used septic tanks and pour flush latrines, data on the same neighborhoods from a city-wide survey conducted by WSP in 2013 show a remarkable transformation, with 36% using pit latrines and 64% septic tanks and pour flush. This rapid switch from pits to septic tanks has meant that desludging operations now need to remove greater volumes of a more watery sludge than was originally envisaged at project design.

Increasing access to household water connections maybe one of the main reasons why people are moving up the sanitation ladder to water-seal toilets. Starting from late 2011, a number of water supply improvements were made in Maputo, including connection campaigns, improvements to the tertiary network and increased water production. In Nhlamankulu, access to individual connections doubled to almost 80% by 2014. This is closely reflected in the type of sanitation facilities, with the use of flush toilets (WC) tripling in two years, thereby reducing the use of pit latrines.

Customer Satisfaction

An assessment of customer satisfaction was carried out in September and October, 2014, with a view to understanding their reasons for using or not using the new service. A total of 99 households were interviewed, 61% of which were customers and the remaining 39% potential customers who decided not to use the services after contacting an operator. Eighty-seven percent of respondents were septic tank users and only 13% pit latrine users. The majority (63%) of households which rejected the new services had used manual emptying methods before, either by informal emptiers or household members; while customers who used the services had commonly (47%) used mechanized services previously, followed (33%) by manual services. Forty-two percent of respondents reported that the fecal sludge was buried in their yards, whilst 43% stated that it was taken to the wastewater treatment plant. About 10% of respondents (mainly those using manual emptiers) reported that the sludge was dumped the into drainage channels. Households relying on pit latrines were primarily (77%) using manual emptying, while those on septic tanks used both manual (35%) and mechanized (45%) emptying services.

Almost 50% of the customers that used the new services did so to try out its efficiency and adequacy and another 23% were attracted by the good customer care available from a locally-based operator. Those rejecting the services cited price as the main reason. General feedback from customers using the service was good, with cleanliness and hygienic practices being the main reason for satisfaction (52%), followed by a related factor, the use of appropriate equipment (13%). Though pricing is clearly an issue that needs to be reviewed, 85% of the customers reported that they would use the service again.

Cost of the Services

Typical prices charged were between US$ 30 and US$70, for both those that accepted and those that rejected the service. At least 13% of those who rejected the service hired a manual emptier after rejecting the new services, admitting that they were conscious of the associated risks, but that they had no option but to use a cheaper service. Many (55%) of the pit latrine users (generally less well off than septic tank users) are not willing to pay more than US$ 25 for emptying, whilst of septic tank users, 42% were willing to pay up to US$ 40, and 35% more than US$ 40.

Many potential customers, particularly pit latrine users, continue to use cheap and unhygienic manual emptying with local burial or open dumping, with price being the most common disincentive cited. While the prices applied during the pilot do not cover amortization of capital investment cost, they still appear to be too high for poor households, and about three times those practiced by the manual emptiers.

Size and Scope of Service Providers

With a variety of sanitation facility types to be serviced and the fast-changing nature of peri-urban communities, service providers need to be able to provide an inclusive and comprehensive set of options in order to sustain their business. The very small scale primary service providers appear to be too small to be self-sustaining and ended up working with the larger secondary operators, often in the role of front-line sales staff.

Technology Issues

A few spillages occurred initially with both the Gulper handpumps and the diesel-powered trash pumps, but as the operators became more skilled, these problems were overcome. The use of plastic water tanks to carry the sludge also gave rise to some spillages on the rough roads in the project area, as the covers are not watertight. Solutions to this problem are being developed.

The use of a handcart with a 500-liter tank for primary collection was found to be very challenging on the unpaved roads in the project area, so the possibility of using a motor tricycle instead of a handcart was considered, but rejected as the great majority of demand comes from septic tanks, where sludge volumes per service are typically $2m^3$-$3m^3$. The operators spontaneously developed a system whereby fecal sludge is directly transferred by bucket or trash pump to a $2m^3$ or $6m^3$ tank that can be hauled directly to the treatment works at reasonable cost.

Recommendations

Given the on-going modification of the service models, more time is needed to draw out the full lessons from this pilot, and this will be done over the coming months. However, there are already some clear recommendations that can be made to MMC and the existing service providers, and which would also be valid in other areas, if and when the experience is rolled out.

Subsidies

The low affordability of improved FSM services to the poorest potential users emerged clearly as an issue that needs to be resolved. In Maputo, as in most African cities, transport to the treatment works is by far the largest component of the service cost. As this is primarily a public good, and in line with the fact that nearly all sewerage systems, at least in developing countries, fail to recover capital costs, a subsidy for this step in the sanitation service chain should be considered. This could be paid out of the sanitation tariff which will soon be added to all water bills.

Although sanitation is entirely a municipal responsibility and the water utility has no mandate for sanitation, the principle of charging for sanitation on water bills is already established nationally, and has been operationalized in Beira (and for a time in Quelimane). Solid waste fees are charged in many cities via the electricity bill, with the utility charging a commission for the collection, and the procedure for the sanitation fee would be the same, but via the water bill. The main difficulty in introducing the sanitation tariff is the need for regulatory oversight, which in turn requires clear separation of the finances of the Municipal Sanitation Department, so that they can be examined by the regulator. The establishment of autonomous municipal entities is a new phenomenon, and it is taking time for the Municipalities to develop the necessary institutional and legal arrangements.

Decentralized Treatment

Given the larger sludge volumes generated by the water-using facilities that have been built following water supply

improvements in the project area, transfer stations and transfer equipment would need to be much larger, and thus less cost-effective. However, decentralized treatment facilities would greatly reduce the need for road haulage. This would of course depend on the availability of land and the acceptability of the technology to nearby residents. WSP and MMC will continue to examine possible approaches to this.

Size of the Service Provider Enterprises

This study confirms the observation by the Bill & Melinda Gates Foundation (Choudhry and Kone, 2012) that very small FSM enterprises are not sustainable, and that other sources of income than household emptying are necessary to ensure viability. Given the range of facilities to be emptied, from the simplest of dry pits to fully engineered septic tanks, and the variable access conditions in peri-urban areas, a FSM service provider needs to be able to maintain a range of equipment to deal with all eventualities. It is also clear that marketing is important, which requires a certain critical mass to be effective, although individual efforts through local networking are also useful. Following the arrangements that are evolving spontaneously amongst the operators, and taking cognizance of the fact that one operator per neighborhood is appropriate for solid waste management, but possibly too many for FSM, an option could be to establish a limited number of full-service (collection and transport to disposal) operators with small trained temporary teams in each neighborhood, who would promote the service and be paid per client by the main operator. These small teams would be branded and supervised by the main operator to ensure service quality.

Technology

Technological options for FSM in peri-urban areas still need to be improved. A number of technologies have been adapted to date, but they still require further development. In particular, dealing with the thicker and drier sludge from dry pit latrines while minimizing contact with the operator is still a challenge which needs to be addressed. Better tanks for primary fecal sludge transport are also needed. WSP will collaborate with the service providers to develop suitable solutions.

Monitoring

Access to information is essential for service design and development. Given the dynamic nature of peri-urban settlements, local government should establish monitoring systems that continually update sanitation status to support better planning and prioritization.

I. Introduction

1.1 Background and Objectives

Over the next 100 years, Africa's population will expand from 1 billion to 4 billion, and most of this growth will be in urban areas. This rapid urbanization has already happened in Organization for Economic Cooperation and Development (OECD) countries and Latin America, and is currently happening in Asia. Sewerage systems will at best expand from current levels of 10-20% to perhaps a third of the urban area (although just keeping up with population growth will be a major challenge) which means that the norm for urban Africans will continue to be on-site sanitation. Despite this, a wide-ranging study[1] shows that effective fecal sludge management (FSM) is still a largely unsolved problem, with services mostly delivered by an unregulated informal sector. It is, however, beginning to receive more attention, and progress is now being made in a few places, notably in a global research project currently being undertaken by WSP, and in Dakar, Senegal, where the Bill & Melinda Gates Foundation is funding a major project to systematize FSM in the city. The work reported in this document focuses on a pilot project to develop sustainable and affordable FSM services for Maputo's most densely settled and unplanned district, Nlhamankulu.

Access to sanitation services is still a major challenge in Mozambique's urban areas, especially for the poor. Almost four decades after independence, less than half of the country's 8 million urban residents have access to improved sanitation[2], and 12% still defecate in the open. However, these figures hide serious deficiencies further down the sanitation service chain, with very limited availability of emptying, transport and treatment services for fecal

TABLE 1: IMPORTANCE OF ON-SITE SANITATION IN DEVELOPING COUNTRY CITIES (SOURCE: WSP, 2014)

Country	City	Pop (M)	% Households Using On-site Systems	Sewerage	Open Defecation
Latin America					
Bolivia	Santa Cruz	1.9	51%	44%	5%
Honduras	Tegucigalpa	1.3	16%	81%	3%
Nicaragua	Managua	1.0	56%	40%	4%
Africa					
Mozambique	Maputo	1.9	89%	10%	1%
Senegal	Dakar	2.7	73%	25%	2%
Uganda	Kampala	1.5	90%	9%	1%
South Asia					
Bangladesh	Dhaka	16.0	79%	20%	1%
India	Delhi	16.3	24%	75%	1%
East Asia					
Cambodia	Phnom Penh	1.6	72%	25%	3%
Indonesia	Palu	0.4	91%	n/a	9%
Philippines	Dumaguete	0.1	97%	n/a	3%
Philippines	Manila	15.3	88%	9%	3%
Totals			**64%**	**34%**	**2%**

[1] WSP, 2014

[2] JMP, 2014

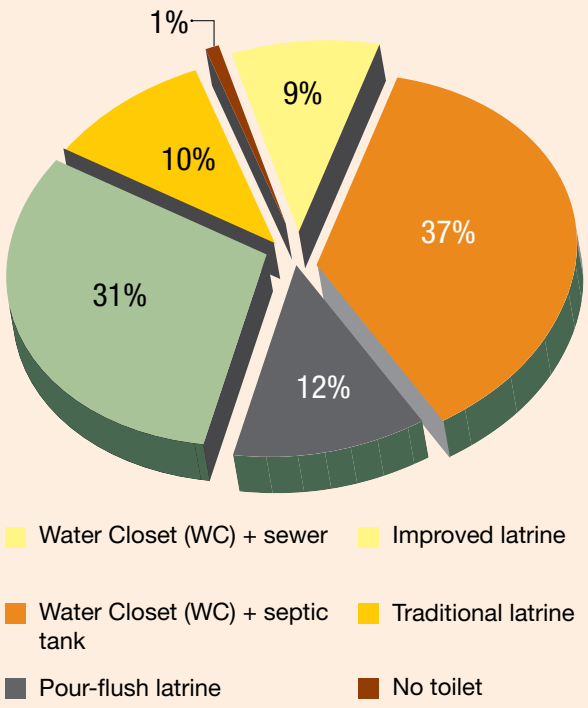
waste in most Mozambican urban centers. Currently, less than 5% of premises in these urban centers are sewered, usually in the city center, while the great majority of the population relies on on-site sanitation solutions, mostly improved latrines.

A number of studies have shown that inadequate access to sanitation increases health risks, especially in children under five, who are the victims of 80% of sanitation-related illnesses and diarrheal disease (Bartlett, 2003; Bartlett, 2008; Bartram & Cairncross, 2010) and stunting, with this effect most severe in densely-populated urban areas (Spears, 2013). In Mozambique, inadequate sanitation results in regular cholera outbreaks (on average 7,500 cases per year), widespread diarrheal disease (on average 25,000 reported cases per year) and high child mortality (108 per 1,000 live births)[3]. This poor sanitation costs an estimated 124 million dollars per year[4] to the country's economy, mostly due to time lost accessing health care, premature death, productivity losses and health care costs.

In Maputo, Mozambique's largest urban center and national capital, a recent (2013) study carried out by WSP in partnership with the Maputo Municipal Council (MMC) showed that only 9% of Maputo residents have sewer connections, while the remaining 90% use septic tanks, improved pit latrines and pour-flush toilets, as shown in Figure 1. However, despite this fairly high coverage of sanitation facilities, most of them are not emptied hygienically, which results in large quantities of fecal sludge being dumped directly into the urban environment, with obvious and extremely negative implications for public health and the environment.

Figure 2 shows schematically how excreta are managed along the sanitation service chain in Maputo, in terms of the percentage of population served. The width of the arrows is proportional to the population whose wastes follow each route, and the dark colored arrows represent the fecal matter not safely managed. It can be seen that only 3% of the total sludge and sewage produced actually passes through the treatment plant, whilst more than 50% contaminates

FIGURE 1: SANITATION COVERAGE IN MAPUTO



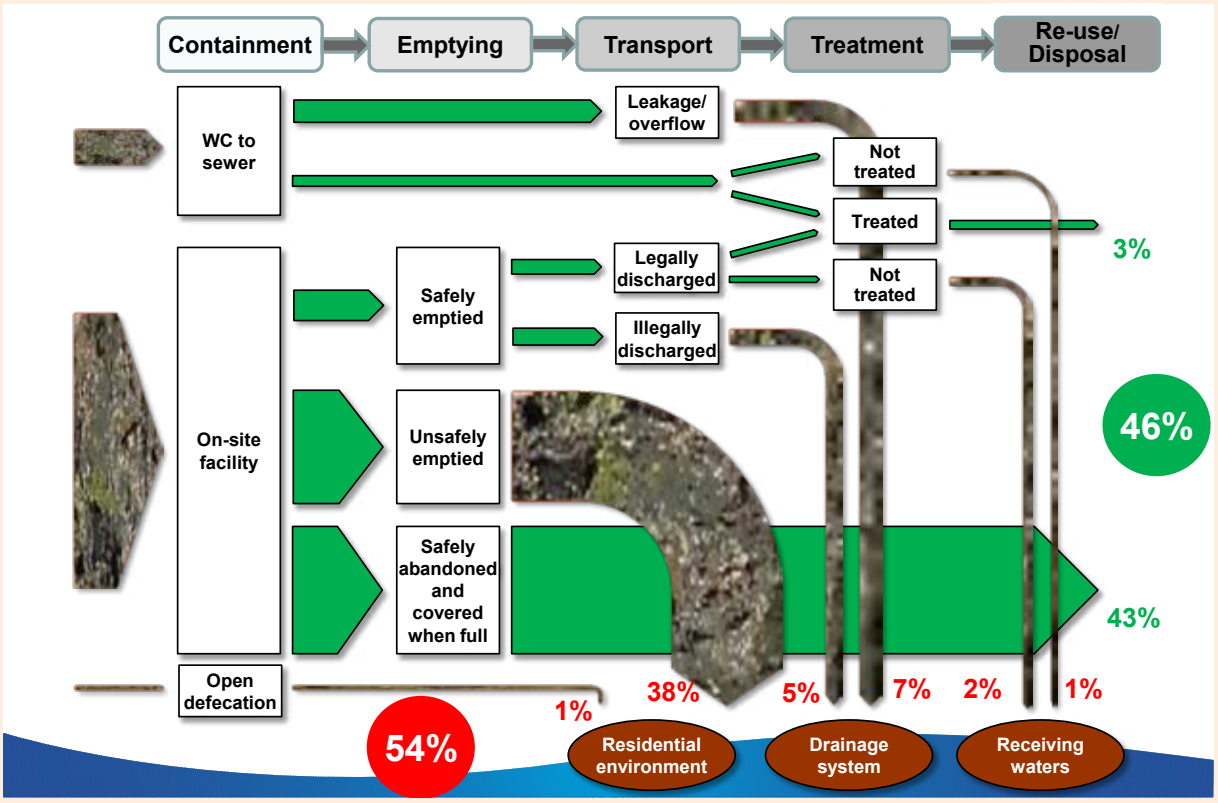
backyards, the drainage system and Maputo Bay. It is also clear that the biggest problem area is with on-site systems, with much fecal waste being unsafely dumped by local burial or in ditches and unoccupied ground, and even that which is safely removed being partly dumped into the environment or inadequately treated. Furthermore, the limited access to improved sanitation is compounded by inadequate water supply, drainage and solid waste management, resulting in the frequent flooding, overflowing latrines and erosion experienced almost everywhere in peri-urban Maputo.

Although the issue of urban sanitation is now receiving more attention from the authorities, following approval of the government's Urban Water and Sanitation Strategy in 2011, and the recent adoption of a national Integrated Sanitation Plan, attempts to date to improve the situation have been frustrated by the need to involve and effectively coordinate many different institutions and actors, and a lack of proven approaches to tackling the problems on the ground.

[3] Disease data from Ministry of Health and mortality data from National Statistics Institute (MICS 2008)

[4] WSP (2012), Economic Impact of Poor Sanitation In Africa

FIGURE 2: FECAL WASTE FLOWS IN MAPUTO



MMC has ultimate responsibility for providing sanitation services to its citizens, but it lacks capacity to manage both the existing sewerage system (to which about 9% of the city's households are connected, although it is accessible to about 15%), and fecal sludge from the on-site facilities that serve the rest of the population, principally in the peri-urban areas. As a result, in peri-urban Maputo, responsibility for sanitation falls on individual households, who have to build their own sanitation facilities and seek solutions for emptying them when necessary. This gap in service provision has opened a space for small-scale independent providers, ranging from manual bucket emptiers to vacuum tanker operators, who provide emptying and (only in the case of tanker operators) transportation services for fecal sludge. The manual operators either bury the fecal sludge in the customer's back yard, or dump it on open ground or in drainage ways. This latter option is becoming more common, as densification and subdivision of plots reduces the size of back yards, and available space for burial may have been taken up already by previous emptyings.

To demonstrate the potential of targeted infrastructure, services and sanitary education activities to improve sanitation in informal settlements, a series of interventions was undertaken to improve domestic sanitation at scale in Nhlamankulu District where the challenges seem to be most intractable; Nhlamankulu is one of Maputo's most densely populated and least well drained low income, unplanned peri-urban areas. Interventions include the improvement of toilets in low-income rental compounds, building technical capacity in the municipal sanitation department, and promotion of improved sanitary practices at household level. The project is also building sustainable private sector capacity to provide Fecal Sludge Management (FSM) services for the desludging of domestic sanitation facilities, and to adapt and develop viable low-cost technology suitable for the physical and economic conditions in these peri-urban communities.

This document focuses specifically on the development of commercially viable FSM services by private providers in Nhlamankulu District, within the context of the wider intervention on sanitation improvements in the District involving the participation of multiple stakeholders. It examines both the technical and commercial viability of the business models tested by 8 small service providers (estimated as being sufficient to serve the whole District) over eight months, and recommends further action towards establishing sustainable FSM services in peri-urban areas. The analysis is complemented by a sanitation survey carried out in 2013, a user assessment in 2014, and a market assessment in 2015 covering the entire city of Maputo.

1.2 Origins and Objective of the Project

This project began with a request from the MMC for WSP assistance to develop a sanitation master plan for the city. It was, however, noted that the previous sanitation master plan (produced in 2004 by Lahmeyer, with World Bank funding through the first Maputo Municipal Development Project) had not led to any significant results, and that subsequent interventions in sanitation were small, isolated initiatives, mostly consisting of subsidized latrines offered by NGOs. MMC lacked current information on sanitation status across the city, and so were unable to provide much orientation to these initiatives. It was agreed that MMC would be able to make better progress by taking a more proactive stance, collecting basic information on a regular basis, and intervening in the 85% of the city not served by sewers, which had lacked any public sector intervention since the collapse of the national Improved Latrines Program in the early 2000's.

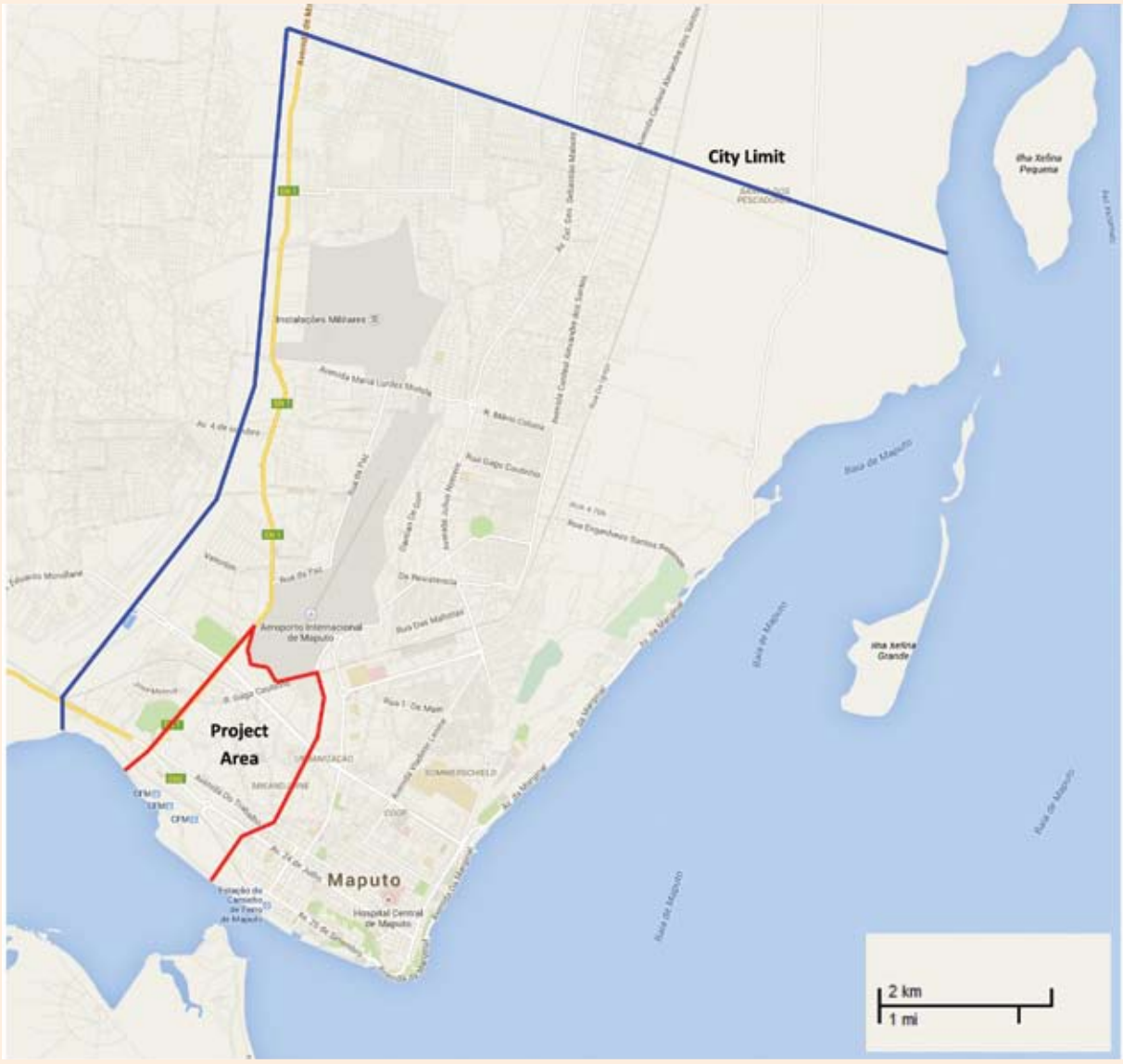
There was also a need to establish a more programmatic approach, so as to escape from the cycle of small, uncoordinated projects with little impact at city scale. It was therefore decided to work at the scale of a whole Municipal District, so that all the levels of municipal administration would be involved, with the possibility of scaling-up in the other three peri-urban Districts. Nhlamankulu (see Figure 3) was chosen due to its high concentration of slum housing. It is one of five Municipal Districts that comprise the mainland portion of Maputo city, and has a population of about 150,000 distributed across 11 neighborhoods.

The objective of the project was to develop a sanitation service model for informal settlements, involving relevant public and private sector stakeholders, and to examine its costs and institutional implications, as the first step in developing a model for improving sanitation at scale in peri-urban areas throughout Maputo and in Mozambique's other main cities. In order to mobilize the necessary resources, WSP established three interlinked partnerships, with:

- **Water and Sanitation for the Urban Poor (WSUP),** an international Non-Governmental Organization (NGO), which was already working in Maputo, providing tertiary water networks, standpipes and house connections, and improved sanitation for low-rental compound housing, where sanitation conditions are deplorable. WSP obtained US$1.8 million from the Japan Social Development Fund (JSDF – a World Bank Trust Fund) to enable WSUP to continue with providing sanitation facilities for compound housing, promoting sanitation among the population at large, and developing FSM services adapted to peri-urban realities.
- **The Second Maputo Municipal Development Project** (ProMaputo), funded by the World Bank, which has the objective of strengthening the capacity of MMC to develop, manage and maintain quality service delivery to its citizens. In support of this objective, entrepreneurial training and market analysis were provided to the private sector FSM operators equipped using the JSDF funds. This component was funded by the Public-Private Infrastructure Advisory Facility (PPIAF – a World Bank Trust Funded program).
- **The Maputo Municipal Council's Water and Sanitation Department,** under which were developed the beginnings of a neighborhood-based sanitation monitoring system, a plan for building up the sanitation function, a new sanitation byelaw, as well as obtaining funding of about US$ 500,000 from ProMaputo for basic equipment that was lacking.

There was a ready-made partner for FSM service provision in the form of the Mozambican Association of Micro-Enterprise Service Providers (AMMEPS, using its Portuguese name), whose 25 members, currently all in Maputo, provide primary solid waste collection services in

FIGURE 3: MAP OF MAPUTO AND THE PROJECT AREA



the peri-urban neighborhoods – although the scope of the Association is national, it only exists in Maputo at present. They were seeking business opportunities to supplement their modest income from the solid waste management contracts, and agreed that FSM was a promising new business opportunity. Once the other components outlined above were in place, the private operators were quickly mobilized and have taken an active role in the work.

1.3 Data Sources

1.3.1 Data Collection and Monitoring by Local Authorities

MMC, in collaboration with WSP, introduced a monitoring process involving local community leaders at the lowest tier of the municipal administration, with the aim of collecting information to improve sanitation planning. It was initially piloted in 2011, in three neighborhoods, and expanded to

10 in the same year after it was found to be a useful tool for informing the planning process and future interventions by MMC, as well as contributing to sanitation and hygiene promotion. The system is currently being expanded to district level in Nhlamankulu, and will potentially be extended to cover the entire city over the next two years. This exercise has provided detailed information on water and sanitation status at block level[5] (see Annex 1) and raised awareness on the potential role of community-based monitoring in changing sanitation behavior and improving sanitation services in peri-urban areas.

1.3.2 Fecal Sludge Management Business Design and Monitoring

The FSM pilot aimed at collecting data on the technical and financial viability of the services, as very little information is available worldwide. The operators involved in providing the improved services recorded the technical and financial details of each and every emptying operation they carried out, which were then analyzed by the project team, resulting in a number of changes and adaptations as the work progressed. Monitoring data were collected from April, 2014 and it is expected to close the cycle by April 2015 (after one year of operation).

1.3.3 Characterization of Sanitation in Maputo

Two data collection exercises were carried out in order to inform the pilot design, and a broader service development initiative being implemented by MMC with support from WSP.

The first data collection exercise was focused on a general characterization of sanitation in the city and the development of indicators for service monitoring and evaluation (see Annex 2). This survey was carried out in late 2013 and covered 1,097 households, giving a 95% statistical confidence level at 3% error. Households were randomly selected across the mainland area of Maputo and interviewed and mapped over 10 days by 12 enumerators using Personal Digital Assistants (PDAs) and Global Positioning System (GPS). Additional data on discharges at the wastewater treatment plant were also collected during this survey.

The second data collection exercise, aimed at specifically understanding attitudes and practices of potential customers regarding the emptying of onsite systems, targeted households where onsite facilities had previously filled up. This survey, conducted in partnership with IHE Delft, covered 1,200 households. The fieldwork was carried out by 10 trained enumerators in 20 days, using GPS and PDAs, and measuring tapes to determine the size of the onsite facilities.

1.3.4 Customer Feedback

Six months after the start of the project, in September 2014, a customer feedback assessment was carried out in order to understand perceptions on the quality of the new services and to inform measures to improve them. This exercise covered both customers served and potential customers who had contacted a service provider but rejected the service. A total of 99 households, representing about two thirds of those who had been in contact with a service provider, were interviewed by two independent enumerators. The aim of the survey had been to follow up all customers, but this proved to be difficult, as the operators were not able to locate all of them. Since then, the operators have started collecting customers' contact details so they can follow up with them and market repeat services.

[5] A block (*quarteirão*) in Maputo consists of about 70 houses

II. Peri-Urban Sanitation in Maputo

2.1 Status of Fecal Sludge Management Services in Mozambique

Around five million people (62% of the urban population of Mozambique) currently lack access to even basic improved sanitation facilities[6] and, with about two thirds of Mozambique's population growth between now and 2050 expected to be in urban areas[7], access to improved sanitation will continue to be a critical challenge. The lack of access to improved sanitation is acute in the informal settlements and peri-urban areas of Mozambique's main cities, resulting in frequent cholera outbreaks, widespread diarrheal disease and high child mortality. The issue of urban poverty is receiving increasing attention from Government, and the improvement of urban sanitation is an explicit goal in the country's most recent poverty reduction strategy[8] as well as being the subject of a current inter-ministerial initiative.

Although, for the first time in many years, the issue of urban sanitation is finally gaining some traction with the authorities, results on the ground are limited, partially due to the lack of an approach to sanitation interventions that integrates the multiple stakeholders that need to be involved (Municipal Councils, small-scale private sector, customers). This is compounded by the national policy on water and sanitation, which assigns responsibility for urban sanitation outside sewered areas to individual households, on the mistaken assumption that (self-built) latrines can resolve the problem. This fails to take into account that urban sanitation services do not end at containment, but comprise a whole chain from containment, to emptying, collection, treatment, and final disposal.

62% **Percentage of the urban population of Mozambique currently lacking access to even basic improved sanitation facilities.**

[6] WHO and UNICEF JMP *http://www.wssinfo.org/data-estimates/table/,* accessed August 2011

[7] Based on projections by the National Statistics Institute (INE)

[8] Republic of Mozambique (3 May, 2011) Poverty Reduction Action Plan (PARP) 2011-2014. The general objective relating to human and social development includes promoting hygiene, expanding access to and use of sanitation services in urban/peri-urban zones, pursuing sustainability in sanitation infrastructure, promoting construction of improved latrines and family latrines, upgrading informal human settlements and installing sanitation infrastructure and services.

During the 1980s and 1990s, the Government of Mozambique funded a national Improved Latrines Program, which aimed at improving access to sanitation in peri-urban areas by providing subsidized latrine components and construction services. This resulted in the large-scale construction of improved latrines with concrete slabs in the main cities, which still continues today through local private sector precast yards (making mostly concrete blocks and laundry tanks) and masons. The program did not include FSM services, since in the 1980s most peri-urban areas were relatively low density and the rural system of backfilling full pits and relocating the latrine was still viable. However, as the cities densified, starting with the mass rural-urban migration of the civil war years (1982-1992), and continuing subsequently, the need for emptying services has increased drastically in most peri-urban areas. This demand has been met almost entirely by the private and informal sectors, providing services mostly with second-hand vacuum tankers, or manually, with local burial or open dumping on open land and in drainage ways. This has created a number of challenges, which are discussed below.

2.1.1 Pit Emptying Practices and Affordability

In most large cities there is a limited availability of vacuum tankers. However, many parts of the unplanned peri-urban areas are inaccessible to these large vehicles, and the service is in any case unaffordable to many low-income households, whilst in smaller cities there is no mechanical emptying equipment at all. The service provision gap is filled by individuals and very small-scale, informal service providers, who currently empty pits manually by unhygienic means, and fail to dispose of the waste safely. Moreover, these service providers are perceived to be doing undignified, demeaning work, and are marginalized socially, whilst at the same time being called upon to provide this essential service. As the price of these services is still relatively high for low-income residents in the areas concerned, pit latrines may be abandoned when full. Space is in any case often not available for new latrines, and as a result, even some households who were previously served, albeit poorly, are slipping back into the use of shared facilities or open defecation.

2.1.2 Financing

Hygienic fecal sludge management services are more expensive in unplanned neighborhoods, due to the need for primary collection with small equipment capable of accessing densely occupied areas, coupled with secondary transport to disposal with larger tankers, whilst premises with decent road access can be served directly by conventional tankers. In addition, poor people face difficulties in funding large, infrequent expenditures such as for pit emptying, as their incomes tend to be on a daily basis. This double constraint of higher cost and lower availability of money to pay for the services is why no alternative to vacuum tanker services apart from the unhygienic manual service has not emerged spontaneously, and implies the need for a subsidized service, or at the very least, facilitated payment options.

2.1.3 Service Provider Capacity

Local providers of on-site sanitation services – which include the Municipal Councils, precast yards, builders, and pit emptiers (both formal and informal) – have limited capacity and resources to effectively address the lack of access to improved sanitation services in low income areas, perpetuating the current situation. Informal pit emptying service providers in peri-urban areas are generally working at a very small scale and have limited capacity in areas such as hygiene, application of standards, business planning, setting viable service charges, and coordinating with the municipal authorities, as well as limited resources and equipment with which to provide a hygienic service. This is compounded by a total lack of regulation arising from the designation of peri-urban sanitation as a purely household responsibility.

2.2 Peri-Urban Sanitation Services in Maputo

2.2.1 Containment

User facilities do no fall into neat and clear technology types. Figure 1 divides them into septic tanks, pour flush toilets, improved pits and unimproved pits, but the reality is more of a continuum. Septic tanks are either simple self-built one or two compartment units or prefabricated plastic ones, connected to a simple soakaway pit. Pour-flush toilets are basically offset pit latrines, with the fecal waste being flushed into the pit through a short sloping PVC soil pipe. Improved pit latrines are characterized by a well-made concrete slab or floor and a block-lined pit, while traditional pit latrines are typically covered by soil or a precarious arrangement of assorted waste building materials, with the pit not lined or lined with tyres or oil drums. Such pits are too weak to be emptied by mechanically powered equipment, but the Gulper handpump has proven effective in many cases.

From the perspective of pit emptying, the key dividing line is between the septic tank and pour flush types that depend on the use of water, and the pit latrines (sometimes called "dry pits") which do not require water, and only take in the small quantities used for anal cleansing. The water flushed types produce a more watery sludge, which is easy to pump but which needs to be removed in larger volumes (typically $2m^3$-$3m^3$), whilst pit latrines have thicker sludges that may require the use of scoops and buckets as they are too heavy to pump, but produce smaller volumes per service, typically around $0.5m^3$.

The urban environment has the potential to change rapidly over time, which complicates planning in general, and this has also affected this project. A survey in 10 of the city's 53 neighborhoods carried out by MMC in 2011 with support from WSP[9], showed that in the 5 neighborhoods of the project area covered by the survey, 68% of households used improved and traditional pit latrines and 32% septic tanks and pour flush latrines. Data on the same neighborhoods from the city-wide survey in 2013 show a remarkable transformation, with 36% using pit latrines and 64% septic tanks and pour flush (Figure 4a). The progressive switch from pits to septic tanks has meant that desludging operations now need to remove greater volumes of a more watery sludge than was originally envisaged at project design. The implications of this are discussed further in Section 5.1.

Increasing access to household water connections (Figure 4b) may be one of the main reasons why people are moving up the sanitation ladder to water-using toilets. Starting from late 2011, a number of water supply improvements were made in Maputo, including connection campaigns, improvements to the tertiary network and increased water production. In Nhlamankulu, access to individual connections doubled to almost 80% by 2014. This is closely

[9] The survey covered 25,000 households in parts of the densely-occupied peri-urban Municipal Districts of Nhlamankulu and Maxaquene

reflected in the type of sanitation facilities, with the use of flush toilets (WC) tripling in two years, thereby reducing the use of pit latrines.

A chi-square test on both the 2011 and 2013 datasets showed very strong correlation between on-plot water supply and the use of a WC or pour-flush toilet.

FIGURE 4: PROGRESS IN SANITATION AND WATER SUPPLY IN NHLAMANKULU FROM 2011 TO 2013

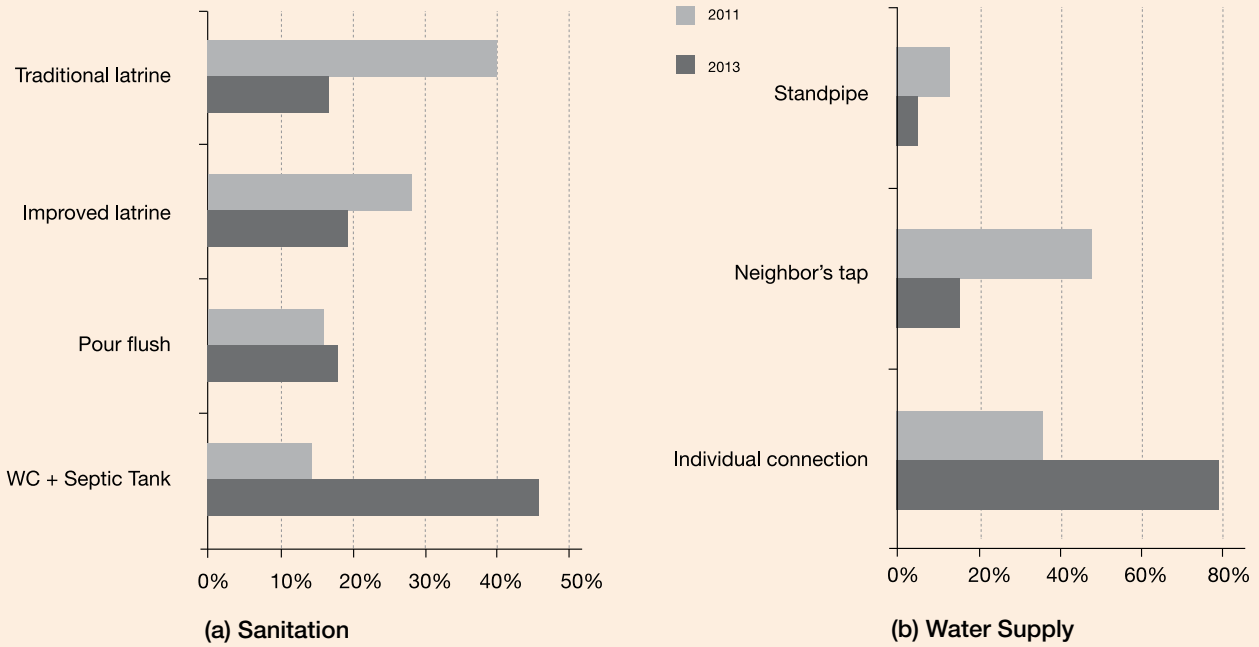
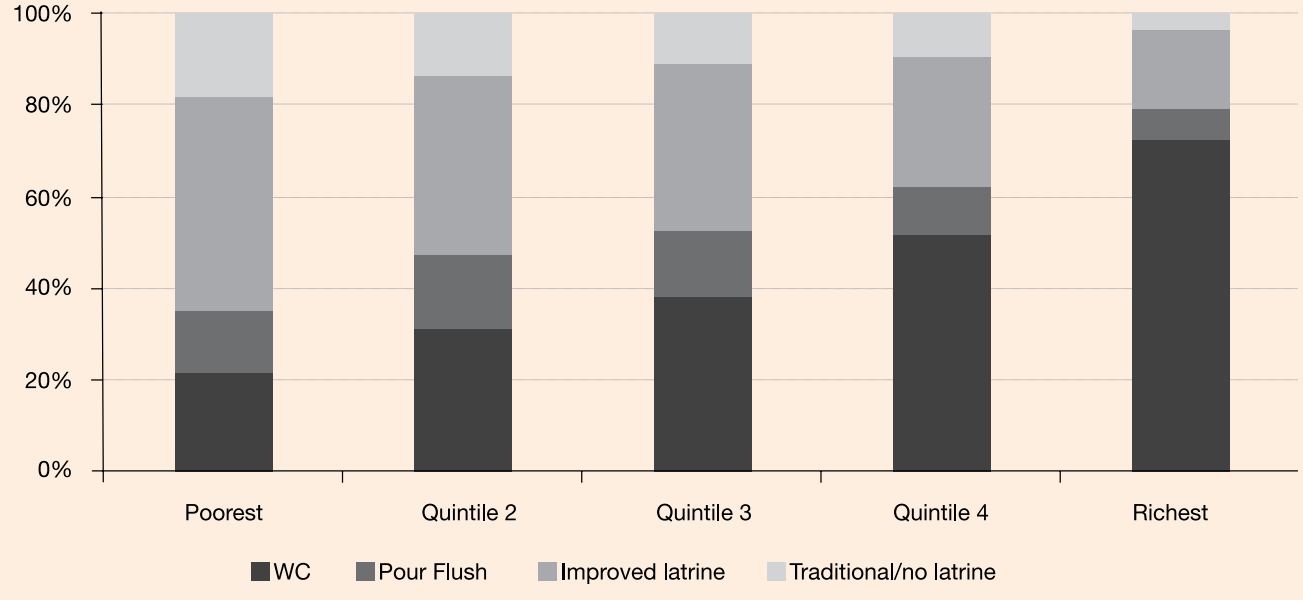


FIGURE 5: SANITATION FACILITIES BY POVERTY QUINTILE IN MAPUTO



As in almost all urban areas across Africa, the poorest households are more likely to use on-site sanitation facilities. An analysis of the distribution of sanitation facilities by poverty quintile in Maputo (Figure 5, based on the 2013 survey) has shown that pit latrines are the most common facility used by the poorest while the wealthiest rely mainly on water closets for their sanitation needs. Pour flush latrines are almost uniformly distributed among the different quintiles, as they represent a transition technology from pit latrines to septic tanks.

About one third of the on-site sanitation facilities in Maputo are almost impossible to empty, mostly due to poor pit lining, or none at all. With an average volume of 3.9 m^3, at least 13% of the pit latrines are built from tyres, barrels and/or timber; another 20% are completely unlined, making them difficult to empty with mechanical equipment. Moreover, on-site systems take 3 years to fill up on average, with traditional pit latrines filling up faster than improved latrines and septic tanks, as shown in Table 2.

Building a sanitation facility is a household responsibility, and in Maputo, on-site sanitation facilities cost on average US$ 54[10], with traditional latrines costing US$ 35 and septic tanks US$ 220. Many of the facilities built by households on their own fail to meet technical and environmental standards, and there is no quality control either by themselves or by Maputo City Council, giving rise to risks of collapse and harm to users. Improved latrines are mainly built by informal masons or microenterprises with prefabrication yards where they sell latrine components, amongst other items. Some now privately-run units of the defunct national Improved Latrines Program, and some community-based organizations (CBOs) also offer components or build latrines for low-income households. Traditional latrines are normally built by householders themselves, and they buy only the materials.

2.2.2 Emptying

This is another big challenge for peri-urban residents, as there is no formal service available. Though only 24% of the pits were reported to fill up, at least 57% of those would require to be emptied, making an average of 30 units to be emptied daily in Maputo. Pits in less dense residential areas are more likely to be replaced, rather than emptied as shown in Figure 6, so that urban districts in the outskirts of the city (KaMavota and KaMbucuane) reported more cases of replacement, while in the inner peri-urban districts demand for emptying services is higher. KaMfumo is the central, fully urbanized area, where sewerage and septic tanks predominate

In general, there is a lack of hygienic toilet desludging services in peri-urban Maputo, especially in those areas where it is difficult for conventional vacuum tankers to gain access[11]. Although some on-site facilities (37%) are emptied with vacuum trucks[12], which take the wastes to the municipal sewage treatment works, the much cheaper service most commonly used (43%) for latrine emptying is manual, by individuals and very small-scale, informal service providers using buckets. In these cases, the sludge is generally buried in the user's backyard, or dumped in the drainage system or in the skips used for secondary collection

TABLE 2: AVERAGE FILLING PERIOD IN YEARS FOR ON-SITE FACILITIES IN MAPUTO

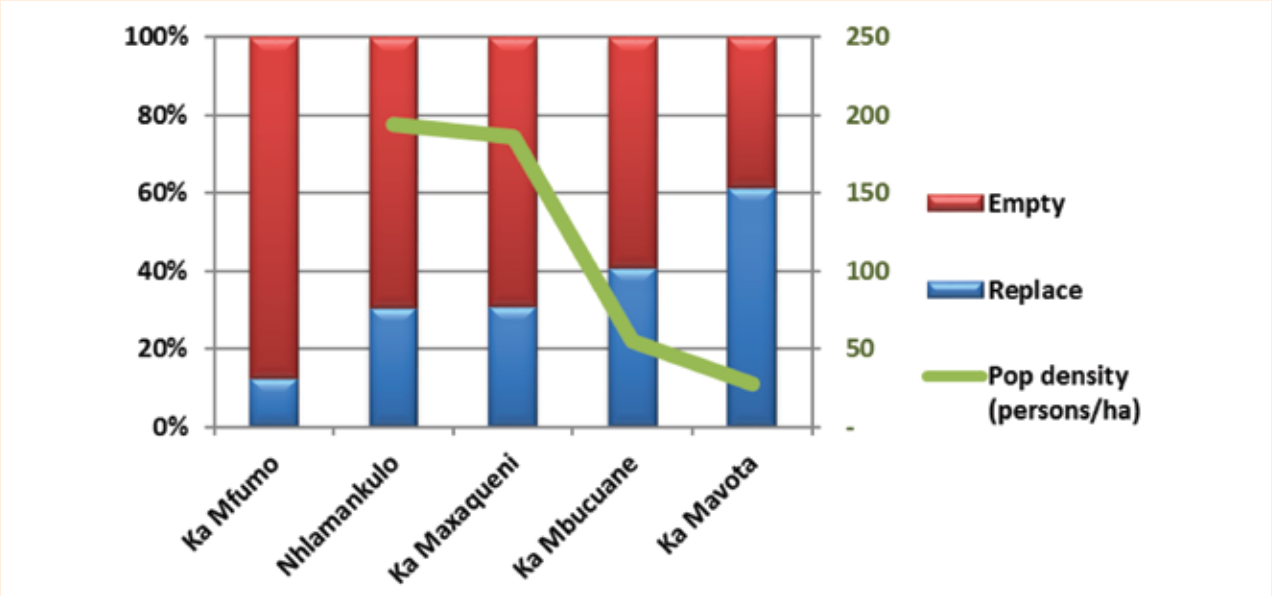
Sanitation facility	Max	Min	Mean	Median	Average vol (m^3)	N
Septic tank	12.0	0.25	3.26	2.0	12.20	65
Pour flush	15.0	0.50	4.99	2.5	8.50	16
Improved latrine	40.0	0.08	2.95	2.0	10.70	104
Traditional latrine	5.0	0.08	1.32	1.0	3.70	65
Overall	40.0	0.08	2.91	2.0	8.89	249

[10] 1US$ = 30Mts

[11] Difficult road access was reported in 23% of cases

[12] Mostly in the case of septic tanks and middle-income households

FIGURE 6: SYSTEMS REQUIRING TO BE EMPTIED VS. POPULATION DENSITY



of solid waste. Even these services are unaffordable to the lowest-income residents, resulting in pit latrines being abandoned when full and left to overflow during heavy rains when household members are not capable of doing it themselves, which is the case for 18% of households.

Furthermore, as space becomes less available, especially in the densely occupied districts of Nhlamankulu and KaMaxaqueni, some households which previously had improved facilities have been unable to maintain this standard, and end up using shared or unimproved sanitation facilities. This is especially true of compound houses, some of the cheapest and lowest-quality accommodation on the rental market.

The average price for emptying in Maputo was US$ 40, with manual emptying being the least expensive (average US$13 to US$20) while mechanized services cost on average about three times as much, at US$53 (Figure 7). The graphic also shows that manual emptying typically costs 500Mt, with a secondary peak of 1,000Mt, whilst mechanical emptying typically costs 1,500Mt, with secondary peaks at 2,000Mt, 2,500Mt and 3,000Mt, implying that prices are negotiated rather than based on pre-determined volumetric charges.

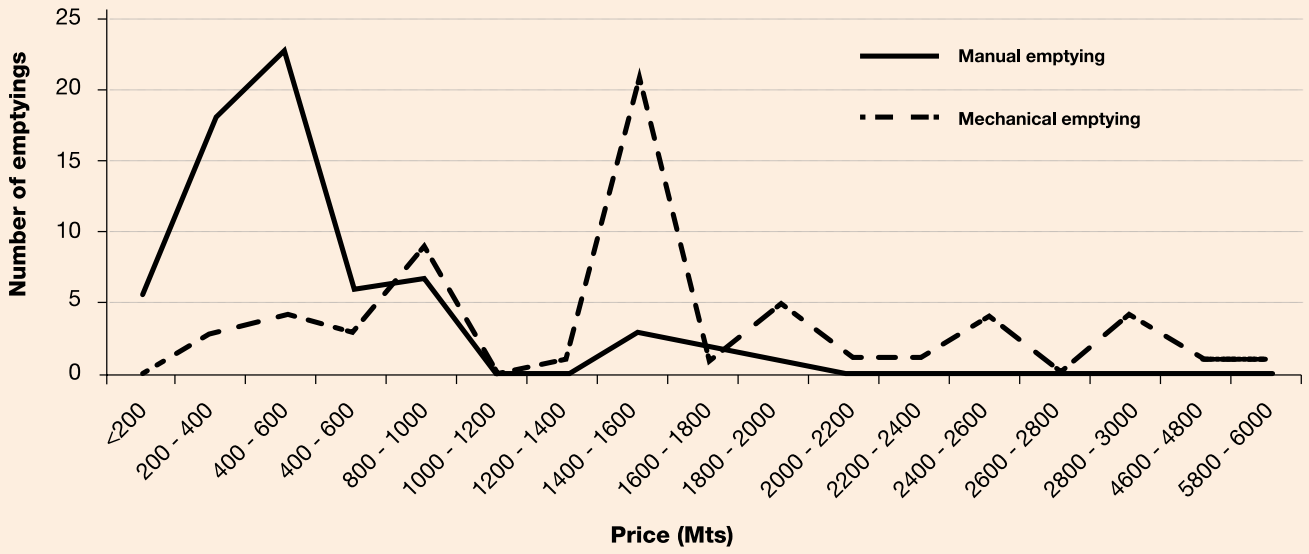
2.2.3 Fecal Sludge Treatment

Only some of the fecal sludge from the city is discharged at the sewage treatment plant. This comprises stabilization ponds which are neither maintained nor monitored, and are largely ineffective, due to siltation and uncontrolled industrial waste discharges probably containing toxic chemicals. More than half of the fecal sludge emptied is buried in the yards of the house where the emptying was carried out. In general users are indifferent as to where their fecal sludge is dumped after being removed from the pit or septic tank.

2.2.4 Overall Status of Sanitation in Maputo

As shown above, sanitation status in Maputo becomes progressively worse moving along the sanitation service chain, with transport and treatment being the least developed components. While containment is generally good and households have invested in improving their sanitation facilities, public services such as emptying, transport and treatment are yet to be improved, posing risks to public health. In order to assist planners and managers in prioritizing interventions, WSP developed an Urban Sanitation Status Index (USSI – see Annex 2), which allows for the assessment, visualization and comparison

FIGURE 7: PRICES CHARGED FOR EMPTYING



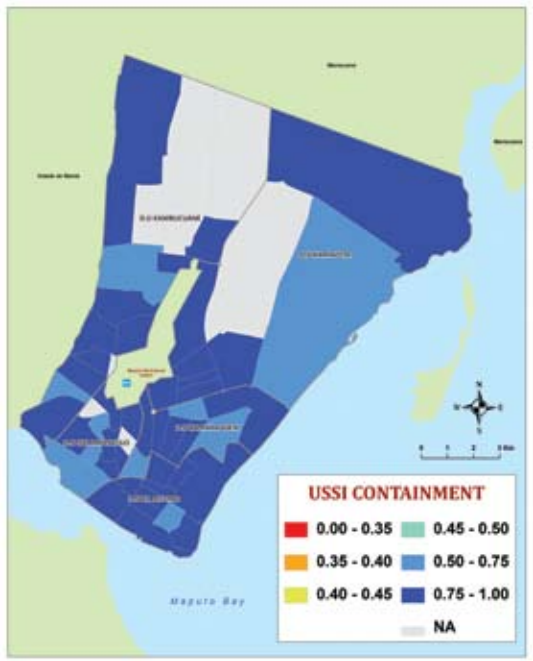
of the various components of the sanitation service chain by neighborhood (ward) across the city, and also includes complementary services such as solid waste and drainage which have direct impact on excreta management services. The following graphics are based on the USSI calculated from the 2013 survey. Figure 8 shows the USSI for Maputo.

This type of analysis has clear applicability for municipal planning, as it gives a fairly fine-grained insight into sanitation in the city. Beyond the obvious differences between the well served central area in the south and the poorly served peri-urban areas further north, the maps show significant variations within each of the Municipal Districts, with the pilot District of Nhlamankulu displaying the greatest internal diversity. This implies the need for diverse solutions, and underlines the usefulness of regular monitoring, as this spatially diverse behavior is also reflected in rapid changes over time, as mentioned in section 2.2.1. These data (and updated versions of it) will be used by Sanitation Department personnel to plan subsequent steps, as the MMC rolls out sanitation services in the other peri-urban districts.

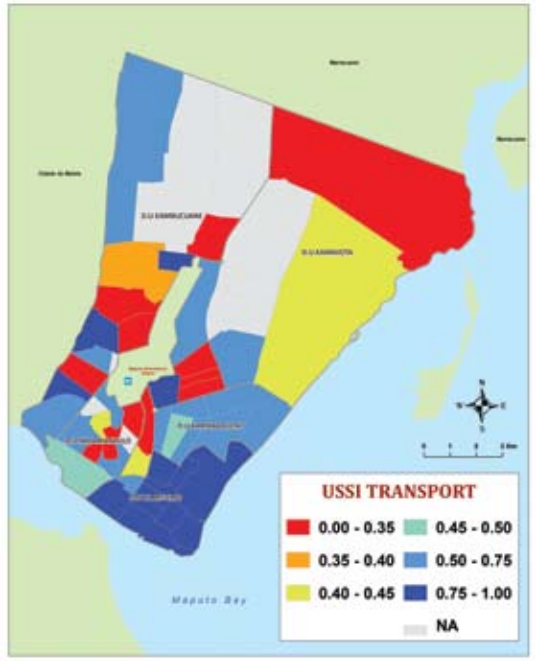
BOX 1: DOING A CITY-WIDE SANITATION SURVEY

The data collection exercise for the 2013 survey was undertaken with a team of 12 enumerators over 10 days. An extra 4 days was used for training the enumerators and testing the survey instrument. The total cost was about US$21,000, of which $8,000 for the enumerators, $9,000 for the supervisor, PDA programmer and data manager, and $4,000 for transport. This excludes the costs of developing the survey instrument and analyzing the data, which were done in-house by the WSP team. Similar costs (about $25,000) were reported for a similar exercise in Dhaka, Bangladesh, under the on-going WSP global study of FSM. In the context of project preparation for a large city, this is eminently affordable, and will enable managers to make informed decisions from a city-wide perspective, rather than simply relying on “more of the same” as has been the tendency to date. The on-going WSP global study of FSM aims to produce a suite of diagnostic tools for urban sanitation before June 2016, which will incorporate model survey instruments and protocols, amongst other tools.

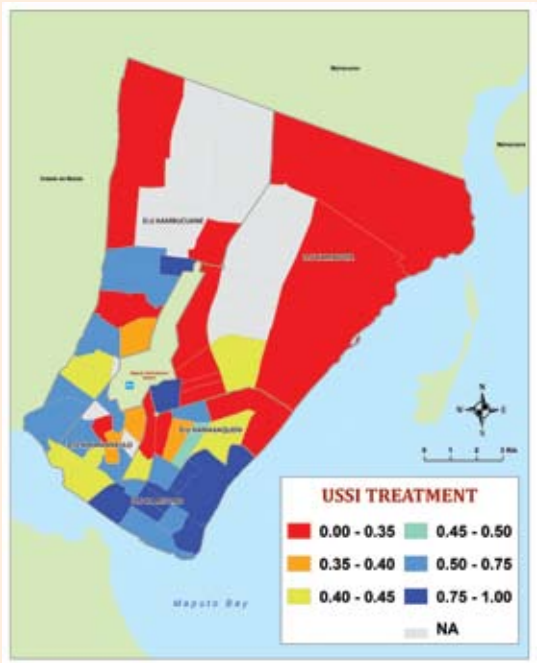
FIGURE 8: SANITATION STATUS IN MAPUTO



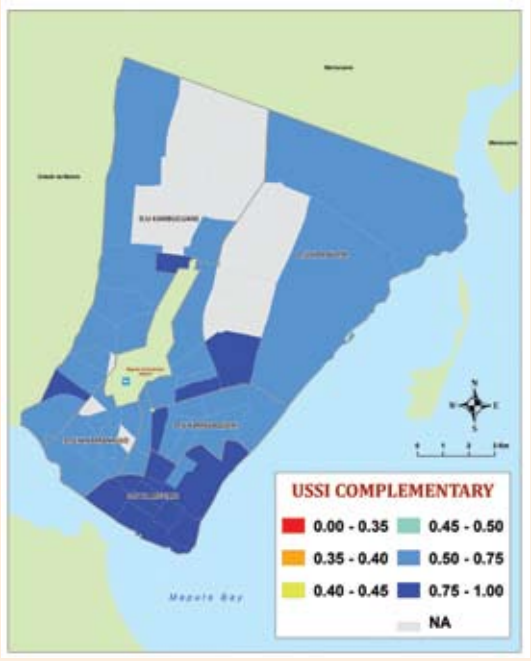
1. (a) Containment Status



2. (b) Emptying and Transport Status



3. (c) Treatment and Final Disposal



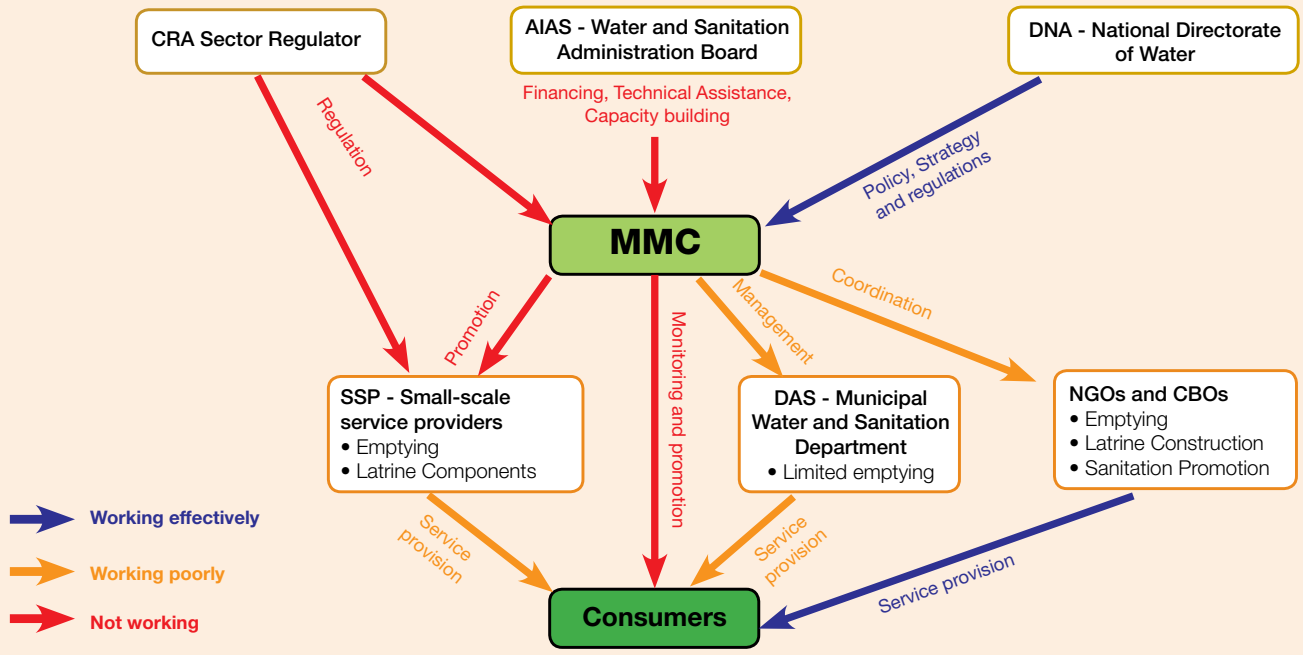
4. (d) Complementary Services (solid waste, drainage)

2.3 Institutional Arrangements

Responsibility for sanitation in peri-urban areas of Maputo is not clearly defined. The Water and Sanitation Infrastructure Board (AIAS) – under the Ministry of Public Works and Housing (MOPH) – is the primary agency responsible for ensuring both water supply in small towns and sanitation in all urban areas in Mozambique, whilst the Water Regulatory Council (CRA), the water and sanitation sector regulatory agency, is responsible for balancing the interests of the main stakeholders, principally the asset manager, service providers and consumers. However, MMC has ultimate legal responsibility for providing sanitation services to its citizens, which it does through its Water and Sanitation Department within the Infrastructure Directorate, as set out schematically below in Figure 9. MMC is not delivering very effectively on this mandate, due on the one hand to a lack of capacity and weak organization throughout the institutional framework, and on the other, to unclear definition of the services required.

While there are reasonably clear policies, strategies and a defined institutional framework for sanitation service delivery, implementation at municipal level leaves a great deal to be desired. Most of the existing institutions are not discharging their responsibilities effectively, and service provision is highly fragmented and poorly coordinated. The main constraints are in financing, regulation and monitoring, all of which are key elements in effective sanitation delivery. Both CRA and AIAS have been assigned responsibility for sanitation only recently, and still have a long way to go in developing their capacity to support Local Governments in tackling the sanitation agenda, a major component of which is the management of fecal sludge in peri-urban areas. CRA has the mandate to regulate private sector service providers and the autonomous sanitation departments envisaged for the larger cities under current legislation, whilst AIAS has the brief to invest in infrastructure and capacity-building for municipal sanitation entities.

FIGURE 9: INSTITUTIONAL FRAMEWORK FOR URBAN SANITATION



Although sanitation is not being well managed at present, the situation has been improving recently and there is reason to believe that this will continue. Through its long term partnerships with central government and the MMC, WSP has played a central role in raising the profile of sanitation, convincing key decision-makers of its social and economic importance, and a multi-sectoral national Integrated Sanitation Program with a dedicated budget line has now been established by government.

At the MMC, senior managers agreed to include sanitation among a series of functions to be decentralized to the Municipal Districts, and although this decentralization program has largely died away, the leadership remains committed to improving sanitation. MMC is actively seeking investment to re-equip the sanitation department and rehabilitate the wastewater treatment works, which had fallen into disrepair under central government administration prior to being transferred to MMC in 2013, and is currently developing a framework to improve sanitation services in Maputo, including the introduction of a sanitation tariff, enacting a new sanitation byelaw that directly addresses FSM, and planning, on the basis of this pilot, to roll out FSM service provision by private operators across the rest of the city.

III. Components of the Pilot Intervention

3.1 Market Assessment

Prior to developing an improved service model, an assessment of the existing service providers and demand patterns was made. On the supply side, three types of small-scale FSM service providers were identified in the city, apart from the conventional vacuum tanker operators:

- Individual manual bucket emptiers (IEs);
- Community-Based Organization (CBO) service providers Associação para o Desenvolvimento de Água e Saneamento no Bairro da Urbanização [Urbanização Neighborhood Water and Sanitation Development Association] (ADASBU) and Xivoningo, providing services with VacuTug mini-tankers;
- A micro-enterprise service provider, Uaiene Gama de Serviços de Maputo [Uaiene Maputo Miscellaneous Services] (UGSM), developed with WSUP support and providing similar services to the Nhlamankulu operators.

Table 3 summarizes the main features of existing FSM service providers in peri-urban Maputo.

3.1.1 Individual Manual Emptiers

The IEs do not have a clear strategy for service provision, and undertake desludging amongst other manual labor tasks, mostly in construction. Customers contact them at locally known locations, often a bar, where they wait for available work (Choudhry and Kone, 2012). Most of them provide their services during the night, as it is less troublesome to the neighbors. Moreover, these service providers are perceived as doing undignified, demeaning work, and are socially marginalized, whilst at the same time providing this essential service.

Many peri-urban residents prefer these traditional services, as they are usually less expensive and also more effective – the mechanical emptiers mostly fail to remove the heavier, more compacted, sludge at the bottom of pits, so it is common for an IE to be called in after a mechanical emptying (Choudhry and Kone, 2012; WSP, 2012). Although they take the business seriously, FSM services alone are insufficient to survive on, and they combine them with other activities. Fluctuations in demand are high, and they can only rely on FSM services as a source of significant income during the rainy season. As in other African cities, most of them drink heavily before emptying a latrine, as they feel unable to confront the fecal sludge when sober.
As entrepreneurs they would like to expand and improve their services, but they perceive access to finance as a major challenge. The project tried initially to work with the IEs, but this proved difficult, partly due to their observed behavior of being drunk while carrying out their pit emptying functions, and partly because they typically operate outside organized institutions. An alternative presented itself in the form of the micro-enterprises that undertake primary solid waste collection in peri-urban neighborhoods under contract to the MMC. This arrangement was facilitated by the World Bank through the ProMaputo project, which was why they approached the Bank, through their association, AMMEPS, in search of extra income-generating opportunities to supplement their rather low income derived from solid waste collection. This also ensured a good spatial distribution, as each micro-enterprise is assigned to a different neighborhood.

3.1.2 CBO Service Providers

This business model is based on the delivery of social services such as education on issues like Human Immunodeficiency Virus infection and Acquired Immune Deficiency Syndrome (HIV/AIDS) or gender to benefit the community, rather than with a view to making a profit. Although they generally cover operating costs, they rely on grant funding for capital expenditure. Similarly to many other CBOs in Maputo, both ADASBU and Xivoningo lack sustainability. Since WaterAid withdrew their financial support to these CBOs in 2010, their FSM services have been deteriorating and they currently have no capacity to provide secondary transport to the treatment plant, leading them to depend on MMC to empty their transfer tanks every two weeks.

TABLE 3:FSM SERVICE PROVIDERS IN PERI-URBAN MAPUTO PRIOR TO THE PILOT

Type of SP	No of SPs interviewed	Services Provided	Areas Covered	Technology Used for FSM	Price for Emptying	Challenges
Individual emptier (IE)	6	• Emptying of traditional and improved latrines • Emptying of septic tanks during the dry season • Excavation and other manual labor for latrine and drain construction	Mafalala, Munhuana, Xipamanine, Maxaquene D, Nhlamankulu C	• Buckets • Burial of sludge in the yard • Use of petroleum and creosote to reduce smell	• Depending on the latrine type, depth and diameter, and client capacity to pay: - Latrines (0.2-0.4m^3) ‣ US$ 7-13 - Septic tanks ‣ US$ 30-70 • Client should buy creosote and traditional alcoholic drink	• Unsafe latrines (mainly traditional latrines) • Lack of safety equipment (gloves, boots, masks, etc.)
CBOs	2	• Latrine and septic tank emptying • Construction of sanitation facilities and components • Hygiene and sanitation promotion • Primary solid waste collection	Urbanização, Maxaquene A, Munhuana, Hulene A, Hulene B	• Mini vacuum tankers (VacuTug) for sludge removal from latrines and septic tanks • Temporary storage in a transfer tank • Transport to sewage treatment plant by vacuum tanker	US$ 7-13 per 0.5m^3 depending on distance	• Funding of replacement and major repair of equipment • Development of a commercially viable business model
Micro-enterprise	1	• Latrine and septic tank emptying • Primary and secondary solid waste collection • Transport (taxi) • Car wash • Micro-finance	Maxaquene A, Maxaquene B, Mafalala, Urbanização	• Buckets, handpump and mechanized pump for sludge removal from latrines and septic tank • Transport to sewage treatment plant in plastic tanks on a small truck	US$ 20-60 per latrine or septic tank emptied, depending on latrine type, depth and diameter, and client capacity to pay	• Demand fluctuations, with lower demand during the dry season • Capacity and willingness to pay, especially by low-income households • Marketing strategy

In contrast to solid waste management services, where they are regularly paid by the municipality, it is very likely that the FSM services provided by these CBOs will collapse over the short term, if no recovery strategy is put in place. This would create a significant gap in service provision, leaving more than 20,000 households in the neighborhoods where they are based with very limited access to FSM services.

3.1.3 Micro-enterprise Service Provider

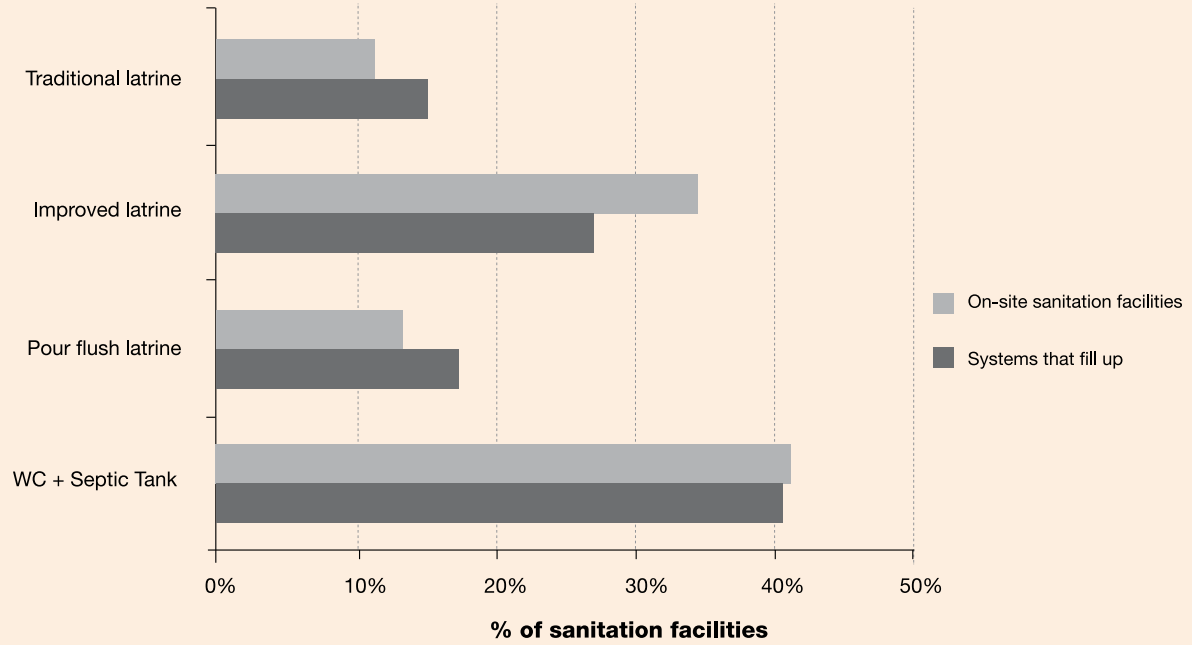
UGSM was originally a solid waste contractor, but has also been providing emptying services on a commercial basis for almost three years (Godfrey, 2012). Well-equipped[13] and assisted by sanitation specialists, UGSM's FSM activities have been tested and a business plan for sustainable services developed, including marketing and flexible service options. UGSM offers a range of services from traditional bucket emptying, to manual and mechanical emptying, and transfer to the treatment plant. Their initial experience showed that they also needed a transfer station to make their operation economically viable. One was constructed by WSUP, but the results of the investment in terms of reducing FSM costs and the burden on the poorer households are yet to be assessed.

Although all these operators are informal, and their business models not well structured, prior to the pilot they were the only available FSM service providers in Maputo, apart from conventional vacuum tankers, which are often too expensive and/or unable to reach the houses of the majority of peri-urban residents. Whilst there was clear potential for them to adopt improved technologies and business models to become more effective and more sustainable, they needed to be supported by secondary collection services and fecal sludge treatment. These are larger-scale and essentially public goods which should thus, in principle, be provided by the MMC[14].

3.1.4 Demand for FSM Services

The ultimate demand for FSM services is difficult to assess as there are many factors that influence if and when a system is emptied. To gain insight on this, an assessment of on-site facilities which had filled up in the past was carried out early 2015 to complement the pilot. This showed that there is no particular type of facility which is significantly more or less likely to require emptying (Figure 10). However, on

FIGURE 10: OCCURRENCE OF FILLING UP BY TYPE OF ON-SITE FACILITIES



[13] Capital investment financed by WSUP at zero interest rate

[14] MMC would need institutional strengthening and investment to provide these services effectively

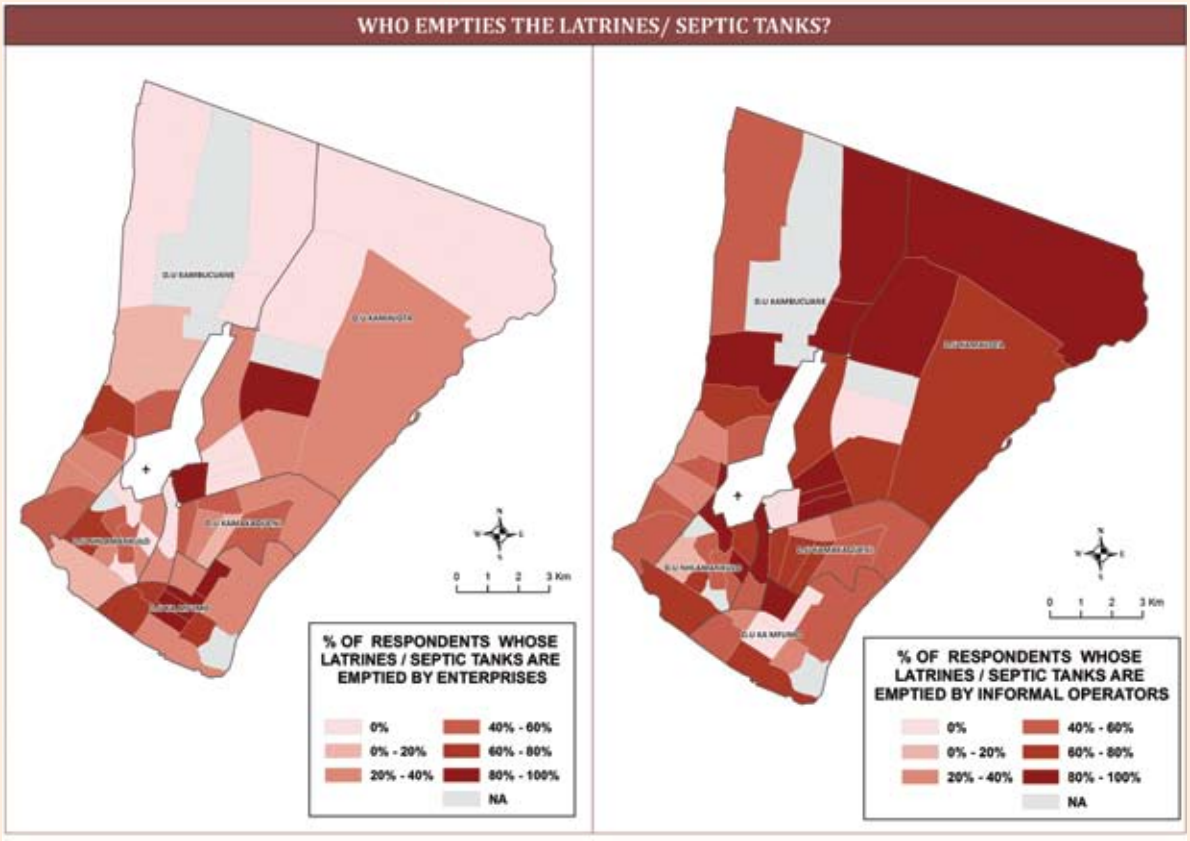
average, systems that fill up are used by 8 people, which is 33% higher than the average number of users for Maputo in general.

Only 9% of respondents reported discharging grey water into their sanitation facility, while others reported discharging it in their yards (71%), and/or let it flow onto the access roads (43%), as most of them do not have specific facilities for grey water management. Only a very small proportion (0.4%) of households reported dumping solid waste into their latrines. This may be one of the reasons why sanitation systems in Maputo take more time to fill up than in other African cities, such as Lusaka or eThekwini, where solid waste is commonly found in pit latrines (Brouckaert et al, 2013). About half the systems that fill up are emptied, while the other half are covered over and replaced when full. Around 40% of emptyings are carried out by formal service providers, 40% by manual emptiers, and 20% by household members. Manual, informal emptiers are more predominant in the northern part of the city (Figure 11), located in the outskirts of Maputo and where pit latrines are more common. Price, affordability, simplicity and habit seem to be the prevailing reasons for choosing the emptying service provider, followed by the quality of the service. The main reasons given for facility replacement or emptying are that the facility was full (42%), followed by smell (25%), preventive measure (13%), collapsed pit (13%), and pit overflowing (6%).

3.2 Improved Service Models

Based on the 2011 survey, the pilot design team estimated an average demand of 2,300 emptyings per year in the district, with a ratio of about 3 pit latrines to one septic

FIGURE 11: FORMAL (A) AND INFORMAL (B) SERVICES COVERAGE IN MAPUTO



40% Estimated percentage of emptyings carried out by formal service providers.

40% Estimated percentage of emptyings carried out by manual emptiers.

20% Estimated percentage of emptyings carried by household members.

tank, and a network of service providers was designed to fulfill these needs. Drawing on current international experience, the improved service model was designed with transfer facilities, to allow for primary collection with small equipment capable of accessing narrow alleyways and secondary transport to the treatment plant with larger, more economical and roadworthy equipment. Eight private service providers (5 equipped only for primary collection and 3 for both primary collection and secondary transport) were selected competitively from amongst MMC's existing peri-urban solid waste management contractors through their association (AMMEPS), which had earlier approached WSP to assist them in developing alternative businesses to complement their solid waste income stream. The selected service providers were trained and equipped to provide hygienic emptying and transport to the municipal wastewater treatment works.

The primary operators were equipped to provide services from collection to the transfer station, using a 0.5m^3 plastic water tank mounted on a handcart, while the secondary operators also had a 2m^3 plastic tank which could be mounted on a small truck and taken directly to the treatment works. Emptying equipment issued to all operators consisted of buckets and appropriate hand tools and a Gulper (handpump designed for desludging), intended for use on pit latrines, and a 100mm diesel-powered trash pump for use on the more liquid sludge from septic tanks, as well as personal protective equipment for the workers. Following difficulties with siting the transfer stations (sites were made available by MMC, but could not be used due to resistance from nearby residents), 6m^3 vacuum tank trailers were procured and issued to the secondary operators as a substitute. The equipment and costs are listed in Table 4, and illustrated in Figure 12.

The initial project concept was to charge commercial interest rates to the operators, but the interest rates prevalent in the market (25% to 36%) were too high to allow for repayment over an estimated 5 year equipment lifetime whilst still charging affordable prices for the service. This was not a fatal setback, as it was already clear that some kind of subsidy would probably be required, in order to make the service affordable to poor people. In any case, the public goods nature of the downstream portion of the sanitation service chain, and the almost universal situation that investments in sewerage do not repay capital (and hence are effectively subsidized) both justify subsidization of the FSM service. The capital investments were therefore funded through the Japanese Social Development Fund grant to WSUP. However, a nominal fee of 3% off the top of receipts is paid to AMMEPS, which channels the money into a fund to assist the operators with minor investments.

TABLE 4: FSM EQUIPMENT USED

Operator Type	Equipment Issued		Services	Capital Cost (US$)
	Collection	Transport		
Primary	Gulper Trash pump Buckets	Handcarts 0.5m^3 tank	Desludging Primary transport	9,000
Secondary	Gulper Trash pump Buckets	Handcarts 0.5m^3 tank 2m^3 tank 6m^3 trailer tank 1 operator had his own pickup	Desludging Primary transport Secondary transport	21,000

FIGURE 12: EQUIPMENT USED FOR FSM PILOT IN MAPUTO

Trash pump

0.5m³ handcart

Gulper

6m³ trailer

2m³ pickup

Based on a qualitative assessment of the market, assuming a minimum of one operation a day for both primary and secondary operators, the minimum price to sustain the service was estimated at US$ 40 per 500-liter unit (around 3 times the price charged by the informal emptiers) and transfer fees at US$ 13 for the same quantity of sludge. These prices were used initially, but as the operators gained knowledge of the market, their pricing strategy changed (see Table 4).

3.3 Stakeholder Roles and Capacity-building

The project aimed at building capacity in the micro-enterprises already providing solid waste management services, to deliver hygienic, and technical and commercially viable services to serve the peri-urban households of Maputo. Capacity building was designed to target both the operators, through their association, AMMEPS, and the Municipal Water and Sanitation Department, with a view to ensuring a technical assistance capability for service providers after project completion. Two main forms of support were provided under the pilot: (a) training packages for FSM operation and business management, and (b) capital investment funding, as described in the previous section. Figure 13 presents the key stakeholders involved.

At this stage, MMC was mostly acting as an observer and learning and documenting the Nhlamankulu experience to expand the services to the other areas of Maputo. However, MMC has been promoting the services through its local administrative structure, and has been providing secondary transport support to the secondary operators by way of using a municipally-owned tractor to pull the 6m³ tanker trailers used for transfer to the treatment plant at nominal charge to the operators.

FIGURE 13: KEY STAKEHOLDERS IN THE FSM PILOT

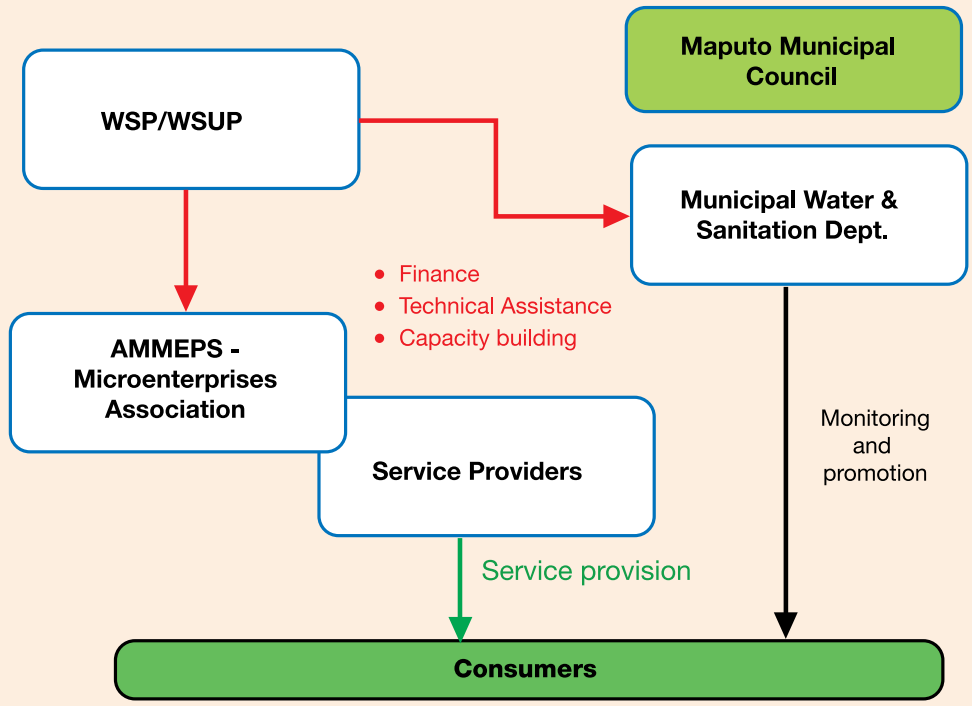


FIGURE 14: TRAINING SESSION ON EMPTYING AND TRANSPORT OF FECAL SLUDGE FROM PIT LATRINES

WSP's role was to design the project, including the training packages, carry out relevant studies to inform the pilot design and implementation, assist the private operators in planning and monitoring their operations, and document the pilot. WSUP was responsible for purchasing the equipment and implementing the capacity building activities under the monitoring component of the project.

Many of the micro-enterprises were not well organized in commercial terms, and some were in any case established as non-profit organizations. The project therefore included training packages on business development and simple accounting for the managers; and technical courses on service management, FSM operations (Figure 14) and safeguards, for the workers and supervisors to minimize public health and environmental risks. The operators were

also trained in simple techniques for market assessment and marketing of their services using simple tools such as posters on their handcarts and talking to potential customers when collecting solid waste.

A combination of theoretical and practical lessons with both classroom and field exercises were designed in order to equip the operators with the necessary knowledge to provide efficient and viable services. Peer-to-peer learning was also used, through the participation of a very experienced operator from Dar-Es-Salaam. The person concerned is a fully trained Environmental Health Officer who worked for many years for the Dar Es Salaam City Council, and then for more than 15 years as a FSM service provider (see Box 2). He was able to provide practical guidance on equipment design and production, service organization and operations. Some experience-based lessons including tips on reducing smell, how to inspect the fecal sludge before choosing the equipment to use, and safe storage, were very useful to the operators and were not taught by the professional trainers.

Furthermore, the project has created business opportunities by introducing the "Gulper" sludge handpumps, based on technology transferred from Dar Es Salaam. A smith from Maputo designed and produced them locally after seeing the ones being used in Dar Es Salaam as well as designing and producing specially adapted handcarts to carry a 500-litre tank or a set of twelve 20-litre buckets.

3.4 Social Marketing and FSM Promotion

A social communication and marketing campaign for promotion of peri-urban FSM services was designed to support the service providers in reaching their potential customers. It included community-level awareness-raising on the importance of FSM and the role of private micro-enterprises in providing such services. In partnership with AMMEPS and relevant local NGOs, the project supported

Emptying

Transfer

Transport

BOX 2: MICRO-ENTERPRISE IN DAR ES SALAAM

Diamon Samson Mhando has been running a FSM micro-enterprise in Dar Es Salaam for over 10 years. He started with manual emptying using a Gulper, primary transport with 20-liter containers and secondary transport with a 350-liter container mounted on a motorbike. With an average cost of US$ 8 per emptying (350 liters), he charges an average of US$ 22, depending on the distance to the treatment facility, difficulties accessing the pit and household capacity to pay. Though he has no formal financial records, it seems that he is making a profit, as he charges almost triple the cost and he has managed to maintain the equipment he was given more than 10 years ago. The main challenges Mr. Mhando faces are related to high solid waste content in the pits and the seasonality of demand.

the preparation and dissemination of information, targeting different interest groups, such as a football tournament for the youth, and a local traditional "board" game called *ntchuva* for older men and women. Additional promotional activities were carried out by the service providers, using their own resources, in order to attract customers and to clarify community and household expectations regarding public and private sector roles in peri-urban FSM service provision. The project also ensured the accurate and timely collection of and analysis of data to document its activities, outputs, and outcomes.

A slogan for FSM was created in order to promote the image of the service. *"Khupa Xicoti"* which in local language means "clean latrine", was the slogan most voted by the community members consulted, and an associated logo was designed, which were used by the service providers in promoting the services. The logo (Figure 15) had to cover the service chain elements of emptying and transport, which were the services offered by the AMMEPS members; and to reflect the technological innovation, cleanness and access to difficult alleyways in peri-urban Maputo.

FIGURE 15: THE FSM LOGO FOR THE MAPUTO FSM SERVICES

IV. Results to Date

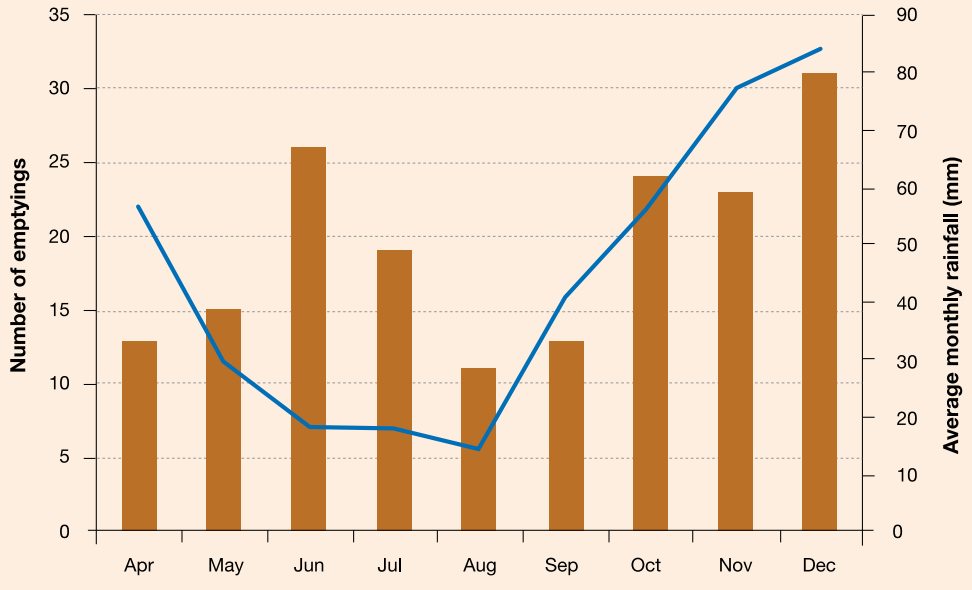
4.1 Take-up of the Service

From April to December, 2014, a total of 180 emptying operations were carried out, as reported by the service providers, of which 84% were septic tanks, and therefore in direct contrast to the project design concept which envisaged that most of the demand would be from pit latrines. As mentioned earlier, one reason for this is the rapid shift from pit latrines to water-seal toilets. A second likely reason is the prices charged, which are more than pit latrine owners currently pay to informal manual operators for emptying with local burial or dumping. The work carried out probably represents 10%-20% of the emptying in the District; however, it is not possible to state the exact proportion with any degree of certainty, as there are as yet no decent methods of estimating demand. It is also suspected that there may have been some under-reporting by the operators.

The peak number of services provided was reached in December, which coincides with the peak of the wet season in Maputo (Figure 16). In April, only 3 of the 8 operators fully started their operations, and the initial increment between April and June is mainly related to increase in the number of operators. There were of course some teething problems in the first few months, notably learning how to use the trash pump, which is quite powerful, and caused a few spillages before the operators learned how to control the hoses. There were also personnel issues, as the operators had taken on staff specifically for FSM, who were paid but produced no income for much of the time. Subsequently, the micro-enterprises opted for having a basic workforce combining their solid waste management work with a minimum of FSM, with a pool of trained and trusted casual workers to be hired on a daily basis as needed. Some of the operators are working with the traditional manual emptiers for this purpose, but using the improved methods, under a supervisor who is a full-time operator employee.

From June to August, the number of emptyings decreased considerably, with the presidential election campaign being the main reason cited by the supervisors in the field. Most of the micro-enterprise managers, especially the secondary operators, were actively involved in the campaign, which coincidentally opened up some space for the primary

FIGURE 16: NUMBER OF EMPTYINGS PER MONTH AND RAINFALL PATTERN FOR MAPUTO



operators to increase their business. However, without the transfer stations, the primary operators faced a challenge in secondary transport and were forced to innovate. As a result, a new service model emerged from the field, which they called "joint venture" and is further explained in the next section.

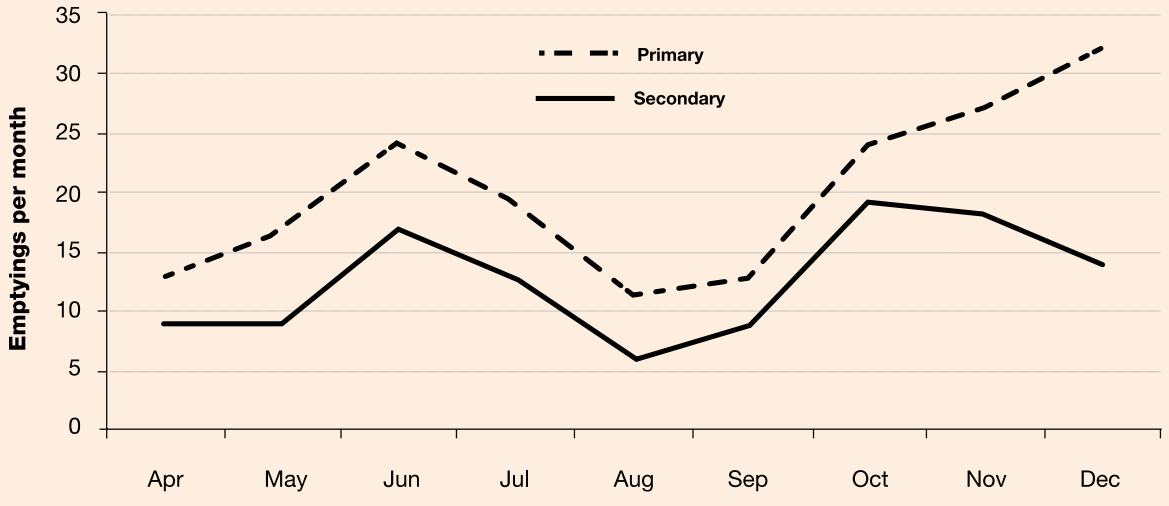
From August to October, most of the operations were acquired by the primary operators, with the secondary operators benefiting from their part in these joint ventures (Figure 17). In the last two months of the year, primary collection continued to increase until it reached its maximum, while secondary operations reduced to less than 15 in December. What appears to have happened is that the primary operators started making their own arrangements for transporting fecal sludge straight to the treatment plant without using the 6m^3 trailers or pickups of the secondary operators, as they could do this more cheaply by renting a small truck or pickup to transport the 500-litre tank and buckets. Thus, they are effectively becoming secondary operators. Meanwhile, a tractor donated to the District Administration by WSUP started operations in Nhlamankulu and was fully available to assist in transferring the 6m^3 trailer, encouraging the secondary operators to use the trailer as a vacuum tank for primary emptying and direct transfer to the treatment plant without paying for secondary transport costs.

4.2 Technical Viability

Manual emptying equipment was rather rarely used, as most of the operations were on septic tanks. Only 29 latrines were emptied in the period to December, using Gulpers, while trash pumps were generally used for desludging septic tanks. There have been some challenges in operating the Gulper, which has proven not to be 100% hygienic, though as the operators have gained experience with it, there have been far less reported cases of spatter. However, it is principally the volume to be emptied which has favored use of the trash pump over the Gulper. The trash pump is also capable of pumping over quite long distances (up to 100m), allowing direct transfer to a vehicle-mounted or trailer tank, instead of having to carry heavy buckets of sludge along the narrow alleyways.

Given the typical volumes of 2-3m^3 emptying required for the now prevalent septic tanks, the use of 0.5m^3 handcarts was not appropriate, and the primary operators found it more viable to request direct transfer to the treatment plant, using the secondary operators' equipment (Figure 18). The usual modality for these "joint ventures" with secondary operators is for the primary operator to use their equipment (trash pump and hose) for emptying, with the secondary operator providing their trailer or pickup to transport the sludge to the treatment works. When required, both operators would link their hoses in order to increase the length to reach

FIGURE 17: FSM OPERATIONS ACQUIRED BY PRIMARY AND SECONDARY OPERATORS



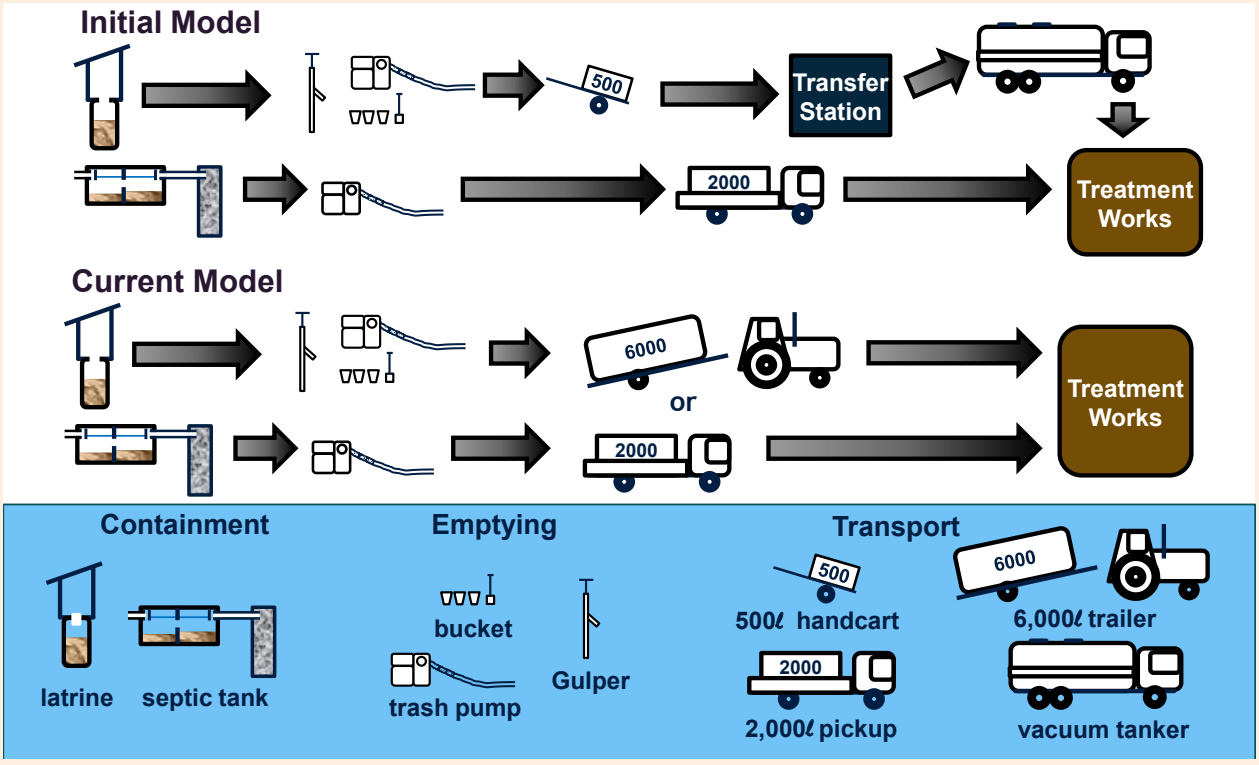
distant septic tanks. In a typical joint venture operation, the operators share the revenues equally, although this would seem to favor the secondary operator. In some cases the two operators could not agree on how to share the revenue, forcing project personnel to intervene in assisting them to estimate their actual costs, before working out how to divide the income. In some reported cases, this disagreement ended up imposing additional costs on the customer, who had to pay more to be able to satisfy both sides. As mentioned in the previous section, the primary operators are now finding their own alternative means of transporting sludge to the treatment works.

With their business being dependent on a secondary operator, the primary service providers requested support to upgrade their equipment set to include a vehicle. However, motorized vehicles were not eligible for funding under the project, and they lacked funds to buy one for themselves. Currently, the better performing service providers are saving money to invest in a pickup to upgrade their ability to provide services.

The net result of operating without the transfer stations, and dumping the sludge directly into vehicle mounted or towed tanks, was that the secondary operators were able to increase their business, with the smaller primary operators mainly serving as their sales promoters. These findings indicate that the FSM business in peri-urban Maputo, where there is a mix of different sanitation facilities, will work best with fully equipped service providers, with enough flexibility to cover both septic tanks and latrines and reach inaccessible facilities, while also being able to transport sludge directly to the treatment plant. Such an operator would effectively be a small rather than micro enterprise, but requiring less capital than a vacuum truck operator. The existence of a steady, if limited, revenue base from solid waste collection was also a clear advantage to the operators undertaking the more variable work of desludging.

Besides the challenges of adapting the service to the lack of fixed transfer stations, primary transportation also presented some problems. The service model as designed was focused

FIGURE 18: INITIAL AND CURRENT SERVICE MODELS ADOPTED BY THE SERVICE PROVIDERS



on reducing secondary transport costs, and did not take into account the difficulty of pushing a handcart with half a ton of fecal sludge along rocky, muddy or sandy access roads. Under these conditions the operators needed more manpower, so that instead of using 3 workers for primary operations, 4 or 5 were needed depending on the distances and volume of fecal sludge to be transported (Figure 19).

A further issue arising from the rough access roads was that the covers of the plastic water tanks used for transportation were not watertight. Spillage was substantially reduced by adding rubber seals, but this was not totally successful, and there is still some minor spillage when travelling on very uneven roads.

4.3 Financial Viability

Intimate knowledge of the local area and skills in hygiene and sanitation promotion seem to have been key factors in gaining customers. Of the 8 service providers, the two who have managed to gain the most customers are a primary operator (Acadec) and a secondary operator (Mbonga Mbilo), both of which are community based organizations situated in Nhlamankulu and are well known among the residents through their previous promotional work. Because of their local knowledge, they were aware of the areas in the district with the greatest emptying needs, and targeted them in promoting their businesses. They also had the local authorities' backing to perform their businesses in the area. Both Acadec and Mbonga Mbilo had an average of 5 emptyings per month, well above the 2.5 average for the whole group. Mbonga Mbilo, in particular, managed to arrange preferential access to the MMC tractor for secondary transport, at no or nominal cost.

While the total number of facilities emptied was far below initial expectations, the volume of sludge was much closer to the original estimates, mainly due to the volume of the septic tanks (average 2.4m^3) which made up the bulk of the work. This had financial implications as the operators were using a flat rate of US$40 per 0.5$m^3$. The total volume of sludge collected during the pilot was around 437m^3, equivalent to 873 units of 0.5m^3. Although it had been recommended to the operators that they reduce the unit price as the volume per operation increased, they are in practice setting prices through negotiation with their customers rather than the size of the facility to be emptied. This is not surprising, given that most informal businesses in Maputo work on the basis of negotiating prices. The main factors involved in price setting seem to be the size of the equipment used (0.5m^3, 2m^3 and 6m^3) and the customer's apparent wealth as indicated by the type and location of the house and the appearance of the owner.

Figure 20 presents the total monthly collections from primary emptying. There is no correlation between the number of operations and total collection, apart from the first three months, when operators were still applying the volumetric approach to pricing recommended in their training as they gradually learned about the business.

Discounting Phatima microenterprise, which has now ceased to operate, average cost per facility emptied by primary operators ranged from US$ 34 to US$ 66, while secondary operators had costs ranging between US$ 18 and US$ 40, as presented in Table 5. Primary operators Acadec and Magoanine were far more profitable than Bejoel and Modac. Looking at the cost breakdown in

FIGURE 19: EFFORT REQUIRED PUSHING A HANDCART WITH FECAL SLUDGE ON UNPAVED ACCESS ROADS



FIGURE 20: TOTAL MONTHLY COLLECTIONS (US$)

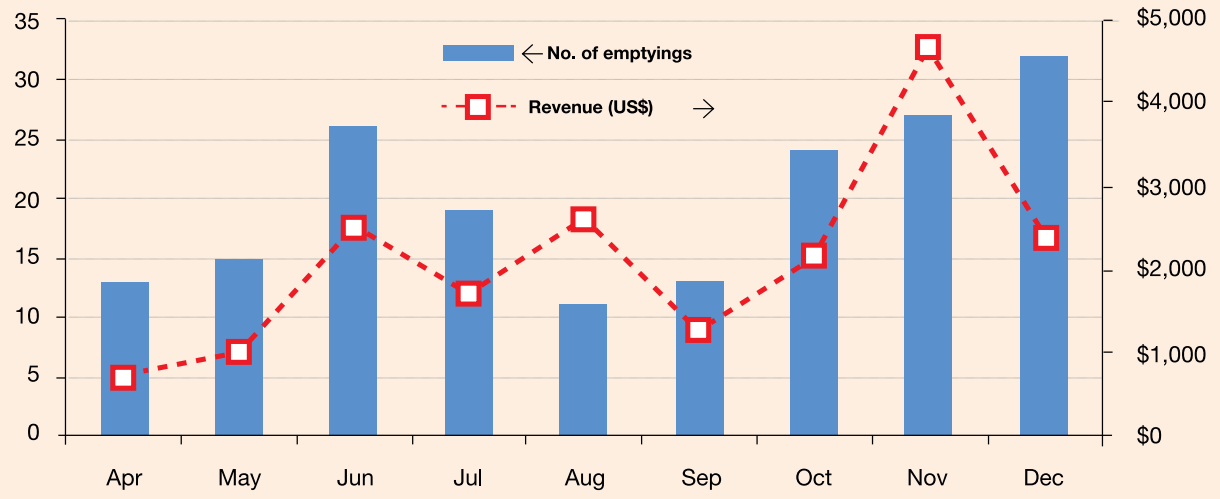


TABLE 5: AVERAGE REVENUE, COSTS AND PROFIT PER FSM OPERATION (US$)

Operator	No. of operations	Total revenue	Average revenue per operation	Total costs	Average cost per operation	Total profit	Average profit per operation
Primary							
Acadec	37	4,000	108	2,386	64	1,614	44
Bejoel	27	2,090	77	1,786	66	304	11
Magoanine	23	2,356	102	995	43	1,362	59
Modac	10	413	41	338	34	75	8
Phatima	5	413	89	508	102	(65)	(13)
Average	**20.4**	**1,861**	**84**	**1,203**	**62**	**658**	**22**
Secondary							
Sizema	41	6,008	147	719	18	5,289	129
Mbonga Mbilo	37	2,807	76	1,465	40	1,342	36
Oliveira	22	4,502	205	836	38	3,666	167
Average	**33.3**	**4,439**	**142**	**1,007**	**32**	**3,432**	**111**

Figure 21, it appears this may be due to more efficient use of labor (contracted only when needed for a job) – and that Phatima may have failed due to very inefficient use of labor. Of the secondary operators, Sizema and Oliveira were far more profitable than Mbonga Mbilo. This is possibly due to Sizema and Oliveira each having access to a vehicle, allowing them to provide services to wealthier and better-paying clients outside the project area, while Mbonga Mbilo, which relies on the 6m^3 trailer, is restricted to the predominantly low-income pilot area.

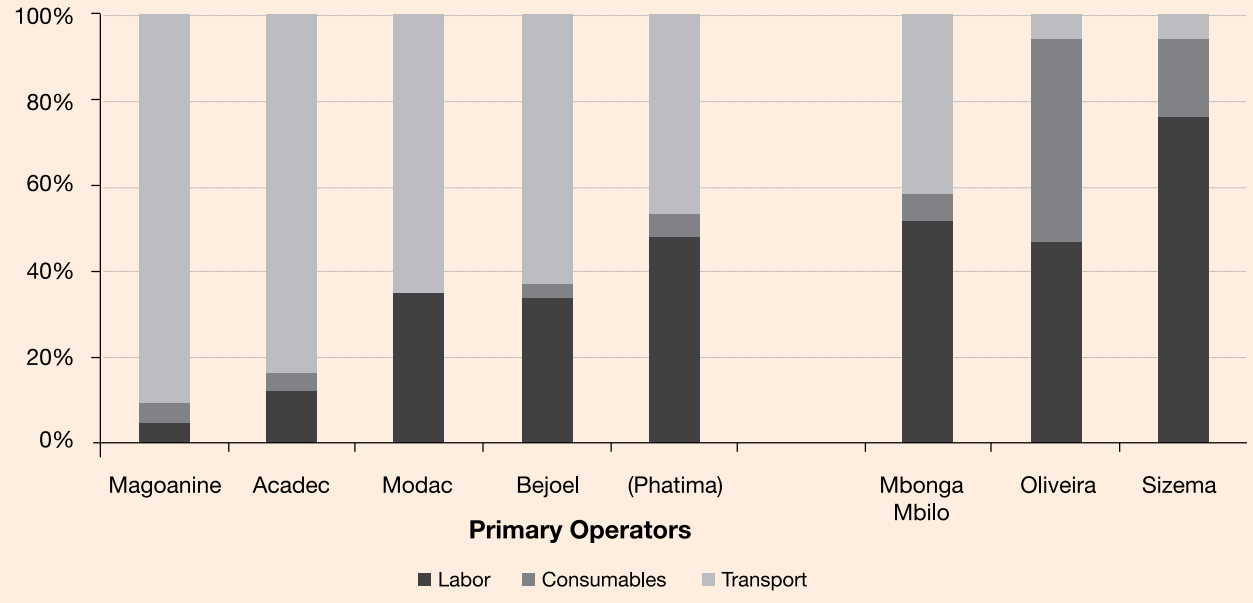
However, given the start-up phase, the influence of the electoral period, and the gradual reformulation of the operational models, it is probably too soon to draw conclusions from the available information, and it is proposed to re-analyze the cost data in about 6 months' time.

4.4 Customer Feedback

An assessment of customer satisfaction was carried out between September and October, 2014. A total of 99 households were interviewed, 61% of which were customers and the remaining 39% potential customers who had not used the services after contacting an operator. Eighty-two percent of respondents had previously experienced their facility filling up, while the remaining 18% were contacting a service provider for the first time. Eighty-seven percent of respondents were septic tank users and only 13% pit latrine users. The majority (63%) of households which rejected the new services had used manual emptying methods before, either by informal emptiers or household members; while customers who used the services had commonly (47%) used mechanized services previously, followed (33%) by manual services. Forty-two percent of respondents reported that the fecal sludge was buried in their yards, whilst 43% stated that it was taken to the wastewater treatment plant. About 10% of respondents (mainly those using manual emptiers) reported that the sludge was dumped the into drainage channels. Households relying on pit latrines were primarily (77%) using manual emptying, while those on septic tanks used both manual (35%) and mechanized (45%) emptying services.

Almost 50% of the customers that used the new services did so to try out its efficiency and adequacy (Figure 22-a), and others (23%) were attracted by good customer care services. Those rejecting the services cited price as the main reason for not using the services offered (Figure 22-b). Households had found out about the services primarily through leaflets distributed by the private operators (36%),

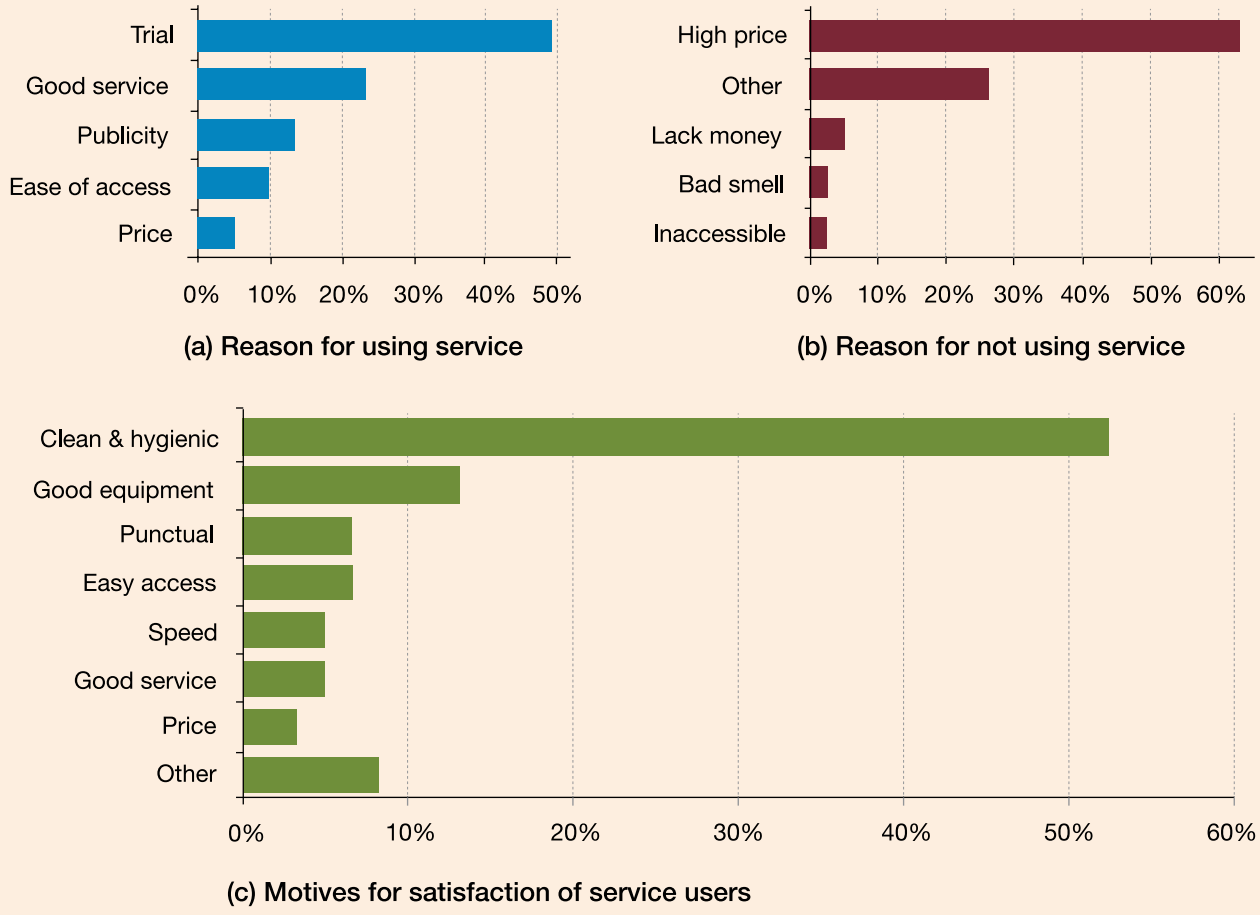
FIGURE 21: EXPENSE BREAKDOWN OF THE OPERATORS



from the local authorities (20%) and from their neighbors (15%). General feedback from customers using the service was good, with cleanliness and hygienic practices being the main reason for satisfaction (52%), followed by appropriate equipment (13%) (Figure 22-c). Though pricing is clearly an issue that needs to be reviewed, 85% of the customers reported that they would use the service again.

Typical prices charged were between US$ 30 and US$ 70, for both those that accepted and those that rejected the service. At least 13% of those who rejected the service hired a manual emptier after rejecting the new services, admitting that they were conscious of the associated risks, but that they had no option but to use a cheaper service. Half of both customers and those who rejected the services felt that the criteria for price definition were not clear; and more than two thirds felt that the price was too high – although the majority ended up using them. Respondents considered that a fair price would be US$ 40 per facility emptied, rather than per 0.5m^3 unit. Many of the pit latrine users (55%) are not willing to pay more than US$ 25 for emptying, while septic tank users showed a wider range of opinion, with 42% willing to pay up to US$ 40, and 35% more than US$ 40.

FIGURE 22: REASONS FOR CHOOSING (A) REJECTING (B) AND LIKING (C) THE NEW FSM SERVICES



V. Key Findings and Conclusions

5.1 Key Findings

- **Sanitation status in Maputo becomes progressively worse along the service chain**

Access to improved sanitation facilities is generally high in Maputo, and households have been investing in upgrading their systems to water flushed toilets, driven by major improvements in water supply coverage over the last 5 years. An improved toilet is a private good, and households have consistently invested in improving them as the opportunity arises; however, transport and treatment are public goods and so deserve the use of public funds. However, little has been done previously to improve FSM services for poor residents in Maputo, and the results from the city-wide survey show that fecal sludge transport and treatment are currently failing.

- **Uptake of the services was lower than initial predictions, probably due to high prices**

The total number of emptyings was only 10%-20% of the estimated potential market – although demand estimates are very rough at best, and this is an area already identified for further research globally. Whatever the real demand may be, many potential customers, particularly pit latrine users, who tend to be poorer, continue to use cheap and unhygienic manual emptying with local burial or open dumping, with price being the most common disincentive cited by both users and non-users. While the prices applied during the pilot do not cover amortization of capital investment cost, they still appear to be too high for poor households, and about three times those practiced by the manual emptiers. In order to sustain services, and benefit the poor, at least a partial subsidy on transport and capital investment must be seriously considered.

- **Rapid upgrading of sanitation facilities made the service model inappropriate for the target area**

The pilot was designed based on monitoring by the local authorities, who reported pit latrines as the main sanitation facility in Nhlamankulu in 2011, serving just over two thirds of the population. A later assessment in 2013 (results available in mid-2014) showed that almost two thirds of households had upgraded to a WC with septic tank or a pour flush latrine, probably driven by water supply improvements, including a connection campaign in the project area. The service model was then inappropriate, as it was conceived based on the smaller emptying volumes required by pit latrines.

- **The service package should be adequately sized and allow for a wider range of options**

With a variety of sanitation facility types to be serviced and the fast-changing nature of peri-urban communities, service providers should be equipped to provide an inclusive and comprehensive set of options in order to sustain their business. Lack of motorized vehicles has proven to be a major challenge for both primary and secondary transportation, requiring extra effort from the operators. The very small scale primary service providers appear to be too small to be self-sustaining and ended up working with the larger secondary operators, often in the role of front-line sales staff. This confirms findings by the Bill & Melinda Gates Foundation that very small FSM service providers are not economically viable. It also renders attractive the option of transforming informal emptiers into decentralized units attached to a secondary operator. However, such attempts failed, as they lack professionalism and accountability. Further research should be carried out in order to understand the dynamics surrounding this category of workers, so that they can be integrated into the formal service chain and abandon their unhygienic working methods.

- **The hygienic performance of available equipment was not fully adequate**

The introduction of "Gulper" handpumps reduced but did not eliminate contact with fecal sludge, and there were several reported cases where operators were spattered with fecal sludge. The plastic water tanks used for sludge transport were not fully watertight, and a few minor spills occurred during transportation of sludge on both handcarts and motor vehicles on unpaved roads. Rubber seals were introduced to minimize spillage, but an effective design has yet to be found.

- **Social marketing skills and local knowledge of customers improved service uptake**

The micro-enterprises with offices in the targeted area and experience of previous interaction with households in social marketing of hygiene and sanitation, have been more successful in attracting customers. Moreover, they were aware of the areas in the district with the greatest emptying needs, and targeted them in promoting their businesses. Also, their good relations with the local authorities meant that they could obtain assistance in case of need, including preferential access to a municipal tractor at nominal cost. Leveraging these relationships with the community is clearly an important factor in promoting the FSM business, and needs to be specifically taken into account when selecting private enterprises for capacity-building in FSM, as well as in the design of publicity and promotion campaigns.

- **There were strong client aspirations for modern and hygienic services**

The great majority of clients were satisfied with the services provided. Although a few minor spills and inappropriate use of equipment were reported, hygiene and cleanliness were given as a principal reason for satisfaction, followed by the adequacy of the equipment. Even those who rejected the services, mainly on cost considerations, acknowledged the risks associated with unimproved manual emptying. This is partially due to memories of the degrading and unhygienic bucket system used during the colonial times in most of the indigenous areas of Maputo.

5.2 Recommendations

Given the on-going modification of the service models, more time is needed to draw out the full lessons from this pilot, and this will be done over the coming months. However, there are already some clear recommendations that can be made to MMC and the existing service providers, and which would also be valid in other areas, if and when the experience is rolled out.

- **Subsidies**

The low affordability of improved FSM services to the poorest potential users emerged clearly as an issue that needs to be resolved. In Maputo, as in most African cities, transport to the treatment works is by far the largest component of the service cost. As this is primarily a public good, and in line with the fact that nearly all sewerage systems, at least in developing countries, fail to recover capital costs, a subsidy for this step in the sanitation service chain should be considered – as has been the case with the operator Mbonga Mbilo, which used the MMC tractor to haul the 6m^3 tanker trailer at nominal cost. This could be paid out of the sanitation tariff which will soon be added to all water bills.

As sanitation has a strong component of public good – i.e. the benefits accrue to the whole community and not to the individual alone – there is a strong justification to use public funds to pay for the public good component and render the service more affordable to users. With sewerage this is relatively simple to do, by investing in the infrastructure, which is a very major cost component, and leaving users to pay for operation and maintenance through tariffs. With on-site systems and FSM it is more complex, as the hardware (toilets, emptying equipment) is all in private hands, and operating costs constitute a much larger proportion of the total cost. Experience is still lacking on mechanisms for providing these subsidies, but might include: partial subsidies for toilet construction, to ensure that containment is adequate and that pits are hygienically emptiable; assistance to entrepreneurs to break down barriers to entry through partial grants, loan facilities, tax exemptions etc.; and subsidizing secondary transport (it is in the user's interest to remove fecal sludge from the premises, but in the public interest to have it arrive safely at the treatment facility). These issues will be further analyzed and experimented in the next phase of this work.

Although sanitation is entirely a municipal responsibility in Mozambique and the water utility has no mandate for sanitation, the principle of charging for sanitation on water bills is already established nationally, and has been operationalized in Beira (and for a time in Quelimane). Solid waste fees are charged in many cities via the electricity bill, with the utility charging a commission for the collection, and the procedure for the sanitation fee would be the same. The main difficulty in introducing the sanitation tariff is the need for regulatory oversight, which in turn requires clear separation of the finances of the Municipal Sanitation Department, so that they can be examined by the regulator. As mentioned above, there is also a need to define the best

ways of channeling such funds so as to maximize the public good achieved. However, the establishment of autonomous municipal entities is a new phenomenon, and it is taking time for the Municipalities to develop the necessary institutional and legal arrangements.

- **Decentralized Treatment**

Given the larger sludge volumes generated by the water-using facilities that have been built following water supply improvements in the project area, transfer stations and transfer equipment would need to be much larger, and thus less cost-effective. However, decentralized treatment facilities would greatly reduce the need for road haulage. This would of course depend on the availability of land and the acceptability of the technology to nearby residents. WSP and MMC will continue to examine possible approaches to this.

- **Size of the Service Provider Enterprises**

This study confirms the observation by Choudhry and Kone (2012) that very small FSM enterprises are not sustainable, and that other sources of income than household emptying are necessary to ensure viability. Given the range of facilities to be emptied, from the simplest of dry pits to fully engineered septic tanks, and the variable access conditions in peri-urban areas, a FSM service provider needs to be able to maintain a range of equipment to deal with all eventualities. It is also clear that marketing is important, which requires a certain critical mass to be effective, although individual efforts through local networking are also useful. Following the arrangements that are evolving spontaneously amongst the operators, and taking cognizance of the fact that one operator per neighborhood is appropriate for solid waste management, but possibly too many for FSM, an option could be to establish a limited number of full-service (collection and transport to disposal) operators with small trained temporary teams in each neighborhood, who would promote the service and be paid per client by the main operator. These small teams would be branded and supervised by the main operator to ensure service quality.

- **Technology**

Technological options for FSM in peri-urban areas still need to be improved. A number of technologies have been adapted to date, but they still require further development. In particular, dealing with the thicker and drier sludge from dry pit latrines while minimizing contact with the operator is still a challenge which needs to be addressed. Better tanks for primary fecal sludge transport are also needed. WSP will collaborate with the service providers to develop suitable solutions.

- **Monitoring**

Access to information is essential for service design and subsequent adjustment during implementation. Given the dynamic nature of peri-urban settlements, local governments should establish monitoring systems that continually update sanitation status to support better planning and prioritization. For instance, in this case the initial project design was focused on a type of facility (pit latrine) which is no longer the most common in Nhlamankulu, but with further data collection, it was possible to understand the market and make the necessary adjustments to improve the results.

5.3 Conclusions

Although the project has not been fully successful in meeting the needs of the poorest households which continued to prefer manual emptiers that charged lower prices, much has been (and is still being) learned which can be applied to developing better services in future. The finding that subsidies would be needed to serve the poorest customers was not a surprise, and this work has revealed much about the technical and cost structure of FSM services in some of Maputo's most difficult areas which will assist in designing services that can be rolled out city-wide, once current efforts to restructure the Municipal Sanitation Department and place it on a more sustainable financial basis have come to fruition. These lessons can also be applied in other cities as Mozambique's new government moves forward with a strong emphasis on improving the country's lagging performance with respect to sanitation.

5.3.1 Next Steps in Maputo

Following the successful proof of concept in this pilot, MMC is planning to scale up the service to the other three peri-urban Municipal Districts. This will be done together with the restructuring of the Municipal Sanitation Department, development and promulgation of a sanitation byelaw, and the introduction of the sanitation tariff, on all of which

issues WSP is assisting MMC. Concurrently, WSP and WSUP will work with the service providers to resolve the technical issues mentioned above, as well as advising them on coalescing into bigger operations.

When the sanitation tariff is introduced, MCC will have to be able to show services to the citizenry, so the introduction of some kind of subsidy for sanitation services will be necessary as well as possible (by virtue of the funds collected). This is a sensitive issue, as when the solid waste fee was introduced without services in the peri-urban areas several years ago, consumers revolted and started dumping solid waste in front of the electricity company offices. WSP will work with MCC to establish the modalities of subsidy, both for secondary transport and for treatment (waiver of the dumping fee).

MMC is already working on the development of a locally-based monitoring system, with WSP and WSUP support, and this will continue. It will inform the roll-out of improved FSM services in the other peri-urban Districts.

MMC has recognized wastewater and fecal sludge treatment as a priority area to seek investment funding. WSP will work with the Municipal sanitation department to examine options for decentralized fecal sludge treatment so that they are considered together with any possible investments in rehabilitating the main wastewater treatment facility.

5.3.2 Next Steps in Mozambique

Other cities have signaled their interest in pursuing improved FSM, such as Beira and Chimoio Municipal Councils, with which the Dutch-funded Frisian Urban Sanitation Project is already working. They are interested in rolling out a similar approach to what has been done in Maputo, including a general survey and diagnostic of the sanitation situation, review and improvement of FSM practices and, in Chimoio, a new sanitation byelaw. WSP has initiated collaboration on these fronts, and envisages an on-going linkage with these and other cities

Other priority cities for engagement are Tete, which is growing explosively and suffered a major cholera epidemic in the 2014-2015 wet season, for which the Mozambique government is seeking immediate and long-term solutions, and Nampula and Quelimane, which both require assistance in establishing autonomous sanitation departments and a regulated sanitation tariff.

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Annex 1: Sanitation Monitoring by Local Authorities

A Case Study in Nhlamankulu Urban District, Maputo, Mozambique

1. Background and Summary

In Maputo, Mozambique's largest urban center and capital of the country, at least 33% of the population, who live mostly in peri-urban areas, still rely on inadequate[15] and, in many cases, shared, sanitation facilities – in some cases serving more than 30 families. The Urban District of Nhlamankulu contains some of the city's most densely-populated (>200 persons/ha) unplanned areas, including the neighborhoods where this work was carried out (Chamanculo D, Aeroporto B and Unidade 7)[16].

Despite the gravity of this situation, families have to depend on their own initiative, seeking on-site sanitation solutions based on whatever limited information and financial resources they may have at their disposal. As a result, many sanitation facilities do not meet even basic standards of hygiene and structural safety. Although environmental health campaigns have reached these areas, many families are unaware of the real risks that their latrines can pose to themselves and their neighbors. Sanitation is not seen as a priority, and it is not uncommon for well-built houses with piped water, electricity and smart furniture to lack adequate sanitation facilities.

In this pilot activity, WSP introduced a monitoring process in the three neighborhoods, involving local community leaders, the lowest tier of the municipal administration, with the aim of collecting information to improve sanitation planning. However, instead of merely informing future interventions by the authorities, the training and monitoring carried out resulted in community leaders and householders becoming spontaneously involved in improving their own conditions. Within less than six months, the results were encouraging: in a sample of those having poor sanitation facilities at the beginning of the monitoring activity, 79% had built a new latrine, upgraded an existing one, or significantly improved the cleanliness of the latrine, halving the overall proportion of unsafe latrines from 29% to 14%. This outcome clearly suggests a potential role for community-based monitoring in changing sanitation behavior and improving sanitation services in peri-urban areas. Description of the Initiative

1.1 Context

This initiative had its origins in a decision by the Maputo Municipal Council to develop community-based monitoring of sanitation conditions, so as to have access to up-to-date information (previously lacking) on which to base decisions on where and how to intervene to improve sanitation. Such monitoring through local government institutions also forms part of the National Water and Sanitation Sector Information System currently being developed. In this pilot activity, WSP introduced a monitoring process in three neighborhoods, with the Block Leaders having a key role.

The Block Leaders are respected citizens appointed by the Neighborhood Secretaries[17] and constitute the lowest tier of the municipal administration, although they are unpaid. They are responsible within their block (average size, 68 houses) for, amongst other things, mobilizing residents to look after public infrastructure and cleanliness. These responsibilities require the Block Leader to monitor all homes in his or her block, including access to water, sanitation and other basic services, making periodic reports to the Neighborhood Secretary. However, these tasks are not always carried out, due to lack of capacity, resources and incentives.

The process of training the Block Leaders[18] for monitoring water and sanitation was based on discussions on water and sanitation services, and the characteristics of the various options in use. As there was a lack of clarity about acceptable standards for sanitation, digital photographs showing the wide range of sanitation solutions adopted by residents of each neighborhood were displayed to them, to inform a debate about what constitutes safe sanitation and

[15] Less than the government approved minimum of an "improved latrine", basically one with a concrete slab.

[16] The total population of the three neighbourhoods is 39,000 inhabitants.

[17] The Neighbourhood Secretary is the lowest tier of paid municipal officials, responsible for administrative functions in a neighbourhood of around 4,000 households, equivalent to about 20,000 people.

[18] All 114 Block Leaders in the three neighbourhoods were trained, as well as the neighbourhood administration

adequate service levels, incorporating the users' perceptions. However, no particular emphasis was placed on discussing the linkages between health and sanitation, awareness of which appeared to be quite high already.

1.2 Step 1: Ignition - Local Leaders

Interestingly, these discussions with local leaders took an unexpected turn. The Block Leaders discussed not only what was acceptable or not, but reacted strongly and questioned whether such awful sanitation conditions really existed in their neighborhood, when certain images were presented to them. Opinions such as *"This is not on my block!"*, *"It can't be!"*, *"How can anyone even consider this latrine? I want to go and see it!"*, were frequently expressed. This feeling of disgust at the community level (in this case, the Block Leaders) is very similar to that promoted in Community-Led Total Sanitation (CLTS) triggering, and in a similar way, the group reached a tipping point, and made a spontaneous collective decision to do something to improve the situation.

1.3 Step 2: Ignition - Households

The second part of the training consisted of visiting households and filling in monitoring forms. Groups of six Block Leaders entered each house to question residents and inspect the household toilet, and then presented its conclusions to the group.

Twenty-five homes were visited in each neighborhood during the training. In general there were no problems obtaining access, although families whose toilets were in a poor state were embarrassed when asked to show them to the visiting team. In households with dirty toilets, the family representative, visibly embarrassed, apologized about the lack of cleanliness, stating that it was not the normal state of affairs and that the Block Leader would never again

Training sessions *(Source: WSP)*

Block leader discussing sanitation conditions with a householder *(Source: WSP)*

find the toilet in this state. Families with latrines which the Block Leaders judged inadequate often responded by saying they were saving up to build a latrine, had contacted a mason, or were looking for a latrine slab.

Just as in the discussions with the Block Leaders, focusing on the issue of sanitation, especially in the presence of community leaders, evoked in the families a feeling of shame about their sanitary conditions, making them reflect on the need to change their sanitation behavior. It was not that they did not know what was wrong, but that they simply did not consider it important. The poor state of their sanitation was not a priority within the confines of the household, when confronting it on a daily basis. However, when made somehow public, the family was shamed, and this triggered in many cases a process of change, as described below.

1.4 Step 3: Monitoring – Local Leaders and Households

Following the training, the Block Leaders carried out surveys in their own blocks. Information on household size, source of water supply, and sanitation facilities, was collected and recorded for each household. This survey took about one month for each block, depending on its size and the availability of the Block Leader.

The Block Leaders reported that, as in the training sessions, families reacted to the survey with embarrassment. Most households promised to make changes, but many expressed difficulties with respect to: a) availability of funds, or b) lack of information about the places where they could acquire latrines, and/or masons expert in latrine construction.

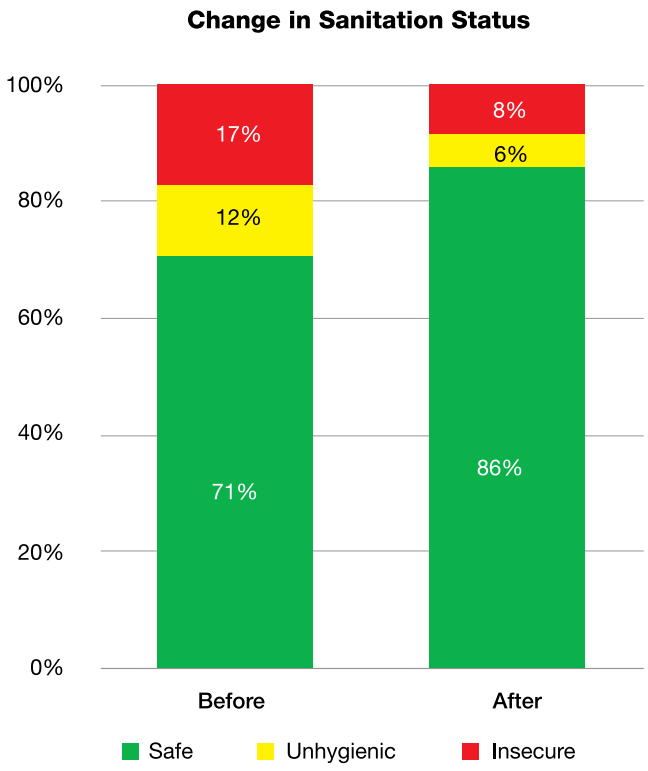
The Block Leaders promised to return between two weeks and a month after the initial visit to see whether households had followed through on their promises, thus putting pressure on them to act quickly to improve their situation. Such monitoring and follow-up of families is recognized as an important factor for success in rural CLTS as well.

2. Results

Three months after the survey, as part of monitoring the Block Leaders' work, WSP visited four randomly selected blocks in the two neighborhoods where the initial survey had been completed. The blocks visited comprise a total of 291 households, of which, at the time of the initial survey carried out by the Block Chiefs, 62% were using a sanitation facility below the official standard for the urban environment, i.e. less than an improved traditional latrine.

However, although it falls below the official standard, a well-managed traditional latrine provides effective sanitation from a functional point of view, whilst equally; an improved but filthy facility does not, although it would be counted as meeting the official standard. For this reason, the concept of "safe sanitation" is being introduced by the Ministry responsible for the sector, which takes account of the adequacy of the structure, sludge management arrangements and hygienic management by the users.

On this basis, the Block Leaders classified 29% of the facilities as unsafe at the time of the initial survey. These include 17% classified as "insecure", which include fractured latrines, with a high risk of collapse, completely filled latrines, and other practices such as the use of plastic bags or holes in the back yard. The other 12% were potentially acceptable facilities, either in an unhygienic state or which could be repaired. 73 of these unsafe facilities were visited in the follow-up assessment, and in only 15 cases had the



sanitary conditions not been improved, although some which had been cleaned up could still not be classified as safe for structural reasons. Of the 15 households where no improvements were made, five were headed by widows, living on (very meagre) social security grants, and one by a widower living only with grandchildren, who had neither the financial nor physical capacity to invest in improving their sanitary conditions.

As a result of the interventions made by the householders, the number of unsafe facilities was halved. Of the 73 unsafe facilities followed up, 20 were rebuilt, 5 rehabilitated and 2 emptied, whilst 31 were cleaned up to a hygienic state. These changes greatly impressed and motivated the Block Leaders, since although some of these households had indicated during the initial survey that they had insufficient funds to invest in sanitation, they had nevertheless made an investment. Moreover, seeing their blocks cleaner and with safer sanitation, without any outside investment, motivated the Block Leaders to continue their work.

The photographs below show the improvements made by some of the households visited, starting from a simple improvement, cleaning and rehabilitation of the

Before

After

superstructure in the first case; emptying the pit and rehabilitation of the superstructure, in the second; and in the third, a major investment, mobilized by the whole family, moving up from an unsafe pit latrine to a WC and septic pit. The third example was in the house of a widow living with her grandchildren, who had reported being too poor to invest in improved sanitation in the initial survey. At the time, the leaders asked about her sons and daughters and highlighted the risk to the health and safety of the grandchildren. This improvement surprised the Block Leaders and even raised applause from the community.

3. Major Drivers for Success

Political will and the commitment of leaders are key factors. The Municipal District Administrator was early on convinced of the utility of the exercise, and prioritized the monitoring of sanitation, encouraging the Neighborhood Secretaries to participate actively in the process. Such political will is critical in mobilizing and involving local leaders.

Technical inputs at neighborhood level were also critical. The process benefited from the participation of the Water Officer, a new figure introduced as a regulator at the neighborhood level, to address water and sanitation related issues and provide information to both consumers, the water company and the Neighborhood Secretariat. The better results achieved in one of the neighborhoods relative to the other two can be ascribed to the greater dynamism, availability and interest of the Water Officer, who accompanied the Block Leaders on their visits and provided advice when requested.

Follow-up and monitoring through regular visits by the Block Leader is important in helping households to implement and maintain their improvements, just as it is in the case of rural CLTS. The political commitment and demand for results from the District and Neighborhood levels was an important factor in this regard. However, the Block Leaders also showed considerable self-motivation when they perceived how their actions were bringing improvements to households in their block.

Confrontation with the ugly reality of poor sanitation, whether by way of photographs during the Block Leader training, or during their subsequent household visits, was the key triggering mechanism. It is not clear to what extent notions of the negative health impact of poor sanitation was a factor; the reaction was spontaneous and based on their pre-existing knowledge and perceptions. However, there have been a number of sanitation campaigns in these areas over the last 30 years, which must presumably have had some effect.

4. Resources

The resources used for this work were relatively modest, but might nevertheless be difficult to scale up. Physical resources used were a digital camera and a digital projector, and monitoring forms distributed to the Block Leaders and Neighborhood Secretaries. Refreshments were provided at the training sessions, which were held in the Neighborhood Secretariat offices. Transport was provided for WSP staff and the facilitator.

Key human resource inputs included the following:
A skilled facilitator for the Block Leader training. As with CLTS, trainers need to be carefully selected and well coached. In a city-wide program there will be a need for many facilitators and a good facilitator training program, obviously not included in this learning-by-doing pilot.

The Water Officers. These are new neighborhood-level personnel whose principal function is to assist the regulation of water and sanitation services at grass roots level, and who were also being piloted in a complementary piece of work by the national Water Regulatory Council (CRA). They receive minimal remuneration, well below the minimum wage, for part-time inputs. They should be respected citizens with secondary education.

Support for the Block Leaders. Many Block Leaders are senior community members, who may be wise and respected, but not necessarily highly literate and numerate. Some of them required assistance in filling monitoring forms and compiling the results for their block. This was given by other family members or the Water Officer.

WSP staff. The work was designed and managed by WSP staff. Once a system has been established and tested, they will no longer be needed, but program management of a fairly high technical caliber (graduate level) will still be required, especially to deal with data consolidation and analysis.

5 Lessons Learned

5.1 Elements of the Process

The effectiveness of a process initially designed to stimulate a debate on sanitation standards amongst Block Leaders, and to train them in categorizing the sanitation solutions adopted by households living in their respective blocks, but which resulted in sanitation improvements by householders, can be attributed to:

The exposure of local leaders to the various sanitation solutions adopted by families living in their neighborhoods brought home to them the conditions in which their community lives. Although probably having heard about or even seen such conditions, having them displayed, in the presence of their colleagues, created a feeling of disgust, and the leaders were not prepared to accept them as typical of the area, nor that there was inadequate sanitation in their block.

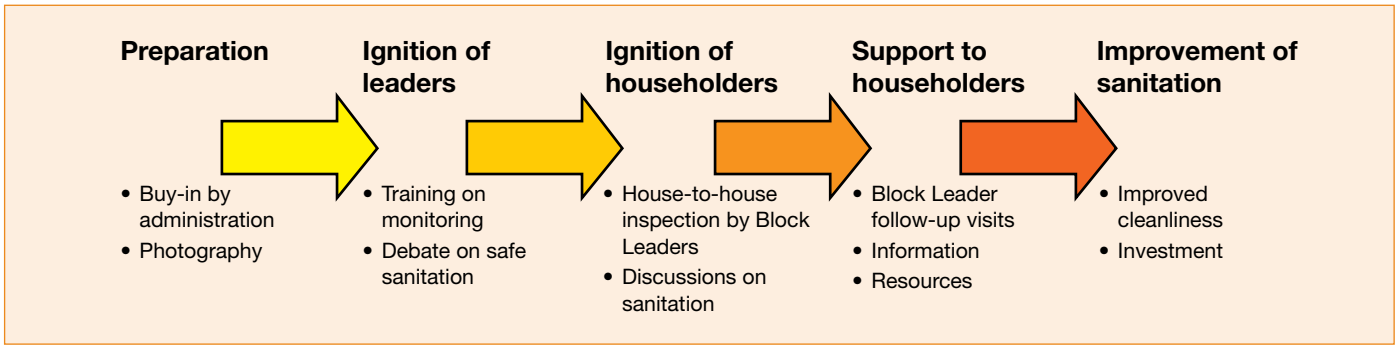
The debate on safe sanitation stimulated a review of the standards previously considered acceptable. As they discussed the concept of safe sanitation, the leaders were forced to reconsider not only the aspects that they were used to inspecting, but also to consider for the first time others which had previously passed unnoticed. With this training and information, the boundary between the acceptable and the unacceptable was moved, triggering the leaders, and resulting in their taking on the monitoring process and mobilization of the families as part of their duties.

The presence of the Block Leader, specifically in the household toilet, triggers a critical analysis not previously undertaken by the family. How does the toilet look to the eyes of a person outside the family circle, the eyes of the leader? This analysis led the householders to notice the dirt to which they had become accustomed, the broken structure which they had forgotten about, and other aspects previously known only to themselves, but which were now exposed to the leader and probably to the community at large.

The Block Leader's statement that he or she will return puts pressure on the household, forcing it to seek and identify solutions within the agreed period. In general, this begins with the easiest action, which is to improve cleanliness, whilst looking for information on the costs, material and manpower needed for their proposed improvements, and mobilizing funds. The persistent presence of community leaders can be critical to the sustainability of such changes, and serve as a driving force.

The financial and physical capacity of households is an important determinant of their engagement with upgrading their sanitation conditions. In many cases, families headed by widows or elderly persons were unable to make improvements, even such as cleaning or minor repairs to their latrines. These cases may require outside help from their family, from NGOs and charities, or possibly the government. However, some of the households that initially expressed unwillingness or lack of capacity to pay, did make investments as a result of triggering and motivation by the Block Leaders.

The availability of information and options suited to various levels of financial capacity is also important. Some families reported that, although they were willing to make an investment, they did not know where to turn for technical advice or materials. Many families ended up hiring a non-specialist mason, sometimes without experience in latrine construction, resulting in structures which were not stable or very durable, in order to alleviate their immediate situation.



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Annex 2: Sanitation Status in Maputo

The Urban Sanitation Status Index for Maputo

1 Overview

Socioeconomic development and poverty reduction are closely linked with adequate access to water and sanitation, and these linkages are more evident in developing countries. The sanitation sector is a fundamental issue in the international development agenda, which recognizes access to adequate sanitation as a human right; nevertheless poor sanitation conditions in the coming years will impose significant constraints on the socioeconomic development of developing countries. For instance, in Mozambique, inadequate sanitation costs around US$ 124 million annually to the country, equivalent to 1.2% of GDP (WSP, 2012).

In developing countries, and especially the Sub-Saharan African (SSA) countries, massive rural-urban migration during the last decades has increasingly put pressure on urban services and infrastructure (UN-Habitat, 2014). Most of this immigration has resulted in the proliferation of new informal settlements in peri-urban areas. This unplanned urban development constrains the efficient functioning of the sanitation service chain (containment-emptying-transport-treatment-reuse/disposal), with the least developed component typically being fecal sludge management. The failures of sanitation in the new African mega cities are due principally to a lack of infrastructure and to poor operation and maintenance routines (WSP, 2009; Tumwebaze and Lüthi, 2013). These problems are exacerbated by the poor governance of sanitation systems, high population density (Tumwebaze, et al. 2013) and mismatches between the various sector policies linked with the sanitation sector. Given this situation in SSA cities, there is a clear need for major investment to tackle the sanitation problems (Hawkins et al. 2013).

Despite the need for interventions in sanitation systems, there is a limited availability of tools to assist in prioritizing sanitation investments at city level (Tumwebaze, et al. 2013). Furthermore, even when prioritization is carried out, many sanitation investments are poorly informed and focus only on the user interface – containment – ignoring the rest of the service chain (WSP, 2013). This has led to the development of new tools aiming to analyze sanitation systems in an integrated way. There is a growing literature devoted to the analysis of sanitation status at city and neighborhood level; it is worth mentioning publications by Ross et al. (2013), Mehta and Mehta (2013) and Gunawardana and Galagedara (2013). However it should be noted that these studies did not base their analysis on the sanitation service chain.

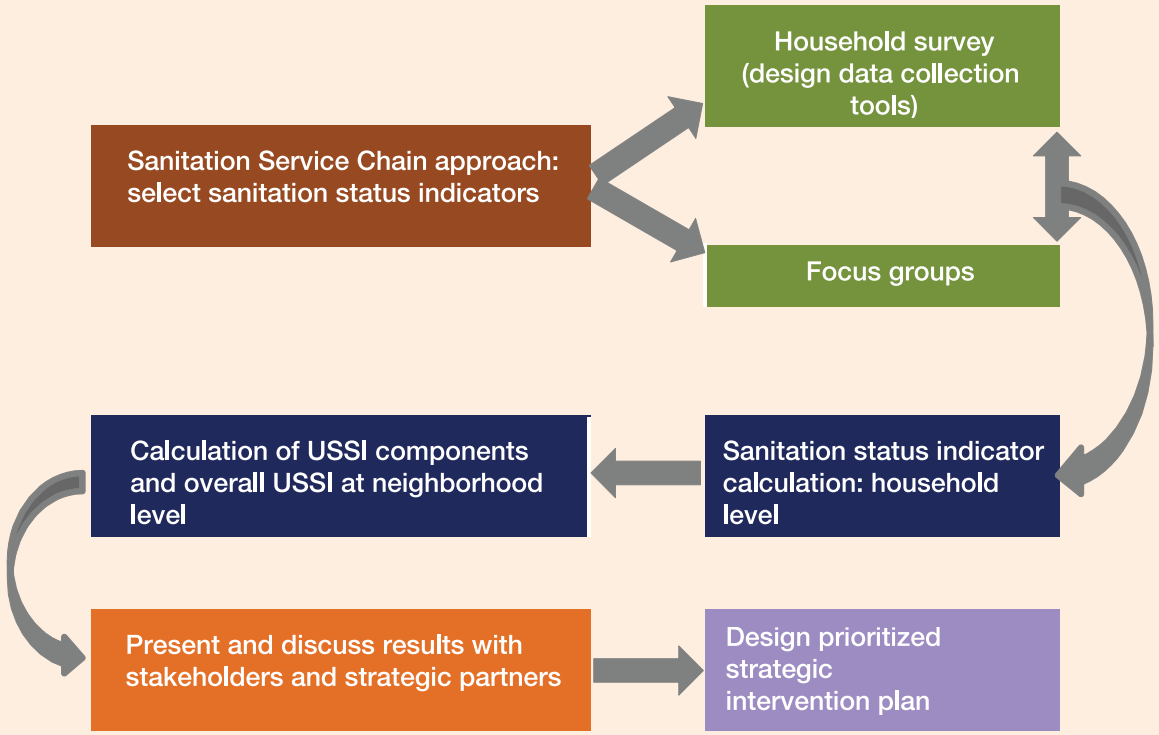
The main objective of this document is to introduce a recently developed strategic tool for evaluating sanitation status at neighborhood level using an Urban Sanitation Status Index (USSI). The USSI is based on the sanitation service chain, and was applied in Maputo (Mozambique) to characterize the city's sanitation status from a holistic perspective. The USSI is designed as a strategic tool for sanitation managers and decision makers, to help them to prioritize and design appropriate neighborhood sanitation interventions. This is in line with the strategic planning currently being undertaken by the Maputo Municipal Council. This document presents the main results of this pilot, as well as a number of reflections and recommendations for further development of the USSI to improve prioritization of sanitation investments across the city.

The document is structured as follows: this introductory section; description of the USSI; description of the Maputo city case study; summary of the key results; and finally, the main conclusions and lessons learned.

2 The Urban Sanitation Status Index: A tool to measure and understand sanitation status at city level

The Urban Sanitation Status Index (USSI) is a tool based on the sanitation service chain that allows the measurement of sanitation status at the lowest administrative unit within the city (neighborhood level), which is usually the unit on which management and planning is built. However, it should be noted that the USSI could also be used at district or city level. Figure 1 presents the five steps for developing the USSI in the context of the strategic planning process:

FIGURE 1: STEPS IN DEVELOPING THE USSI

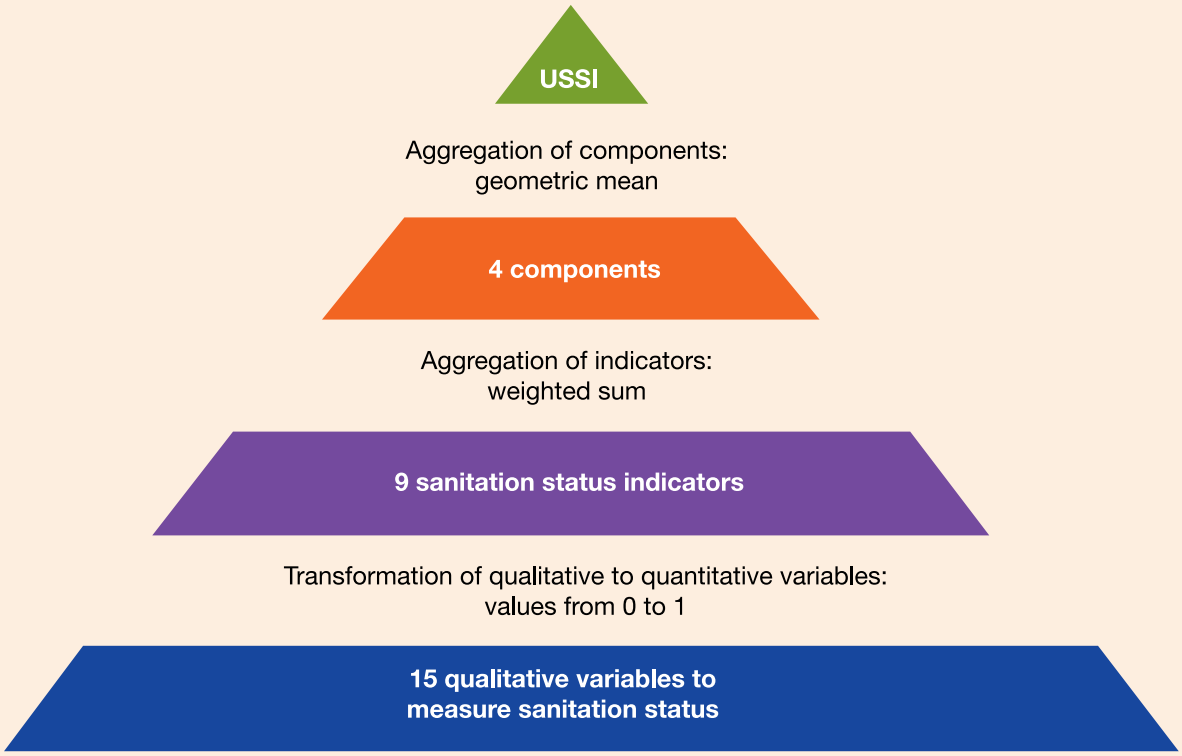


- ***Step 1:*** Selection of the indicators to measure sanitation status.
- ***Step 2:*** Data collection via a) household surveys; and b) focus groups with neighborhood representatives to cross check information.
- ***Step 3:*** Calculation of the sanitation status indicators and aggregation of the information to obtain the USSI.
- ***Step 4:*** Presentation of the results to strategic partners and end users.
- ***Step 5:*** Project planning and prioritization of interventions.

It should be emphasized that for successful implementation of the USSI, the involvement of strategic partners and final users in an interactive way is essential.

The USSI was constructed using methodological guidelines proposed by OECD-JRC (2008) for the construction of composite indicators. These guidelines present the logical steps in the construction of composite indicators, as well as technical aspects that should be taken into consideration in this process. The guidelines also recommend suitable techniques for use in each step of the construction of the composite indicator. Figure 2 summarizes the main steps in the construction of the USSI. The structure and development of the USSI is presented in the subsequent paragraphs.

FIGURE 2: MAIN STEPS IN USSI CONSTRUCTION



2.1 USSI Structure and Indicators

First, in order to select the basic indicators for evaluating sanitation status, a hierarchical structure was developed, covering the main principles and objectives that should be achieved by a sanitation system if it is to be sustainable. This was based on the theoretical framework proposed by WSP (Trémolet, 2011; Hawkins et al. 2013), which considers the sanitation service chain and breaks down sanitation management into three main steps (containment; emptying and transport; treatment and disposal). This approach conceives of sanitation as a series of interlinked services; Hawkins et al. (2013) argue that *"cities need effective urban sanitation systems, consisting of sustainable processes and service providers that will ensure the safe capture, storage, transport, and treatment of excreta in a managed and coordinated way—not just investments in hardware"*. It is important that this sanitation service chain should work efficiently in both socioeconomic and environmental terms. Apart from these considerations, other issues that could affect the services need to be taken into consideration, even if not entirely part of the chain. Key amongst these complementary services linked to sanitation are the management of solid waste, stormwater and grey water. The USSI therefore evaluates sanitation status under four components: a) containment; b) emptying and transport; c) treatment and disposal; and d) complementary services.

For each of the four components the main functions and objectives (see Trémolet, 2011) have been identified (see Table 1). A literature review was then carried out to identify a set of indicators for measuring sanitation status at neighborhood level (Ross et al. 2013; Mehta and Mehta, 2013; Gunawardana and Galagedara, 2013). The main criteria used in selecting the core indicators were that they should be: a) appropriate to the case study context; b) based on data that are available or could be easily collected; c) sensitive to spatial and temporal change; d) easy to interpret; e) relevant from a policy point of view. On this basis, 9 key sanitation status indicators were selected from the technical and scientific literature. This set of indicators is used to

establish a baseline at neighborhood and city level, and to evaluate the impacts of interventions aiming to improve the sanitation service chain. Table 1 shows the main aspects evaluated under each sanitation status indicator.

2.2 Weighting the Indicators

The second step was to quantify the relative importance of each sanitation status indicator. Given the fundamental importance of the local context, the weights of the indicators need to be set locally, so a weighting system that reflects local opinion was selected. On this basis, the Analytic Hierarchy Process technique (see Saaty, 1980) was used to estimate the relative importance of the indicators. A questionnaire was distributed to a panel of 20 national sanitation experts and practitioners from the public sector, international institutions, NGOs, and other stakeholders, in which they ranked pairs of indicators. Table 2 displays the indicator weights derived from this process. It should be noted that the weights calculated for this analysis are representative for this specific case of Maputo, and should not be extrapolated to other socioeconomic contexts.

2.3 Aggregating the Indicators

This is the final and crucial step in the construction of the USSI. It was decided to use a hybrid aggregation method, building up the USSI using additive and multiplicative functions at two different levels of aggregation. The main idea behind the use of a hybrid aggregation system is to obtain more coherent results, by allowing compensation between the indicators within each USSI component, but not allowing for full compensation between the components, so that the weak links in the sanitation services

TABLE 1: USSI COMPONENT FUNCTIONS AND INDICATORS

USSI containment Fecal material safely captured and stored	**USSI emptying and transport** Fecal material removed – latrine emptying – and transported hygienically and safely to treatment facility
Access to infrastructure • type of toilet • number of families sharing the toilet ***Safety*** • structural stability of the facility • type of lining of the pit or septic tank • groundwater level ***Hygiene*** • hygienic condition of toilet	**Access to emptying services** • type of equipment used for latrine emptying **Transport safety** • percentage of fecal material lost during transport to the treatment facility
USSI treatment and disposal Fecal material adequately treated and isolated without risk to public health or the environment	**USSI complementary services** Stormwater system working efficiently, allowing effective functioning of the sanitation system
Level of treatment • type of treatment used **Final disposal** • quality of disposal management	**Solid waste management** • local accumulations of solid waste • solid waste disposal site **Storm and grey water management** • efficiency of the stormwater and grey water systems • local accumulation of storm water • in-house grey water management

TABLE 2: USSI INDICATORS AND WEIGHTS

Component	Indicator	Information capture	Weight
Containment	Access to infrastructure	Household	14.37%
	Safety	Household	8.62%
	Hygiene	Household	12.40%
Emptying and transport	Access to emptying services	Household	17.31%
	Transport safety	Neighborhood	7.59%
Treatment and disposal	Final deposition	Household	13.89%
	Level of treatment	Household	11.01%
Complementary services	Solid waste management	Household + Neighborhood	6.70%
	Storm & grey water management	Household + Neighborhood	8.10%

chain are made clear. Within each of the four components (containment; emptying and transport; treatment and disposal; complementary services) an additive function (weighted mean) is used to derive an independent composite indicator for the component. This will enable the separate evaluation of the status of each of the four USSI components at neighborhood level. The weighted mean allows a "good" indicator value to compensate for a "poor" one within any given step of the service chain. At the second aggregation level, a multiplicative aggregation function (weighted geometric mean) was used to combine the four components obtained in the previous step in order to obtain an overall USSI at neighborhood level. The weighted geometric mean follows the SFD logic that if a link in the chain fails, the whole chain fails. Thus, low values reduce the importance of the other steps, even if they are working well. After the full process of aggregation, the USSI is expressed in a normalized scale that ranges from 0 to 1, where 0 represents the worst possible sanitation status, and 1 the best.

3. Background: Maputo City Case Study

3.1 Maputo City

Mozambique, a sub-Saharan African country with 25 million inhabitants (INE, 2015), is one of the least developed in the world, with a very low human development index – global HDI 0.702; sub-Saharan Africa region HDI 0.502; Mozambique HDI 0.393 – (UNDP, 2014). Thirty one percent of the Mozambican population lives in urban areas. Access to improved sanitation in urban areas has progressively improving over the last 20 years, moving from 34% in 1990 to 44% in 2012 (WHO-UNICEF, 2014). Despite this increasing access to improved sanitation in urban areas, this figure suggests that the country will not reach the Millennium Development Goals for sanitation.

Over the last ten years, Maputo city, the capital of Mozambique, has experienced vibrant and highly dynamic socioeconomic development, and its population has increased by more than 13% (INE, 1999 and 2009). This urban growth is mainly concentrated in unplanned settlements in the peri-urban areas of the city; around 80% of Maputo city population lives in unplanned settlements. The total population of Maputo is around 1.2 million, with an overall population density of 3,156 pop/km^2 (INE, 2009). Administratively, Maputo is divided into 7 Municipal districts, which in turn are divided into a total of 53 neighborhoods. However, this study analyzes only the 5 municipal districts and 47 neighborhoods which make up the mainland part of the city, as the remaining districts are rural in character. The overall average household size is around 5.6 persons.

Whilst water supply coverage in Maputo has grown rapidly during the last 5 years, from 42% to 62% (CRA, annual reports), access to improved sanitation has been increasing

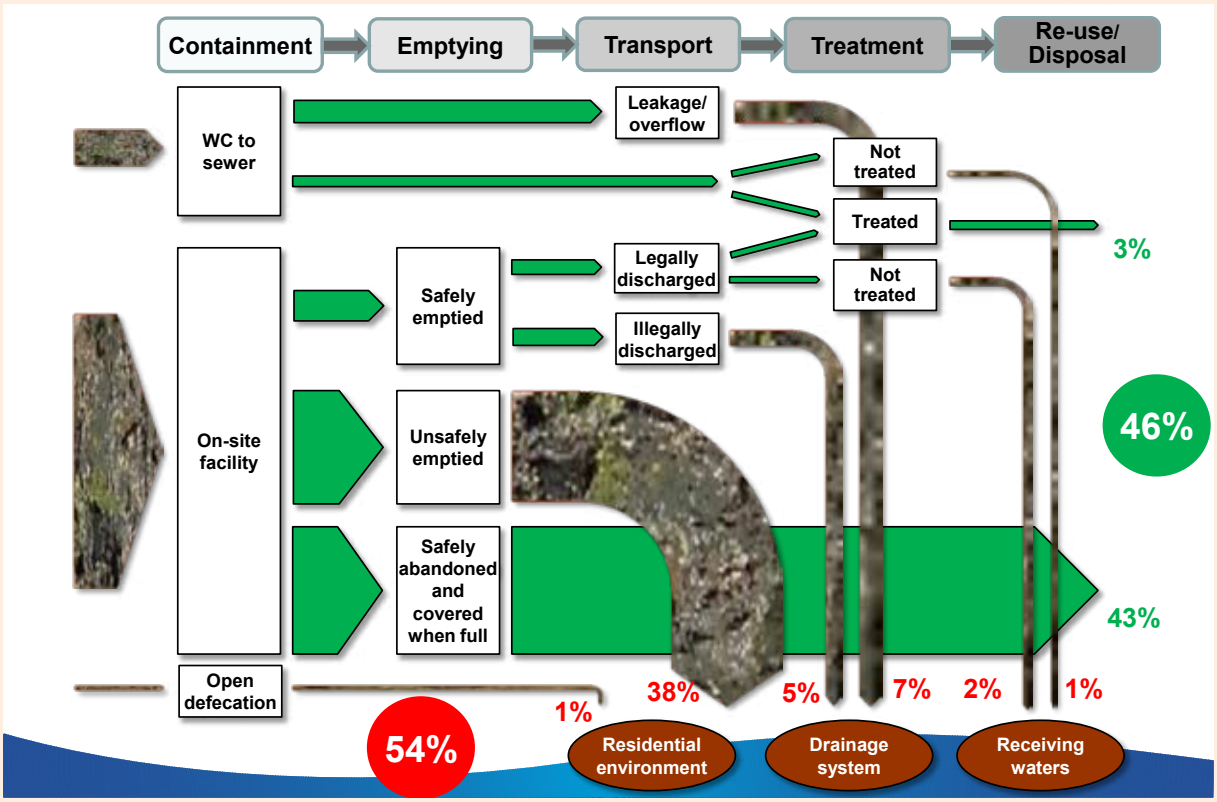
much more slowly (JMP, 2014), and remains a major challenge. Over 30% of the inhabitants lack access to a minimum level of sanitation service, and rely on unhygienic solutions to manage their excreta. The lack of adequate sanitation in Maputo is a major public health problem. It is estimated that less than 10% of the city's fecal waste arrives at the sewage treatment plant, with most of it being dumped into the environment without treatment.

To provide an overview of the sanitation status of Maputo, the fecal waste flow diagram for Maputo is shown in Figure 3. This tool, recently developed by WSP, takes into consideration all the elements in the sanitation service chain.

As can be seen, more than 50% of the fecal waste is deposited in the environment without treatment, which clearly poses a serious risk to public health. Overall, the diagram shows that the main constraints in the sanitation service chain in the city are linked to emptying and disposal.

In this context, the Maputo Municipal Council and its partners are currently working at improving the sanitation situation, including service provision, infrastructure development, promotion and monitoring aspects. The service provision component includes the development of commercially viable small private fecal sludge management operators. The sanitation service chain in peri-urban Maputo is also affected by a series of complementary services, including stormwater and groundwater drainage, and solid waste management (Muximpua and Hawkins, 2014). However, sanitation planning is limited by lack of information on sanitation services, especially in peri-urban areas. There is a clear need to close this information gap to enable effective prioritization of interventions at neighborhood level.

FIGURE 3: FECAL WASTE FLOW DIAGRAM FOR MAPUTO



Source: Peal et al. (2014)

3.2 Data Collection

The information needed to calculate the indicators was collected from a survey of a representative sample of Maputo city households and from neighborhood level focus groups convened by the ward secretaries (neighborhood level municipal officials).

Household data were collected using a structured questionnaire divided in three sections covering the household's socioeconomic characteristics, the main in-home sanitation infrastructures, and the services used for emptying and transporting fecal sludge. A total of 1,273 households were interviewed in the 47 urban neighborhoods of Maputo city, giving a sampling error of <5% with a confidence level of 95%. The number of households sampled in each neighborhood was allocated in proportion to its population, and were selected randomly within the neighborhood.

The survey was complemented by 6 neighborhood level focus groups made up of the neighborhood secretaries and District personnel. The purpose of these focus groups was twofold: firstly, to cross-check the information obtained from the household surveys; and secondly, to collect additional information for the base indicators which are measured at neighborhood rather than household level – for instance stormwater management or disposal of wastewater. Finally, a field visit to the sewerage and storm water drainage systems of the city was undertaken, in order to evaluate their effectiveness for the complementary services component.

The sanitation status indicators for each of the households surveyed were first calculated from the data, and then the mean value of each indicator within each neighborhood. These were aggregated using the process described above to calculate the four USSI components, and finally the single overall USSI for each neighborhood.

4. Measuring the sanitation status of Maputo city[19]

4.1 USSI Containment

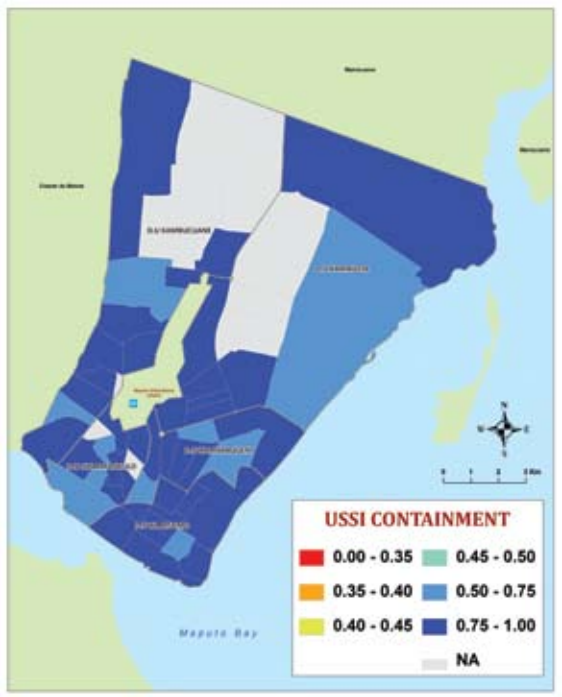
The USSI for containment was measured using three different sanitation status indicators: access to infrastructure, safety and hygiene. The main results for this component are shown in Figure 4a. It can be seen from the map that in general containment, with an average value of 0.794, is fairly good in the 47 neighborhoods evaluated. This can be attributed to a fairly long-standing tradition of latrine construction and use by Maputo residents (demand side), reinforced by the presence of private entrepreneurs dealing with latrine construction (supply side). The lowest value obtained in Maputo city is 0.673 for Chamanculo D. A closer look at the 10 neighborhoods scoring less than 0.750 in the USSI for containment reveals that the problems are related more to the type of latrine used (mainly unimproved latrines), and the number of households sharing a latrine, rather than the hygienic conditions or structural stability of a latrine.

An ANOVA test of significance was carried out to check if there were structural or socioeconomic characteristics in the neighborhoods affecting the values of the USSI for containment. This revealed that its value was dependent on location, with neighborhoods located in the city center scoring 0.872 on average, in contrast to peri-urban neighborhoods with scores averaging 0.791. The values are also closely linked to average household monthly income[20] – neighborhoods with lower average household monthly incomes score lower than the wealthiest neighborhoods. There is also a positive correlation between average household income and the access to infrastructure indicator.

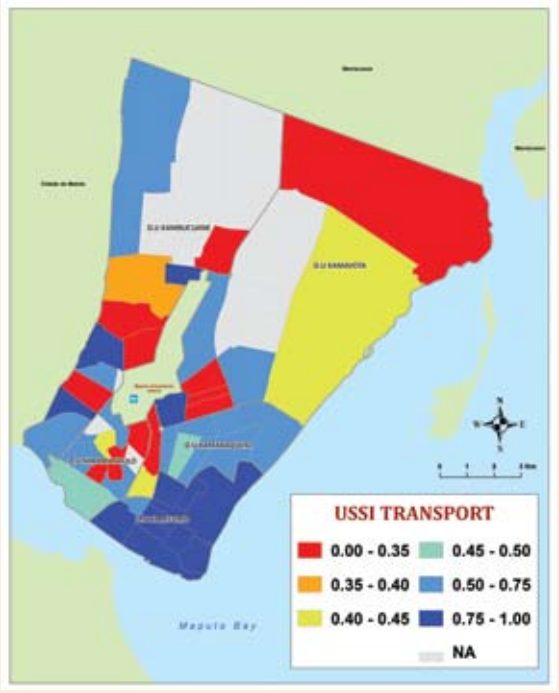
[19] A sensitivity analysis was carried out to check to the consistency of the results obtained with the methodological approach followed to build the USSI. Our results reveal that there are no significant differences from a statistical point of view between the 9 alternative ways to build the USSI which were tested.

[20] Household monthly expenditures were used as proxy of the household monthly income.

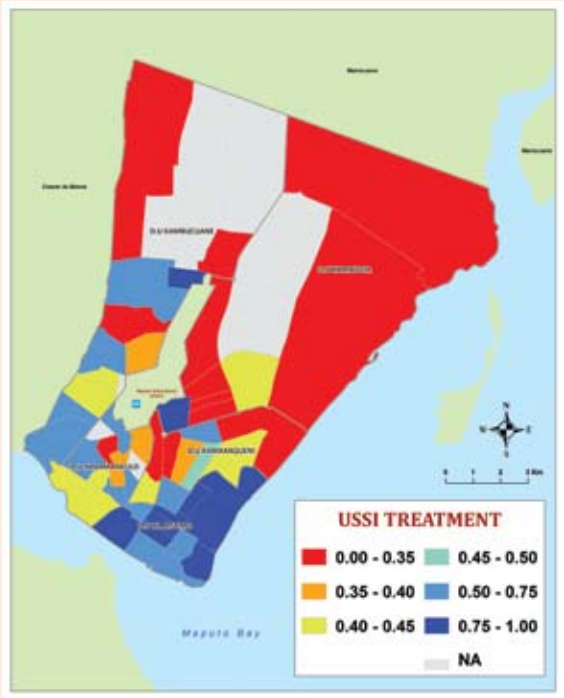
FIGURE 4: USSI COMPONENTS



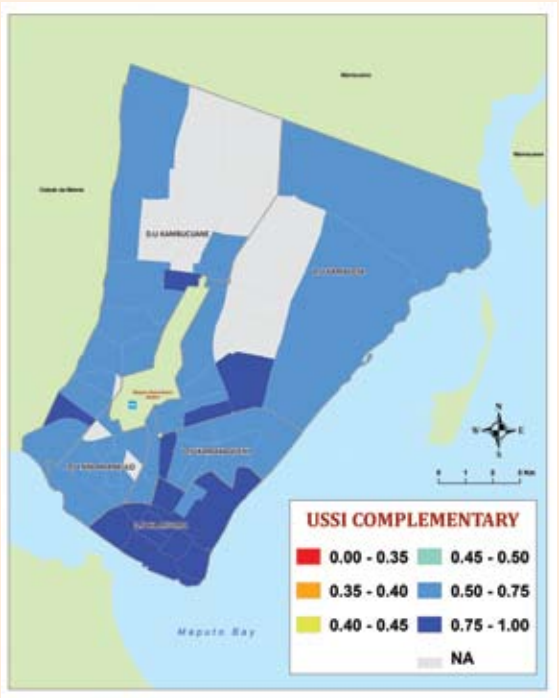
(a) Containment Status



(b) Emptying and Transport status



(c) Treatment and Final Disposal



(d) Complementary Services (solid waste, drainage)

4.2 USSI Emptying and Transport

The USSI for emptying and transport was measured using two different indicators, namely, access to emptying services and transport safety. These revealed a considerably worse scenario than for containment, with a low average value of 0.528, see Figure 4b. Eighteen of the 47 neighborhoods showed a critical situation in terms of emptying and transport (USSI values below 0.500). This clearly indicates that the transport of fecal material is far from adequate. A closer look at the data reveals that the major challenge in this component is the emptying of latrines. Whether due to limitations on access by mechanical equipment, availability of improved services, or possibly capacity to pay for improved services, manual latrine emptying and replacement are the most common practices in the neighborhoods with a low score for this component. These practices may have a negative impact on public health and groundwater quality, as they are mostly undertaken by way of unhygienic and unsafe procedures. Unsafe transport also contributes to these low scores, due to poor equipment maintenance, operation and supervision, which result in spillage of fecal sludge along the access roads. In some cases fecal sludge is dumped directly into the drainage system and/or solid waste containers instead of being transported to the treatment plant.

As for containment, the ANOVA test indicates that the USSI values for emptying and transport are significantly correlated with the geographic location of the neighborhood and the average household monthly income. City center neighborhoods score 0.908 on average, whilst the average for peri-urban neighborhoods is 0.485. The neighborhoods with low average household monthly income also score worse in this component than the those with higher income. A significant and positive correlation was also identified between mean neighborhood household income and the access to emptying services indicator.

4.3 USSI Treatment and Disposal

The treatment and disposal component was evaluated according to the type of treatment and final disposal of the fecal sludge. The results (Figure 4c) show that treatment of fecal sludge is highly inadequate. The average USSI treatment score is 0.449, and more than half the neighborhoods scored less than 0.500. The main reason behind this critically low value is lack of adequate treatment facilities for fecal sludge and inadequate treatment at the existing waste water treatment works; only 3% of the fecal waste is currently treated properly. The waste treatment indicator averages 0.232 and that for final disposal 0.721. Only 5 neighborhoods had scores higher than 0.500 for the waste treatment indicator.

As for the other USSI components, the effect of location and socioeconomic variables was analyzed, and again, higher values were found in the city center and the wealthier neighborhoods. City center neighborhoods scored 0.744 on average, compared to the peri-urban neighborhoods, which averaged 0.431. The service delivery efficiency for treatment and disposal increases as the average household income in the neighborhood increases, and there are significant differences in the USSI treatment and disposal values even between the poorest neighborhoods.

4.4 USSI Complementary Services

The complementary services were measured against two sanitation indicators – solid waste management, and stormwater/grey water management – based on the operability of the stormwater drainage system and the solid waste management system in each of the neighborhoods. In general terms, these complementary services are working fairly well (see Figure 4d). The USSI for complementary services scores 0.682 on average. It is worth noting that the main problem with the complementary services is with the drainage system rather than solid waste management. The stormwater/grey water management indicator scores lower than 0.500 in 12 neighborhoods.

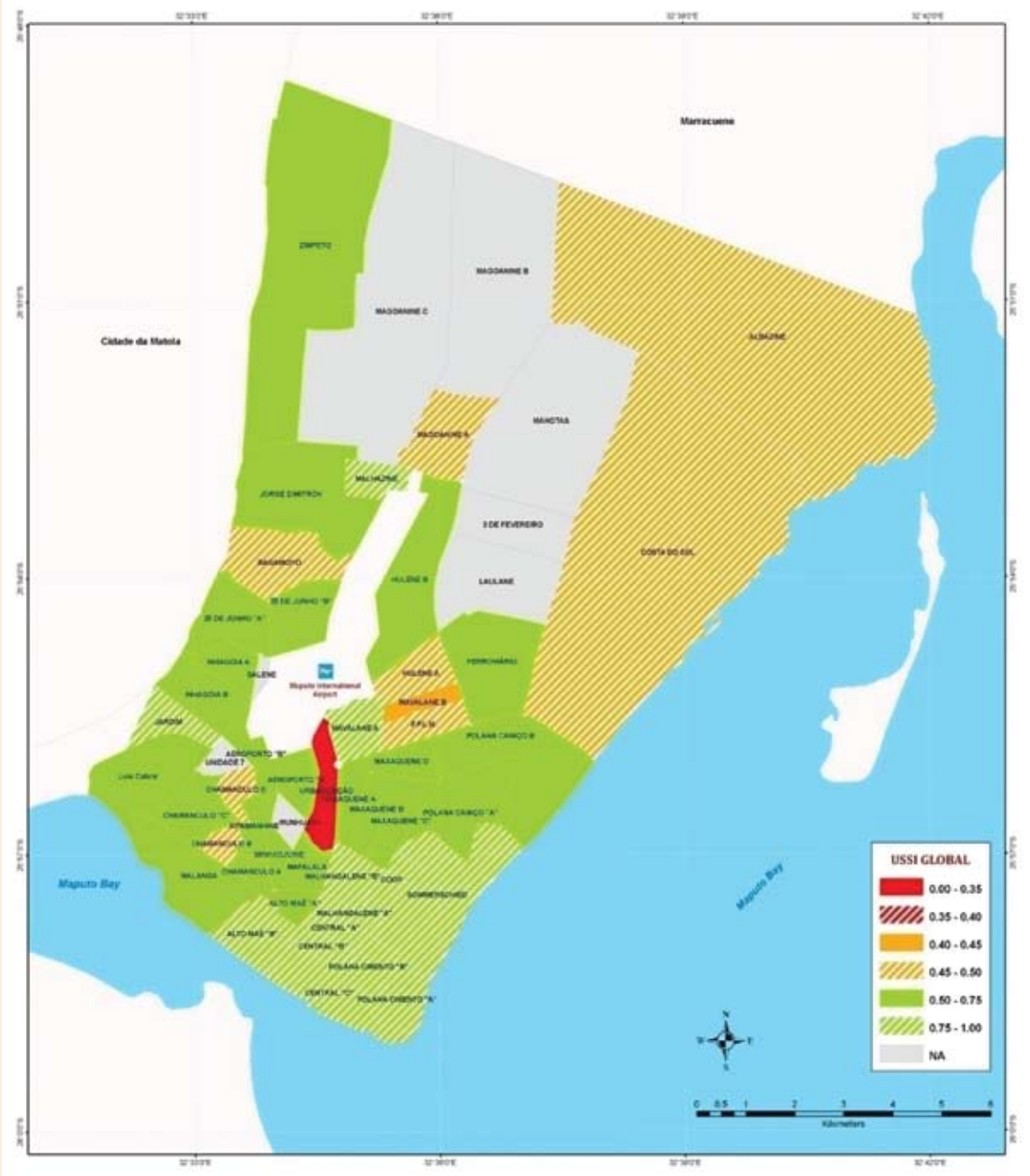
The ANOVA test indicated that neighborhood location and average household income also influence the status of complementary services. The city center neighborhoods score 0.829 on average, whilst peri-urban neighborhoods score an average of 0.676. The USSI for complementary services increases as the average household income in the neighborhood increases, as does the stormwater/grey water management indicator.

4.5 USSI Global – Aggregated Index

The four USSI components were aggregated in a single index (global USSI) to obtain an integrated overall picture

of sanitation status in Maputo city. The global USSI map (Figure 5) shows the results obtained for this composite indicator. The average value for the USSI across the city is 0.609. Despite this medium to high value, it is worth highlighting that there are two major constraints that undermine the sanitation status of Maputo, namely: a) emptying and transport, and b) treatment and disposal.

FIGURE 5: GLOBAL USSI



Thus, in order to improve the overall sanitation status of Maputo city, these two components of the sanitation service chain should be prioritized. The USSI map shows 10 neighborhoods with poor sanitation status characterized by scores below 0.500. Urbanização has the lowest global USSI in the city (0.321).

As for the components, the relationships between the global USSI and the structural and socioeconomic characteristics of the neighborhoods have been also analyzed using an ANOVA test. The results indicate that there are positive correlations between the geographical location, average household monthly income and the USSI value. City center neighborhoods score 0.839 on average, whilst the peri-urban neighborhoods score an average of 0.574. The USSI value also increases with average household income, showing that the quality of sanitation service delivery is worst in the poorest neighborhoods.

5. Lessons Learned and Way Forward

The USSI generates an integrated picture of the sanitation service chain, as well as measuring its performance

The USSI has the potential to contribute both to the analysis of the full sanitation service chain at neighborhood level and to the strategic prioritization of sanitation investments. The Urban Sanitation Status Index presented here captures both the containment component of the sanitation service chain ("access") and the services delivered further downstream along the sanitation service chain. The USSI can present both the big picture of sanitation status and an indication of how service delivery is working.

The sanitation status evaluation carried out in Maputo city using the USSI indicates that the main problems at neighborhood level are those related to emptying, transport, treatment and disposal of fecal sludge. Emptying and transport represent a major challenge in 18 of the 47 neighborhoods, whilst treatment and disposal are inadequate in more than half of the neighborhoods. The results obtained indicate that sanitation status becomes progressively worse along the sanitation service chain, with containment being fairly good and treatment poor. In the case of Maputo, this evidence shows that the containment component, which depends on household investment, is working better than the downstream components of emptying and transport, and treatment and disposal, where public expenditure is required. The Mozambican strategic documents linked to the sanitation sector, the 2007 Water Policy and the 2011 National Urban Water and Sanitation Strategy, clearly state that the containment component is a household responsibility, whilst the remaining steps in the sanitation service delivery chain should be viewed as a public responsibility.

It should be highlighted that sanitation status varies considerably among the different neighborhoods analyzed. The statistical analyses carried out showed significant variations in sanitation status between the city center (with fairly good USSI scores) and the peri-urban areas (low USSI scores, both for individual components and overall). These results are consistent with those obtained using the fecal waste flow diagram; it could therefore be argued that the USSI results are robust and reflect the real sanitation status of the city. The geographical variation in the USSI values is also positively correlated with the average household monthly income in each neighborhood, with the poorest neighborhoods having the lowest scores and highest priority for intervention.

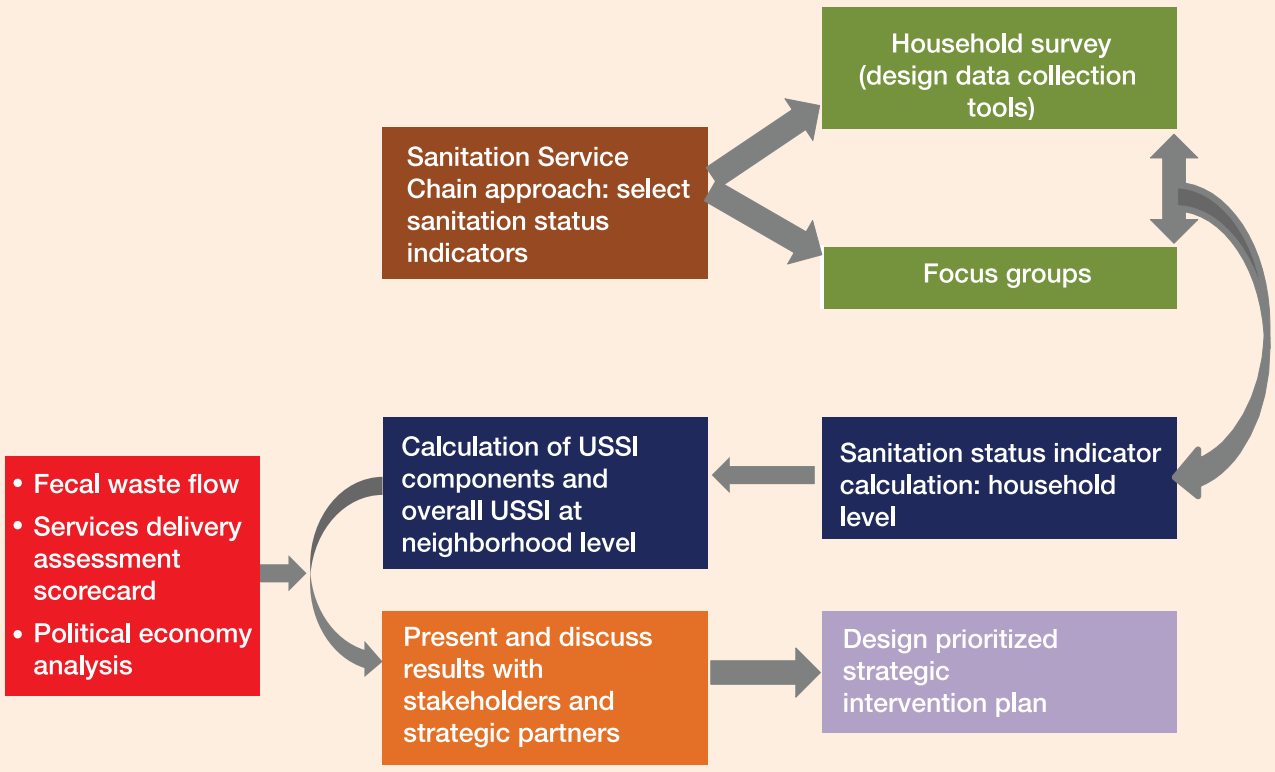
USSI enables the complex sanitation situation to be easily presented to decision-makers to provide strategic guidance. It can be used as participatory planning tool for prioritizing interventions, and for project monitoring and evaluation.

The USSI can be used as a tool to monitor sanitation status over time at neighborhood level as well as to identify the main weaknesses in the sanitation service chain. It has good potential as a strategic guidance tool for sanitation managers and decision-makers, supporting the prioritization of interventions in neighborhoods with low USSI values. Maps of the four USSI components allow the comparison of sanitation status neighborhood by neighborhood, and help to indicate which interventions would be most useful for each neighborhood. The tool could be of potential interest for both municipalities planners, and for regulators to benchmark and monitor the sanitation status of cities over time. The involvement of strategic partners and end users is fundamental in evaluating sanitation status and also in planning interventions.

USSI should be used in urban sanitation planning together with other diagnostic and risk analysis tools. Despite the USSI being an useful tool, it should not be used in isolation. The USSI does not provide information about the origins of the problems identified – the "why" of inadequate service delivery. For instance it cannot determine if poor service delivery is due to a lack of operation and maintenance, or to institutional and financial constraints. Thus, the USSI should be used together with other tools to understand city sanitation status, such as the fecal waste flow diagram and fecal sludge management scorecards (Peal et al. 2014). Figure 6 sets out the steps for strategic sanitation planning using a combination of various diagnostic tools (USSI, fecal waste flow diagram, service delivery scorecards, political economy analysis).

It is suggested that the tool could be augmented to include these other important aspects of sanitation service delivery, such as governance and political economy. The number of variables and indicators making up the index could be increased in order to obtain a more holistic and representative view of sanitation status. The indicators could also be adapted for use in a global context, as compared with the current indicators designed to reflect the specific conditions in Maputo. It might thus be useful to develop a wider set of sanitation service chain indicators that could be adapted to different sanitation contexts.

FIGURE 6: INTEGRATED STRATEGIC SANITATION PLANNING



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