An international partnership to help poor people gain sustained access to improved water supply and sanitation services

A Review of Fecal Sludge Management in 12 Cities

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FINAL DRAFT

Prepared by:
Andy Peal and Barbara Evans
with
Isabel Blackett, Peter Hawkins and Chris Heymans

For WSP Urban Global Practice Team

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Acronyms and abbreviations

Latin America and the Caribbean

AAPS	Autoridad de Fiscalizacion y Contro; Social de Agua Potable y Saneamento Basico (Authority for Oversight and Social Control of Drinking Water and Basic Sanitation) (Bolivia)
ENACAL	Empresa Nicaragüense de Acueductos y Alcantarillados (The National Aqueduct and Sanitation Company of Nicaragua) (Nicaragua)
MARENA	Ministry of Environment and Natural Resources (Nicaragua)
MINSA	Ministry of Health (Nicaragua)
SAGUAPAC	Cooperativa de Servicios Publicos Santa Cruz Ltda (Public Services Cooperative Ltd. of Santa Cruz) (Bolivia)
SANAA	Servicio Autónomo Nacional De Acueductos Y Alcantarillados (National Autonomous Water and Sewerage Service) (Honduras)

Africa

AAAS	Association des Acteurs de l'Assainissement du Sénégal (Pit emptiers Association of Senegal) (Senegal)
AIAS	Water Supply and Sanitation Infrastructure Management Office (Mozambique)
CMM	Maputo Municipal Council (Mozambique)
CRA	Conselho de Regulaçao da Água (Mozambique)
DAS	Water and Sanitation Department (CMM, Mozambique)
DNA	National Water Directorate (Mozambique)
DWRM	Directorate of Water Resources Management (Uganda)
KCC	Kampala City Council (Uganda)
NEMA	Ministry of Environment (Uganda)
NWSC	National Water and Sewerage Corporation (Uganda)
ONAS	Office National de l'Assainissement du Sénégal (Senegal)
PAQPUD	Project d'Assainissement dans les Quartiers Périurbains (Senegal)
PEA	Private Emptiers Association (Uganda)
SDE	Senegalaise Des Eaux (Senegal)

South Asia

DNCC	Dhaka North City Corporation (Bangladesh)
DPHE	Department of Public Health Engineering (Bangladesh)
DSCC	Dhaka South City Corporation (Bangladesh)
DSK	Dustha Shystha Kendra (Bangladesh)
DWASA	Dhaka Water and Sewerage Authority (Bangladesh)
GoB	Government of Bangladesh
GoI	Government of India
MoLGRD	Ministry of Local Government, Rural Development and Cooperatives (Bangladesh)
MOUD	Ministry of Urban Development (India)
NUSP	National Urban Sanitation Policy (India)
PSTC	Population Services and Training Centre (Bangladesh)

SACOSAN	South Asian Conference on Sanitation
ULB	Urban Local Body (India)

East Asia

BAPPENAS	National Development Planning Agency (Indonesia)
BLH	Local Environment Agency (Indonesia)
CWA	Clean Water Act (Philippines)
DENR	Department of Environment and Natural Resources (Philippines)
DKP	Dinas Kebersihan dan Pertamanam - Sanitation Agency (Indonesia)
DOH	Department of Health (Philippines)
DPWH	Department of Public Works and Highways (Philippines)
LGU	Local Government Unit (Philippines)
LINAW	Local Initiatives for Affordable Wastewater Treatment project(Philippines)
MIME	Ministry of Industry Mines and Energy (Cambodia)
MoE	Ministry of Environment (Cambodia)
MoE	Ministry of Environment (Indonesia)
MoH	Ministry of Health (Indonesia)
MoLMUP	Ministry of Land Management and Urban Planning (Cambodia)
MPW	Ministry of Public Works (Indonesia)
MPWT	Ministry of Public Works and Transport (Cambodia)
NSSMP	National Sewerage and Septage Management Program (Philippines)
PDAM	Perusahaan Daerah Air Minum - Water Utilities (Indonesia)
PPSP	Acceleration of Sanitation Development in Human Settlements Program (Indonesia)
PU	Menteri Pekerjaan Umum - Ministry of Public Works (Indonesia)
IPLT	Instalasi Pengolahan Lumpur Tinja - septage treatment facilities (Indonesia)
UPTD	Unit pelaksana teknis daerah - local technical implementation unit (Indonesia)
MWCI	Manila Water Company (Philippines)
MWSI	Maynilad Water Services Inc (Philippines)

General

CSO	Country Status Overviews
SDA	Service Delivery Assessment
GLAAS	Global Assessment of Water Supply and Sanitation
SWA	Sanitation and Water for All
BMGF	Bill and Melinda Gates Foundation
FS	Fecal Sludge
FSM	Fecal Sludge Management
FSTP	Fecal Sludge Treatment Plant
FW	Fecal Waste
JMP	Joint Monitoring Programme of WHO and UNICEF
LAC	Latin America and the Caribbean
LIC	Low Income Country

NGO	Non-Government Organisation
OD	Open Defecation
ODF	Open Defecation Free
PUA	Peri-Urban Area
UGPT	Urban Global Practice Team (of the Water and Sanitation Program)
WASH	Water, Sanitation and Hygiene
WSP	Water and Sanitation Program
WSUP	Water and Sanitation for the Urban Poor
WWTW	Waste Water Treatment Works
DEWAT	Decentralized Wastewater Treatment System

1. Introduction

1.1. Why is fecal sludge management important?

Globally a huge number of people rely for their sanitation on non-sewered systems which generate a mix of solid and liquid wastes generally termed ‘fecal sludge’ (Box 1). Particularly in poor and rapidly expanding cities this fecal sludge represents a growing challenge, generating significant negative public health and environmental risks. Without proper management fecal sludge is often allowed to accumulate in poorly designed pits, or is discharged into storm drains and open water, or is dumped into waterways, wasteland and insanitary landfill sites. Only a tiny percentage of fecal sludge is managed and treated appropriately.

Box 1: Fecal Sludge Vocabulary

What is fecal sludge?

Fecal sludge (FS) is the general term given to undigested or partially digested slurry or solids resulting from storage or treatment of blackwater or excreta.

What is fecal sludge management?

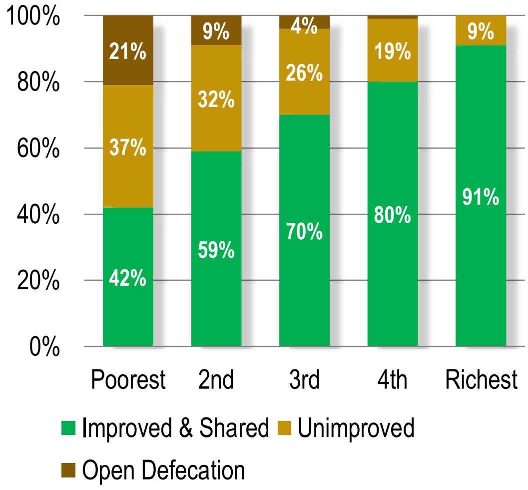
Fecal sludge management (FSM) is the management of fecal sludge contained within non-sewered sanitation systems such as pit latrines and septic tanks. Non-sewered sanitation is also commonly referred to as on-site sanitation because the containment facilities are situated within the plot occupied by a dwelling or its immediate surroundings. In contrast, wastewater management is concerned with sewered sanitation only.

Source: adapted from Eawag/Sandec, 2008

The problem is significant for many cities. International data reported by JMP shows increasing numbers of the urban population now have access to improved sanitation (UNICEF/WHO, 2012). However, this conceals three important points:

- Firstly, in developing countries urban sanitation access is achieved mostly through on-site sanitation systems. For instance, in Sub-Saharan Africa among utilities serving the largest cities, only half of them report operating a sewerage network at all and most of these serve less than 10 percent of the population (Morella et al, 2009). More than half of urban Africans rely on traditional latrines, and eight percent have no toilet at all.
- Secondly, poorer people typically are heavily reliant on informal or unmanaged onsite systems. Figure 1 shows how urban people in Sub-Saharan Africa access sanitation; more than half of the poorest 20% rely on unimproved sanitation or have no toilet at all. Even in regions doing relatively well in terms of overall access, for instance in Latin America and the Caribbean (LAC), there is still a substantial reliance on unplanned onsite systems and even some open defecation in many cities (nearly 2 million urban Brazilians practice open defecation for example, and a further 28 million rely on unimproved or shared toilets (UNICEF/WHO, 2012)). In all regions inadequate and *ad hoc* services are concentrated in slums and informal settlements **(**Morella et al, 2009; and IBNET, 2013**).**
- Thirdly, the fecal waste from the on-site sanitation facilities rarely reaches a treatment facility for safe reuse or legal disposal; in general safe management of

fecal waste downstream of the household is severely neglected. This is true even where households have what is termed an 'improved' toilet.



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Source: UNICEF/WHO, 2012

Figure 1: Urban sanitation in Sub-Saharan Africa by wealth quintile

In summary, in many 'poor' cities across Africa, Asia and LAC improving sanitation is predominantly a matter of fecal sludge management (FSM) but crucially few cities have the management structures, institutional arrangements, infrastructure, skills, or financial systems to deliver this aspect of urban sanitation and it consequently remains a significant but largely neglected and ignored challenge.

1.2. Previous work on FSM

The international sanitation community has focused considerable effort on solving the FSM challenge; recent notable work includes research by Eawag/Sandec into excreta and wastewater management (see Eawag/Sandec, 2013) in various locations, including Burkina Faso, Ghana, Mali, Senegal and Vietnam (Strauss et al, 2006 and Strande, 2012). Similarly, research by universities in USA and Europe on a broad range of technical issues is ongoing; but until field-testing in realistic market conditions is undertaken, the usefulness of this work remains unknown. In addition, organisations such as WSUP and Water for People currently support initiatives in an increasing number of cities (see WSUP, 2013 and Water for People, 2013). The Bill and Melinda Gates Foundation have provided much of the funding for this work, including a 10-country study on business models for emptying, and transportation services in Africa and Asia (see Chowdry and Kone, 2012) while another notable study includes USAID's funding of a seven-country review of septage management in Asia (see USAID, 2010).

In general, the broad focus of these initiatives is on the:

- Challenge of emptying badly designed pits, septic tanks and other containers.
- Need for improved management of pit emptying.
- Need to institutionalise collection and transport processes.
- Need for business models for fecal sludge management.
- Need for more and more appropriate treatment capacity.
- Need for improved reuse of treated fecal sludge.

In summary, much of this work focuses on specific technical interventions with limited analysis on the overall status of FSM on a global scale or of providing an understanding of how the challenges vary from city to city. For instance, a key observation made by practitioners at the October, 2012 Fecal Sludge Management Conference (FSM2) organised by the Water Research Commission in Durban, South Africa (SuSanA, 2012), was that despite the fact that most of the presentations and discussion at the conference centred around scientific and technical issues, it is the underlying policy, regulatory, institutional and financial issues which need to be addressed if FSM is to be improved (Hawkins, 2012). Indeed, a recent WSP Urban Sanitation Scoping Study observes that "much more needs to be learnt and done" and specifically identifies FSM as one of the four key challenges in improving poor-inclusive urban sanitation services (Colin et al, 2012).

Building on this, the Water and Sanitation Program's Urban Global Practice Team (UGPT) commissioned this study to examine global trends in FSM using 12 city case studies as a basis. The objective is to identify specifically where deeper analysis and study is needed; develop analysis tools that can be used to assess FSM at the city level, and identify appropriate operational interventions.

1.3. Review of 12 cities

The study is based on 12 cities (see Table 1). They were selected to represent a regional spread, size and type of city and different level of existing formal service delivery. The smallest city is Dumaguete in Philippines with a population of 120,000 while the largest is Delhi with more than 16 million inhabitants.

The extent of access to sewerage services ranges from a high of 81% in Honduras (indicated here by 19% using on-site systems/open defecation) to a low of 9% in Kampala, Uganda (91% on-site/open defecation) and the two smaller towns: Palu, Indonesia and Dumaguete, Philippines have no sewerage at all – 100% on-site sanitation/open defecation.

Table 1: The 12 city case studies

Region	Latin America & Caribbean			Africa		
Country	Bolivia	Honduras	Nicaragua	Mozambique	Senegal	Uganda
City	Santa Cruz	Tegucigalpa	Managua	Maputo	Dakar	Kampala
Population (M)	1.7	1.3	2.0	1.9	2.7	1.5
% On-site/OD	60%	19%	61%	90%	75%	91%

Region	South Asia		East Asia			
Country	Bangladesh	India	Cambodia	Indonesia	Philippines	
City	Dhaka	Delhi	Phnom Penh	Palu	Dumaguete	Manila
Population (M)	16	16.3	1.6	0.35	0.12	15.3
% On-site/OD	80%	25%	75%	100%	100%	88%

Sources: all data sources provided in city profiles in Annexure 1.

1.4. Data issues

The poor availability of reliable data on sanitation use and FSM in particular was a major constraint to the review. The study was rapid and desk-based. Although the cities were selected in part because they had already been subject to some analysis of FSM, in fact the quality of the available data was generally rather low. Much of the analytical work already done is itself cursory in nature, and there is a paucity of reliable representative technical information. Data are often contradictory and rarely disaggregated in a useful way. Very few documents were found that contained useful or reliable data on the various cities to enable the data to be crosschecked and triangulated rigorously.

Consequently, the study is based on secondary data supplemented with interviews with key informants. The report clearly indicates all data sources and references and, where key data was found to be lacking, the inferences and assumptions made. It should therefore be noted that the reliability of the data at the detailed level cannot be guaranteed.

1.5. The report

The report is comprised of five sections and annexures:

Section 1 introduces the report and provides the background to why fecal sludge management is important.

Section 2 describes the study tools and methods used.

Section 3 looks at the results or key findings of the research.

Section 4 includes a discussion of how the findings can be used at the operational level to inform policy and recommendations on how to address critical knowledge gaps.

Finally, section 5 presents the conclusions drawn from the research.

Annexure 1 includes short case studies on each of the 12 cities.

2. Study tools and methods

2.1. Introduction

This section describes the tools and methods used to carry out the study: firstly, how the service delivery assessment process was modified to assess both the framework for and the actual FSM service delivery in each city; and secondly, how a diagrammatic method was used to analyse and illustrate the physical flow of fecal waste through each city.

2.2. Service delivery assessment

The service delivery assessment process and accompanying tool (which is known as SDA and also CSO in Africa and MAPAS in LAC) was developed to assess the quality of service delivery of urban, rural, sanitation and water sectors at national level and has now been used in 32 African countries as well as in LAC, South Asia and in East Asia and the Pacific. It is an analytical framework to measure the quality of the enabling environment, the level of service development (primarily investment) and the level of commitment to service sustainability. An example of a SDA scorecard for urban sanitation in Uganda is shown in Figure 2.

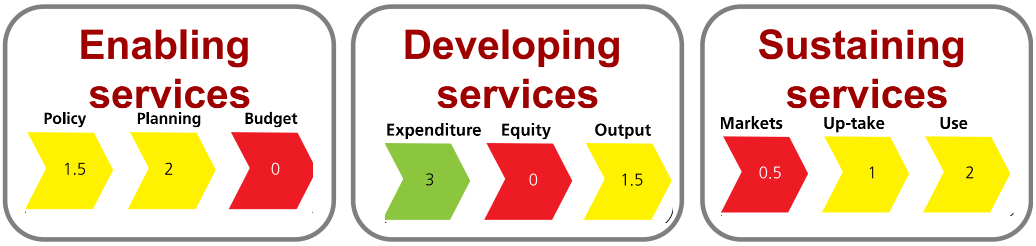


Figure 2: Example of typical service delivery assessment (SDA) scorecard for urban sanitation (this is for Uganda)

The scorecard tool forms the basis for international comparisons of sector performance at the national level and results are used to inform, for example, the Global Assessment of Water Supply and Sanitation (the GLAAS) and the work of Sanitation and Water for All (SWA).

For this study we used an adapted version of the scorecard to analyse FSM service delivery at the city level. The tool generates a score ranging from zero (worst case) to three (best case) in response to a set of specific questions relating to the enabling environment, development of services and sustainability of services with a red, amber, green colour coding used to highlight the scores. The tool used is shown in Figure 3.

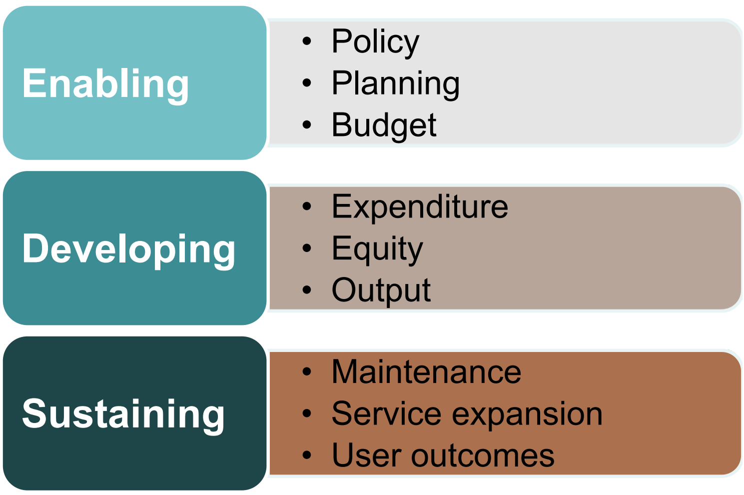


Figure 3: SDA scorecard adapted to analyse FSM service delivery at the city level

2.3. Sanitation service chain[1]

In conjunction with the SDA scorecard the sanitation service chain shown in Figure 4 was used in the study to reflect that urban sanitation is comprised of several parts. At one end is containment – largely a household investment decision relating to a private or shared toilet with transactions that are usually small and managed and financed at the household level. At the other end is treatment and reuse/disposal - typically this is a publicly provided service – and a large lumpy investment.

Figure 4: Sanitation service chain

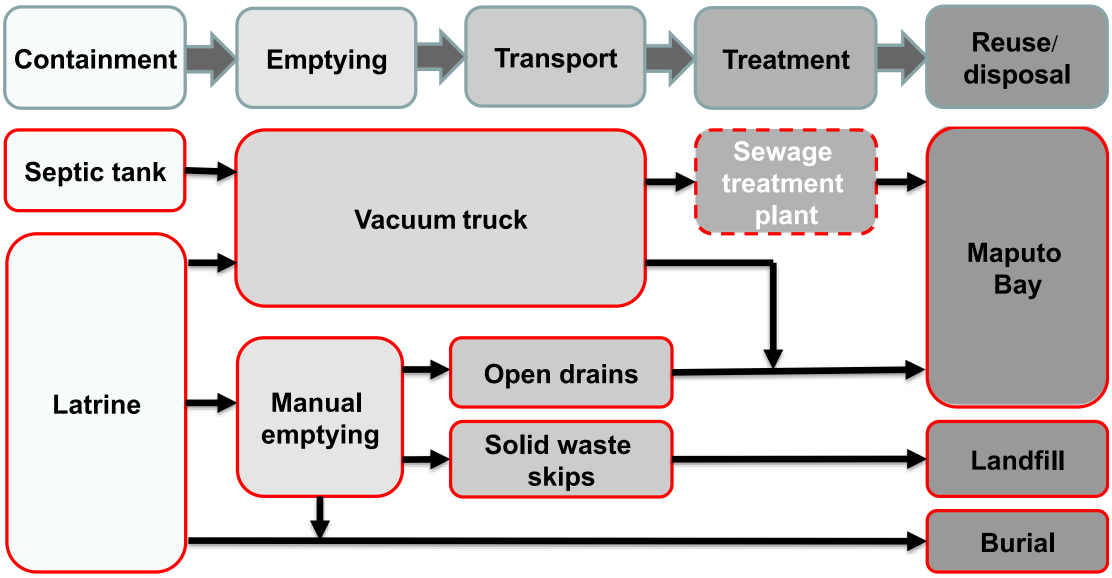
In conventional sewerage (Figure 5), these are connected by a publicly operated sewer service that is normally, or ideally bundled with treatment.

Figure 5: Simple sanitation service chain for sewerage

An FSM service to support on-site services could also be simple (Figure 6) but for most cities the situation is often much more complicated than this. Figure 7 is a representation of how fecal waste flows in on-site sanitation systems in Maputo, Mozambique - from containment in latrines and septic tanks to a range of ultimate disposal points – mostly Maputo Bay. With so many services and the potential for different stakeholder involvement the standard SDA framework needs modification to better understand FSM service delivery along the sanitation service chain.

Figure 6: Simple sanitation service chain for FSM

[1] The term 'value chain' is often used synonymously with 'service chain' (Trémolet, 2011) but in this study the term 'service chain' is preferred.



Source: adapted from Muximpua and Hawkins, 2011

Figure 7: Sanitation service chain for Maputo, Mozambique

2.4. Modified SDA/sanitation service chain

The modified SDA/service chain tool is shown in Figure 8. For this study, in each city, this two-dimensional matrix was used to examine the service delivery framework of FSM at each step of the sanitation service chain.

The advantage of this tool is that it enables the identification of bottlenecks and gaps at any point along the service chain and a focus on whether the issues are in the enabling environment, or in service development or sustaining. Therefore, it is a sharper tool to facilitate better understanding of the barriers preventing formal, safe FSM service delivery in any city.

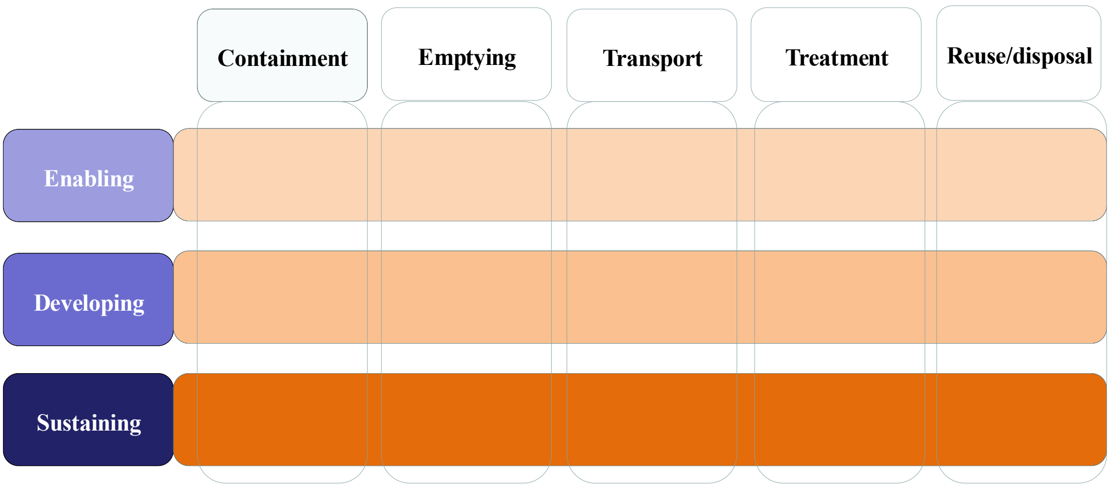


Figure 8: SDA/service chain scorecard modified for FSM

2.5. Tracking fecal waste flows

The second concept used in the study was used to develop a simple method to enable tracking, as well as possible, how fecal waste physically flows through the system. For this purpose a fecal waste flow matrix and fecal waste flow diagram were developed that aim to summarize the net effect of the FSM system in each city. The matrix and diagram help to check on outcomes at the city-level that are reported both in documents and by colleagues and that were included in the SDA scorecard analysis; they also clearly highlight the real bottlenecks to FSM[2].

An example of the fecal waste flow matrix is shown in Figure 9 and an example of the fecal waste flow diagram used is shown in Figure 10 with waste 'flowing' from left to right. In this example (which is again for Maputo, Mozambique) a large percentage of fecal waste is generated in non-sewered systems. As it flows downstream, fractions of the waste drop out of the idealized system at various points and reach unsatisfactory disposal points – some through illegal dumping, some through defective treatment (and even some through defects in the sewerage system which is included in the analysis)[3]. The relative size of the red bar on the right hand side (which reports on ultimate disposal points) indicates how badly this particular system is performing.

Clearly, the accuracy and robustness of the data used will impact on the complexity of the analysis but even where limited primary data is available the tool can be used to provide an overview of the situation.

For the study, and in the absence of fieldwork and accurate data, a process of considered use of best estimates based on available data, expert opinions and thorough checking with field-based staff was used to derive a fecal waste matrix and a fecal waste flow diagram for each city.

Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 46%**
Sewered (off site centralised or decentralised)	9%	100%	25%	50%	**1%**
On-site containment - permanent/emptiable	47%	20%	48%	50%	**2%**
On-site contanment - single-use/not emptied/safely abandoned	43%	100%	100%	100%	**43%**
Open defecation	1%	0%			
Unsafe: 56%		**39%**	**12%**	**3%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Figure 9: Example of fecal waste flow matrix (for Maputo, Mozambique)

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[2] The flow diagram developed and used is similar to concepts developed independently by Scott (2010) in Dakar, Senegal who uses the term 'sanitation cityscape' and also by Whittington et al (1993) in Kumasi Ghana. Other similar frameworks and approaches may also exist.

[3] The defects reported in the sewerage system are mostly due to broken down pumping stations. The defective treatment reported is either a) where the installed capacity is insufficient so some waste is treated and some not at all; b) where a generally defective treatment plant is operating well below its design capacity so waste is treated ineffectively; or c) a combination of a) and b).

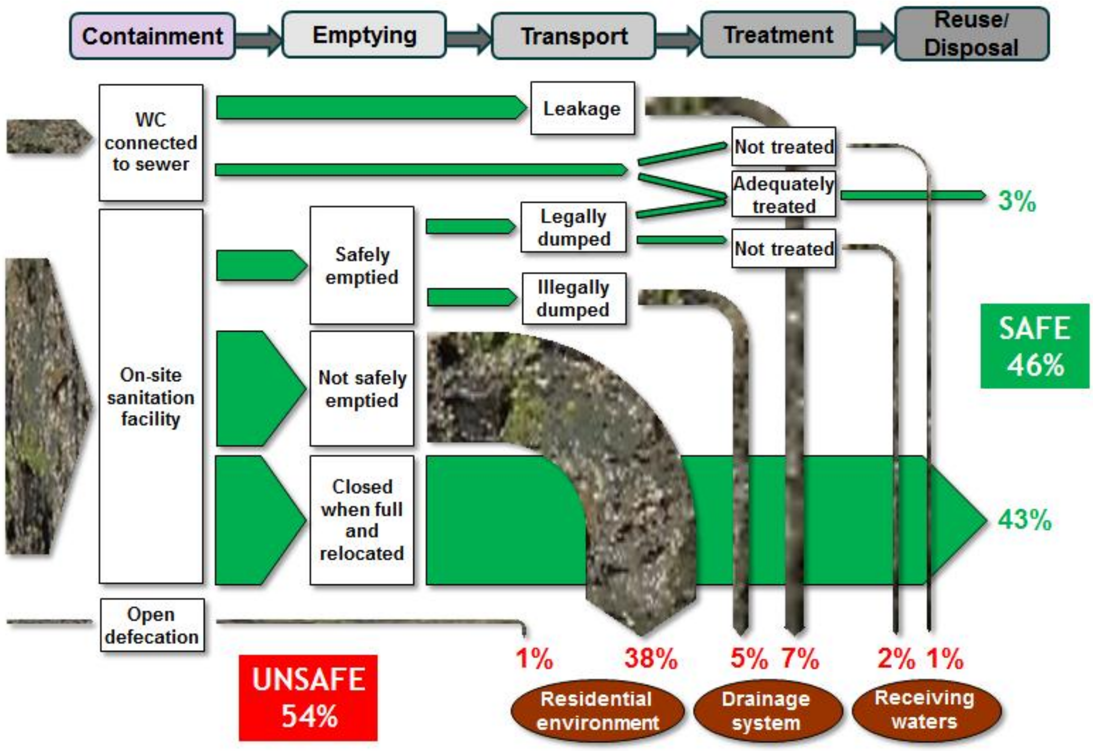

Figure 10: Example of fecal waste flow diagram (for Maputo, Mozambique)

An animated version of the fecal waste flow diagram has been developed for use in presentations.

3. Key findings

3.1. FSM service delivery performance is poor

The level of data collected and made available by city authorities is poor, often contradictory and rarely disaggregated in a useful way. However, it is clear from the study that FSM service delivery performance is generally poor. Table 2 contains a summary of the level of service being delivered in each city. The following significant observations stand out in the table:

- The quality of household containment is generally poor and adversely affects owners' ability to have their units emptied when they fill up. Poor quality pits are often abandoned unsafely with consequential risks to the environment and public health. This situation was reported in all in all but two of the cities - Dumaguete, Philippines and Palu, Indonesia.
- Similarly, illegal dumping by private manual and mechanical pit emptiers into the sea, rivers, wasteland and landfill sites was found to be common in all but the two same cities - Dumaguete and Palu.
- Except in these same two cities in Indonesia and the Philippines, municipalities and utilities rarely provide an emptying and transport service – in most cities the informal private sector steps in to fill this gap (Annexure 2 contains more information).
    - In South Asia and particularly in Africa manual emptying by local 'contractors' predominates;
    - In LAC and East Asia mechanical emptying using vacuum trucks is the norm.
- There is a lack of FSM treatment facilities. Where treatment facilities exist they are rarely dedicated to FSM; the exceptions are Palu, Indonesia; Dumaguete and Manila, Philippines; Dakar, Senegal; and Kampala, Uganda[4]. Usually fecal sludge is simply dumped into the existing wastewater treatment plant which may in turn jeopardize the ability of the process to treat the waterborne sewage properly.
- Only two cities were found that have any mechanism for formal reuse of treated sludge: Dumaguete and Manila in the Philippines. However, in neither city is the activity well developed or raises a profit; in Dumaguete the treated FS is given away free of charge while in Manila the process reportedly accounts for a large percentage of the overall FSM operating expenses.

3.2. FSM is invisible to policy makers

The study found little 'deliberate' FSM – any services provided tend to be informal and outside of public sector control. None of the cities we looked at scored maximum points across all aspects of the enabling environment (see the FSM scorecards in Annex 1 – city profiles); most of them had low scores for policies, planning and budgeting around all elements of the service chain indicating the low priority placed on this aspect of urban sanitation in most countries. Possible reasons for this include:

- FSM is largely seen as a 'temporary' or stop-gap solution and primarily for illegal or informal settlements. This is reflected in cities where provision has been made for some limited management of fecal sludge (through for example the purchasing of a small number of vacuum trucks) but this is not reflected in policy which remains focused on long-term provision of sewerage.[5] In fact this review

[4] The Bugolobi treatment works has recently been revamped to handle 200m^3/day of FS (Mutono, 2013).

[5] It is also often reflected in local building regulations and/or technical standards which fail to specify appropriate onsite systems but are predicated on the assumption that new housing will be provided with networked sewerage.

bolsters the general evidence that shows that FSM is often a long-run solution and that the private sector may sometimes be quicker to recognize this than public policy makers: there is evidence of FSM services being provided by private companies in some cities for over 20 years (e.g. in Santa Cruz, Bolivia; Managua, Nicaragua; and Phnom Penh, Cambodia).

- Usually sewerage is seen as the 'proper' solution. Drivers include the technical bias instilled during engineer training, and the structure of conventional investment projects that may favour simple, single lumpy investments over ongoing service delivery.

3.3. Sludge accumulation and emptying rates vary

3.3.1. Sludge accumulation rates

The study also observed that sludge accumulation rates vary significantly and consequently have a differential impact on public health and environmental risk.

High rates of fecal sludge accumulation are seen in many places (for instance in Kampala, Uganda and Maputo, Mozambique) where pits fill rapidly. This is typically due to one or more of the following reasons:

- A large number of users per pit,
- The use of sealed tanks, clay or other impermeable soils, and/or high water tables;
- The use of solid materials for anal cleansing; and
- The addition of refuse.

Water usage and other external factors may also increase the rate of sludge accumulation.

In a few cases sludge accumulation rates are relatively low. For instance in Palu, Indonesia only an estimated 10% of the 50,000 household containment systems will need emptying in the short or medium term. 90% of the containers are either built very large and will take a long time to fill; and/or are open-bottomed pits which percolate efficiently, so accumulation rates are low. However, the fecal sludge treatment facility provided is designed for a much larger loading and currently operates at less than a third of its installed capacity.

This 'technical' issue is critical for policy makers since it determines the capacity requirements along the service chain; it is almost impossible to generate internationally valid 'norms'. Accumulation rates at the household level determine the requirements of emptying and transport (both total capacity and the nature of the fecal sludge to be emptied and transported) and these in turn have an impact on what types of treatment are required.

3.3.2. Management of full containers

In addition, the study also found that there is great variation in how users manage their "container" once it becomes full. In some situations the fecal sludge remains buried – the user safely covering the pit once it is full.[6] This is considered a safe system of disposal and is shown on the waste flow diagram as a "yellow bar" as the sludge is not collected, transported or treated but is safely disposed of. However, it is only suitable where space allows and is therefore more common on the urban fringes rather than in dense slums.

Where space is limited some users adapt their containers so that they can continue using them even when they are full by allowing the contents to overflow into an open drain or local informal sewer. The drain or sewer then discharges unsafely to the environment via a river or drain without treatment (this arrangement is common in Dhaka Bangladesh).

[6] Often this mimics the operation of an 'arborloo' (see Tilley et al, 2008).

This solution is not safe and where practiced it is included within the “red bar” of the fecal waste diagrams indicating that it is unsafely disposed of to the environment.

3.3.3. Scheduled emptying

Scheduled emptying was found only in two cities - Dumaguete and Manila (both in the Philippines) – where a three to five year emptying cycle is operated by the Water District and by the concessionaires respectively. In the majority of the other cities studied regular desludging is unlikely to be of significant benefit; containment remains a mix of septic tanks, pit latrines and cess pits of various sizes and configurations (some of which are sealed and some of which are unsealed and allow percolation of liquid waste to the sub-soil) and consequently rates of sludge build up are likely to vary. While some systems might benefit from being emptied on a regular cycle many others will need to be emptied when they are full and this will be difficult to predict. In general the demand for/need for pit emptying will vary greatly depending on the context within each city.

However, in Dumaguete and Manila household containment is predominantly through water closets connected to septic tanks and the prevalence of containers in both cities that are well-designed, properly constructed, dual-compartment septic tanks is a significant factor in enabling regular desludging to be effectively implemented. In this situation accumulation rates can be more confidently estimated which allows desludging cycles to be more easily planned and organised; especially when combined with promotion of the benefits of their proper use and maintenance.

3.3.4. Analysis of the local context is key

Clearly, these various scenarios underline the importance of assessing the real demand for services and the actual fecal waste flow before investing in any downstream infrastructure in any city. This requires an analysis of not just the accumulation rates but also of the local practices of containment, how households manage their fecal waste and how they cope with full containers.

Table 2: Summary of FSM service delivery along the service chain in each city

Region: Latin America and the Caribbean

City, Country	Containment	Emptying	Transport	Treatment	Reuse/disposal
Santa Cruz, Bolivia	52% of households use on-site sanitation. Quality is very variable with many of them improvised, precarious and built with little regard for technical standards.	Private operators provide a mechanical emptying service which serves 15% of the population who use OSS. There is no manual emptying but it is inferred that two-thirds of remaining pits and tanks are abandoned unsafely or overflow to environment when full and one-third are covered safely when full.	The private operators transport the FS to a water and sanitation cooperative run (SAGUAPAC) treatment plant. 60% of the waste emptied is transported to treatment but the balance is dumped illegally in the environment	The treatment efficiency is understood to be good and 100% of the sludge delivered is treated and discharged. Only 9% of FS generated from OSS is treated.	No formal reuse
Tegucigalpa, Honduras	16% of households use on-site sanitation type facilities; the majority use traditional pit latrines while around one quarter have water closets connected to a septic tank type system.	12% of the population with OSS use a mechanical pit emptying service provided by three private companies and also by the water and sanitation provider - SANAA. There is no manual emptying in Tegucigalpa but it is inferred that two-thirds of remaining pits and tanks are abandoned unsafely or overflow to environment when full and one-third are covered safely when full.	None of the FS is transported to a treatment plant. 100% of mechanically emptied FS is disposed of in sanitary landfills.	No treatment for FS. A SANAA run WWTW treats a small percentage of sewerage production but does not receive FS. 0% of FS generated from OSS is treated.	No formal reuse
Managua, Nicaragua	57% of households use on-site sanitation type facilities; simple [pit] latrines or septic tanks or chambers. A large majority of the on-site sanitation facilities are inadequate and many unhygienic	2% of the population with OSS use a private sector mechanical pit emptying service. There is no manual emptying in Tegucigalpa but it is inferred that two-thirds of remaining pits and tanks are abandoned unsafely or overflow to environment when full and one-third are covered safely when full.	50% of the mechanically emptied FS is transported to the water and sanitation provider's (ENACAL) WWTW. The balance is discharged illegally.	Only 1% of FS generated from OSS is treated at the ENACAL run treatment works.	No formal reuse

Sources: all data sources provided in city profiles in Annexure 1.

Region: Africa

City, Country	Containment	Emptying	Transport	Treatment	Reuse/disposal
Maputo, Mozambique	89% use on-site sanitation with a mix of latrine types of very varied quality; minority are water closets connected to septic tanks.	Manual emptying by private operators predominates (estimated to be 60% of FS generated from OSS) which is ALL illegally buried or dumped locally. Limited mechanical emptying (20% of OSS) by private sector, CBOs and very small amount by Municipality. (Remaining 20% of FS is buried safely)	Transportation mainly by private sector vacuum trucks and smaller Vacutugs (CBOs) used. Illegal dumping is common - estimated that 25% of FS emptied mechanically from OSS is dumped illegally.	No dedicated FSTP. Dumping of FS in Infulene WWTW is permitted; this is operated by Municipality but operates at only 50% efficiency. Only 8% of FS generated from OSS is treated.	No formal reuse
Dakar, Senegal	73% use on-site sanitation. Predominantly pour flush latrines discharging to septic tanks (77%) or pit latrines of various types (14%).	Mechanical emptying by private sector (46% of OSS) and manual emptying with illegal burial and dumping locally (40% of OSS). (Remaining 14% of OSS is buried safely)	Transportation by private sector vacuum trucks. 30% of FS emptied from OSS is dumped illegally.	Three FSTPs run by national sanitation utility – ONAS. Estimated that plants run at 25% efficiency. Overall 25% of FS generated from OSS is treated.	No formal reuse
Kampala, Uganda	90% of households use some form of on-site sanitation – a mix of latrines, septic tanks and cesspits. Many are of low quality and are not emptiable so are abandoned once full.	Manual emptying is very common (30%) and this entire volume of FS is buried or dumped illegally. 50% of pits are abandoned when full (estimated that half of these are abandoned unsafely and half are safely covered) while the remainder are emptied mechanically (20% of OSS).	Transportation by private sector vacuum trucks; municipality vacuum trucks used for sewer cleaning. A nominal amount of illegal dumping (10% of mechanical emptying) is assumed based on reports by KCC and NWSC.	Dumping of FS in Bugolobi WWTW is permitted; this is operated by NWSC; efficiency is estimated to be 75% (nominal). New FSTP currently under planning/ construction. Overall 14% of FS generated from OSS is treated.	No formal reuse

Sources: all data sources provided in city profiles in Annexure 1

Region: South Asia

City, Country	Containment	Emptying	Transport	Treatment	Reuse/disposal
Dhaka, Bangladesh	80% of households not connected to the DWASA sewer network. These use a mix of pit latrines, septic tanks and cess pits.	Majority of pits (89%) are not emptied but are connected/overflow to open drains and crude informally constructed sewers connected to the river via open drains and local sewers. Manual emptiers who bury or dump the sludge in the local environment do 90% of emptying; but this is only done by a small percentage (10%) of households. Mechanical emptying by NGOs is done by only 1% of households.	None of the FS from the NGO-run mechanical emptying service reaches treatment.	No treatment. The DWASA run WWTW does not receive any FS from OSS. 0% of FS generated from OSS is treated.	No formal reuse
Delhi, India	24% of households have access to an on-site type sanitation facility with the use of various forms of pit latrines and septic tank type systems being roughly equal.	The majority of pits are not emptied and allowed to overflow to the environment when full (67%). Mechanical emptying by private operators (29% of OSS) is more common than manual emptying (4% of OSS). The manual emptiers dump or bury the FS locally.	Private operators use vacuum trucks to empty and transport 100% of the mechanically emptied FS to the Municipal Corporation of Delhi -run landfill sites.	No treatment. The Delhi Jal (Water) Board run WWTW does not receive any FS from OSS. 0% of FS generated from OSS is treated.	No formal reuse

Sources: all data sources provided in city profiles in Annexure 1

Region: East Asia

City, Country	Containment	Emptying	Transport	Treatment	Reuse/disposal
Phnom Penh, Cambodia	61% of households use a pit or septic tank type containment facility that is then in-turn connected to a combined sewer system. Quality of containment varies enormously and there is no control over the type and/or quality of construction.	The majority of owners (78% of OSS) have a containment system that overflows to the local sewer network and/or have never emptied their pit or tank. Mechanical emptying by private operators accounts for 22% of FS.	The private operators dump the majority of mechanically emptied FS illegally and only 12% reaches the authorised disposal point.	No treatment facility. A wetland provides partial treatment only and is the official disposal point but in reality 0% of FS generated from OSS is treated.	No formal reuse
Palu, Indonesia	All sanitation is on-site (91% with 9% open defecation) and most households use pour-flush water closets that discharge to a single compartment open-bottomed tank (locally known as a cubluk). .	The municipality does all emptying mechanically. There is no manual emptying. Demand for pit emptying is very low – only 10% of OSS is emptied – because the cubluks percolate efficiently and/or are over-sized so accumulation rates are low. The majority of FS (77% of OSS) is therefore considered as safely contained in the cubluks.	The municipality transport 100% of the mechanically emptied FS to treatment. There are no reports of illegal discharge.	The municipality-run FSTP treats 100% of the FS delivered. 10% of FS generated from OSS is treated but a further 77% of FS is considered safely contained.	No formal reuse
Dumaguete, Philippines	All sanitation is on-site (97% with 3% OD) with the use of septic tanks predominating. A survey of the pits in 2005 suggested that as many as 80% were in a poor condition. A new FSM service has included a community awareness campaign to promote improved household sanitation provision.	A Water District does all emptying mechanically (there is no manual emptying) on a five-year cycle of regular desludging. The service is new (May 2010) and as of September 2011 20% of pits had been emptied, which suggests that the operation has started well.	The Water District transport 100% of the mechanically emptied FS to treatment. There are no reports of illegal discharge.	The City Gov. runs two new FSTP. WSP receive the FS from the Water Districts trucks; while a DEWAT unit treats FS from a public toilet. Treatment by both is effective and it is estimated that 78% of FS generated from OSS is treated.	A small amount of formal reuse has begun - the City Government uses treated FS in their parks and gardens.
Manila, Philippines	88% of households use on-site sanitation – primarily in the form of septic tanks.	Two concessionaires (Manila Water Company (MWCI) and Maynilad Water Services Inc (MWSI)) are responsible for FSM in their respective geographical zones. Both operate regular mechanical desludging programmes on a three to five year cycle. Their combined operations empty 39% of Manila's septic tanks. The remainder are either emptied by private operators (assumed 45%), fill up and are abandoned unsafely (assumed 45%) or are not emptied and provide safe containment (10%).	The concessionaires transport the emptied FS to treatment and in the absence of data it is assumed that a nominal 5% is dumped illegally.	MWCI operate two FSTP while and MWSI operates one FSTP. In the absence of data it is assumed that the plants operate at 95% efficiency (5% of the FS received at treatment is therefore discharged without treatment). 35% of FS generated from OSS is treated	A market for reuse has been initiated by MWCI but the scale is small and has not proved profitable for the company. There are no reports of formal reuse within the MWSI operating zone.

Sources: all data sources provided in city profiles in Annexure 1

4. Discussion

4.1. Introduction

A review of the modified SDA scorecards and fecal waste flow diagrams for each city revealed that while the context in each location is different the extent of the service delivery framework (and the level of service being achieved) in a number of the cities was broadly similar. For instance, in Managua, Nicaragua; Delhi, India; Phnom Penh, Cambodia; and Dhaka, Bangladesh there is no framework for FSM delivery and almost no services. In contrast, in Dumaguete, Philippines and Palu, Indonesia the core of the framework is in place and a 'partial' FSM service is being delivered.

The study therefore identified that amongst the 12 case studies there are, broadly speaking, three 'types' of city:

- Type 1 cities have 'poor FSM' with no framework and almost no services.
- Type 2 cities have 'improving FSM' where some of the service delivery framework is in place and there is some but limited service provision.
- Type 3 cities have 'partial FSM' where most of the framework is in place, services exist but there is still room for improvement.

Figure 11 shows a summary scorecard for each of the three 'types' of city.

There are also cities where both the framework and service delivery arrangements for FSM are in place resulting in a complete or near-complete FSM system (what might be termed 'Type 4' or "Managed Fecal Sludge" cities). None of the cities included in this review fell into this category. Cities which exceed the standard of a 'Type 3' city do exist but are generally found in countries with much better developed overall sanitation frameworks, and a longer track record of investment and well-financed service delivery than we see in the cases considered here. Such cities call for a very different policy and investment response. The available evidence suggests that cities of the three types covered in this review predominate in many low- and middle-income countries (see for example section 1.1).

Based on this Table 3 typology gives an overview and indicates the 'type' of FSM service that is being delivered in each of the 12 cities while Table 4 gives estimates of the fecal waste safely managed in each city. The following section describes in more detail one city from each of the three 'types'.

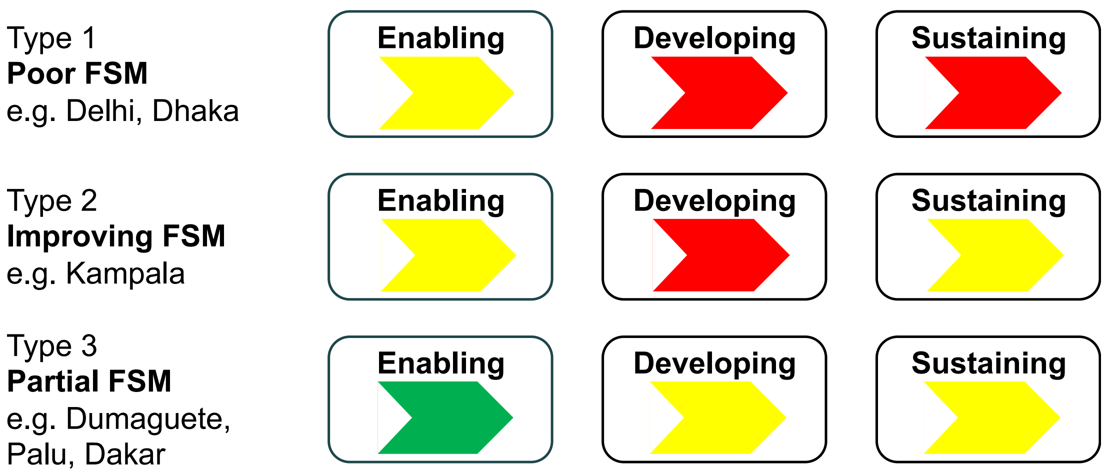

Figure 11: Typology of cities and summary scorecards

Table 3: Overview of FSM service delivery in the 12 cities

Region	Latin America & Caribbean			Africa		
Country	**Bolivia**	**Honduras**	**Nicaragua**	**Mozambique**	**Senegal**	**Uganda**
City	**Santa Cruz**	**Tegucigalpa**	**Managua**	**Maputo**	**Dakar**	**Kampala**
FSM framework	Poor	Poor	Poor	Poor	Improving	Improving
FSM services	Poor	Poor	Poor	Poor	Partial	Poor/ Improving
City type	1	1	1	1	3	2

Region	South Asia		East Asia			
Country	**Bangladesh**	**India**	**Cambodia**	**Indonesia**	**Philippines**	
City	**Dhaka**	**Delhi**	**Phnom P**	**Palu**	**Dumaguete**	**Manila**
FSM framework	Poor	Poor	Poor	Improving	Improving	Improving
FSM services	Poor	Poor	Poor	Partial	Partial	Improving
City type	1	1	1	3	3	2 to 3

Table 4: Summary of estimates of fecal waste safely managed in each city

Region	Latin America & Caribbean			Africa		
Country	Bolivia	Honduras	Nicaragua	Mozambique	Senegal	Uganda
City	Santa Cruz	Tegucigalpa	Managua	Maputo	Dakar	Kampala
Percentage of households using on-site sanitation or open defecation	60%	19%	61%	90%	75%	91%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	45% to 59%[7]	6% to 11%	33% to 52%	8% to 26%	21% to 31%	19% to 40%
Percentage of sewage safely managed	100%	0%	82%	4%	14%	78%
Percentage of fecal sludge from OSS safely managed	9% to 38%	up to 25%	1% to 18%	8% to 28%	25% to 39%	14% to 37%

Region	South Asia		East Asia			
Country	Bangladesh	India	Cambodia	Indonesia	Philippines	
City	Dhaka	Delhi	Phnom P'	Palu	Dumaguete	Manila
Percentage of households using on-site sanitation or open defecation	80%	25%	75%	100%	100%	88%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	2%	34%	0%	Up to 86%	78% to 92%	39% to 44%
Percentage of sewage safely managed	12%	45%	0%	NA	NA	78%
Percentage of fecal sludge from OSS safely managed	0%	0%	0%	Up to 95%	80% to 95%	35% to 40%

Sources: all data sources provided in city profiles in Annexure 1.

[7] The percentages that are shown as ranges indicate where there is uncertainty over the actual percent of waste safely managed. For instance, it is understood that in some cities (for example in Africa) a proportion of the fecal waste is buried in containers which are used once, not emptied and safely covered over once the pit is full; whilst it is also understood that in other cities (e.g. Palu, Indonesia) the type of container used and/or their size and/or the soil conditions mean that some of the containers will take a long time to fill. Both cases are considered to be safe methods of disposal but the data available is insufficient to accurately estimate the percentage of fecal waste concerned.

4.2. Typology of cities

4.2.1. Type 1 city: Poor FSM

Figure 12 shows the FSM scorecard for Dhaka, Bangladesh. As explained in section 2.2, this is the standard SDA scorecard (of enabling, developing, sustaining) modified for FSM and alongside the sanitation service chain (of containment, emptying, transport, treatment, reuse/disposal).

	Containment	Emptying	Transport	Treatment	Reuse/ disposal
Enabling					
Policy	1	0.5	0.5	0	0
Planning	0	0	0	0	0
Budget	0	0	0	0	0
Developing					
Expenditure	0	0	0	0	0
Planning	0	0	0	0	0
Budget	0	0	0	0	0
Sustaining					
Maintenance	0.5	0.5	0.5	0	0
Expansion	0	0	0	0	0
User outcomes	0.5	0.5	0.5	0	0

Figure 12: FSM scorecard for Dhaka, Bangladesh

The scorecard indicates that in Dhaka there is virtually no framework within which FSM is formally delivered and there are almost no services. Overall, looking down the diagram there are very low scores in the enabling, developing and sustaining aspects of service delivery, and looking across it is evident that this is true for *all* aspects of the sanitation service chain. The scores confirm that national and local policy is focused on containment only while the emptying and transport components are limited to small-scale informal services.

The result of this ‘Poor FSM’ scenario is shown in the fecal waste flow diagram (see Figure 13) which shows a failed sanitation service chain with all but a tiny proportion of the waste (from the sewerage system) entering the environment in an unregulated and uncontrolled manner; it could perhaps be best described as institutionalized open defecation.

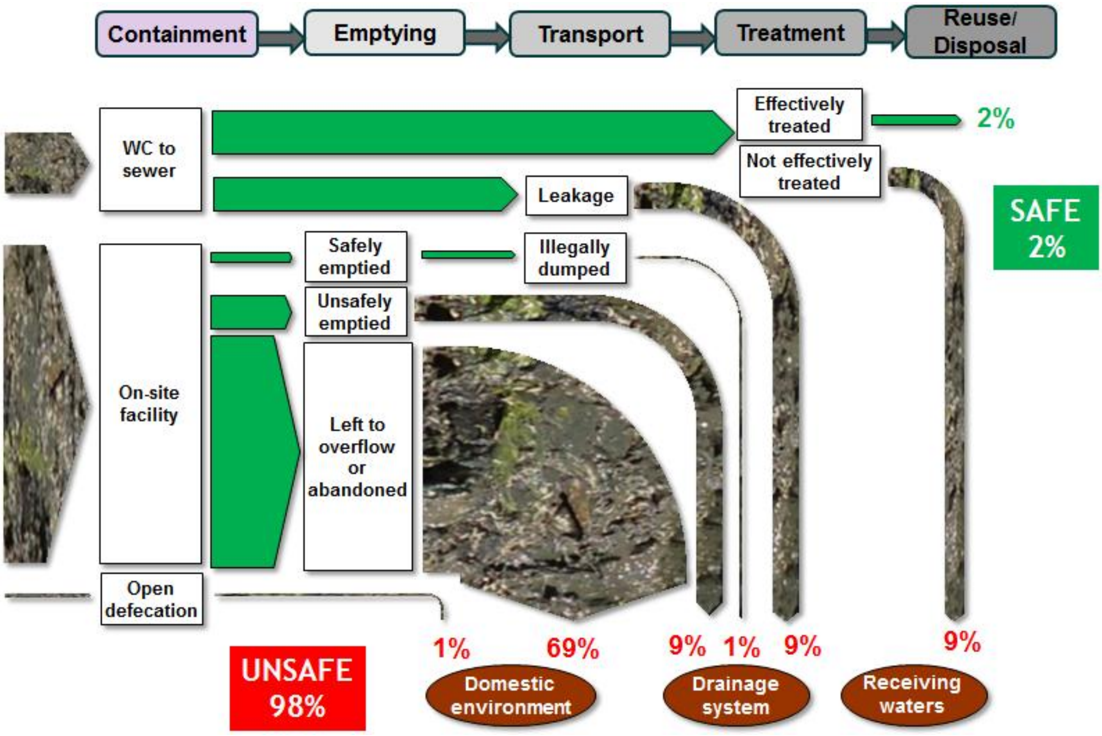

Figure 13: Fecal waste flow diagram for Dhaka, Bangladesh

4.2.2. Type 2 city: Improving FSM

Figure 14 shows the FSM scorecard for Kampala, Uganda. The scorecard indicates that the framework for service delivery is being developed and parts of it are in place, particularly at the level of policy and planning where the scores are improving. There is however, clearly, inadequate budget to facilitate significant development of infrastructure except in the treatment element of the chain which scores comparatively well. Indeed, country experts confirm that improvements in treatment capacity are expected following recent expenditure and reports suggest that more are planned.

Emptying and transport of fecal sludge is taking place; a private-sector led mechanical pit emptiers' service is active and shows signs of improvement. The pit emptiers have formed an association and this service could potentially become consolidated to deliver improved and at-scale services. However, areas of weakness do persist, most noticeably in equity and output and especially in containment and reuse/disposal where the score are very low.

	Containment	Emptying	Transport	Treatment	Reuse/ disposal
Enabling					
Policy	2.5	1.5	1.5	1.5	1.5
Planning	2	1	1	1.5	1
Budget	0	0	0	1.5	0
Developing					
Expenditure	0	0	0	1.5	0
Planning	0	0	0	0	0
Budget	0.5	0	0	1	0
Sustaining					
Maintenance	0	1	1	0	0
Expansion	0	1	1	0	0
User outcomes	1.5	0.5	0.5	0	0

Figure 14: FSM Scorecard for Kampala, Uganda

The resulting fecal waste flow diagram for Kampala, Uganda is shown in Figure 15 which shows that the net effect is that the sanitation service chain is performing better than a typical Type 1 city with at least part of the fecal sludge moving through a formalised managed process with some level of treatment. However, despite the improvements in Kampala, over half the fecal waste generated remains untreated and is unsafely reused/disposed of to the environment.

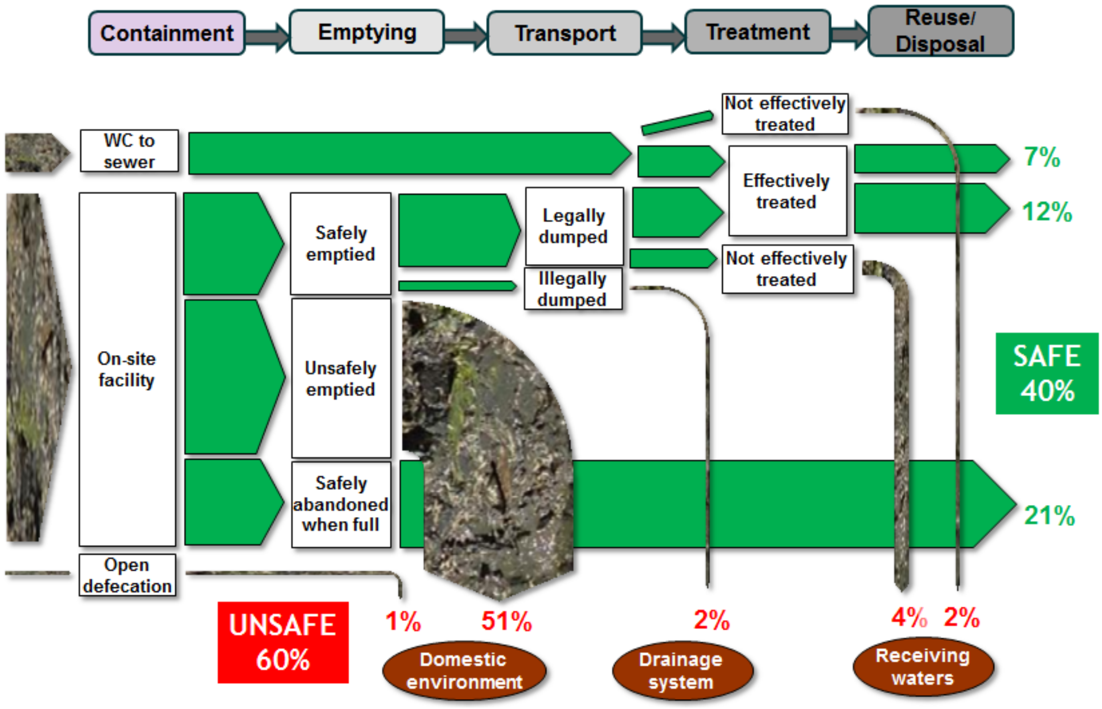

Figure 15: Fecal waste flow diagram for Kampala, Uganda

4.2.3. Type 3 city: Partial FSM

Dakar, Senegal is considered to be typical of a Type 3 city; the SDA scorecard for the city is shown in Figure 16. The core parts of the enabling framework are in place and, compared to the Type 1 and 2 cities, there is considerable improvement in the developing and sustaining pillars with noticeably higher SDA scores (i.e. more yellow and green).

The FSM service has been developed and is being maintained although it is noticeable looking across the scorecard that this is more pronounced at the start of the service chain than at the end.

The World Bank's Project d'Assainissement dans les Quartiers Périurbains (known as the PAQPUD project) has been instrumental to this success through infrastructure investments from containment to treatment and is considered to have had a positive influence. However, the challenge remains to develop and sustain progress following completion of the project.

The key remaining weaknesses appear in 'sustaining' treatment and overall in the lack of a framework and positive management for reuse and proper disposal.

The estimated fecal waste flow diagram is shown in Figure 17 and confirms that the service chain is strengthening particularly in the emptying and transport elements, although performance is lagging behind the development of the enabling environment and investments which are taking place.

The challenge in Dakar is to consolidate the existing services, expand the services to reach more households; and incentivise the emptying/transport service to reduce illegal dumping.

	Containment	Emptying	Transport	Treatment	Reuse/ disposal
Enabling					
Policy	1.5	2.5	2.5	1.5	1
Planning	3	3	3	3	0
Budget	1.5	1.5	1.5	1.5	0
Developing					
Expenditure	1.5	1.5	1.5	1.5	0
Equity	1.5	1.5	1.5	1.5	0
Output	1.5	1.5	1.5	1	0
Sustaining					
Maintenance	1.5	1.5	1.5	1	0
Expansion	1	1.5	1.5	1	0
User outcomes	2	1	1	0	0

Figure 16: FSM scorecard for Dakar, Senegal

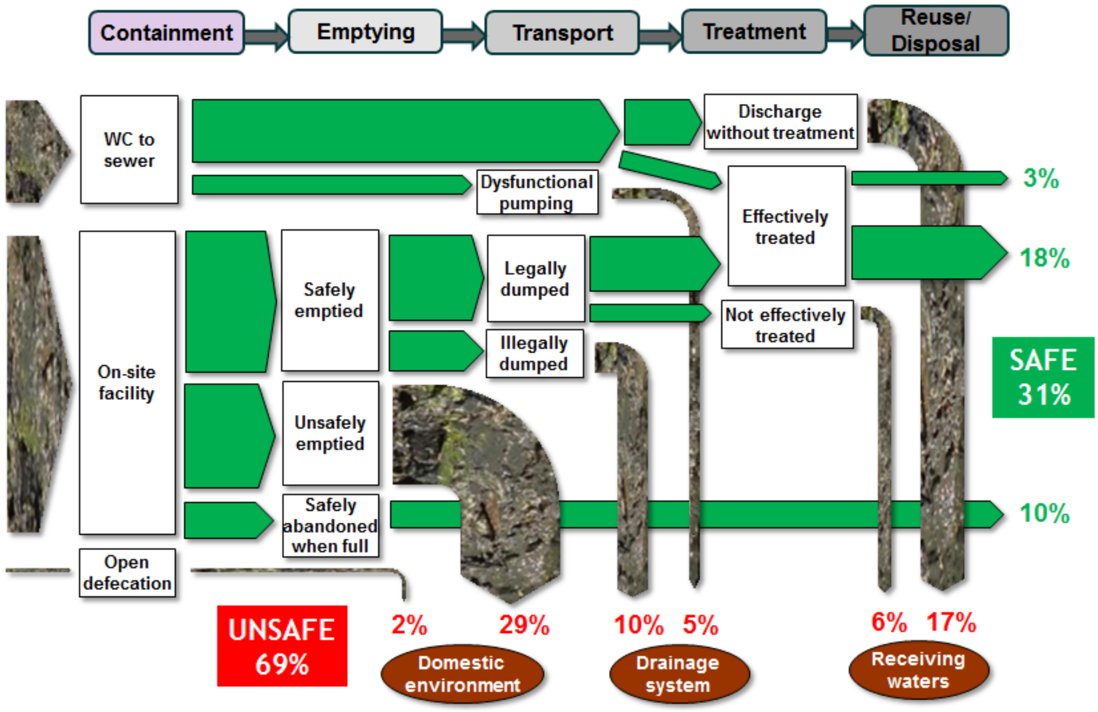

Figure 17: Fecal waste flow diagram for Dakar, Senegal

4.3. Responding to the challenge

4.3.1. Gearing the response to the context

In this section we look at the types of interventions that are likely to be most effective in overcoming the barriers to progress in delivering FSM services identified for each type of city; from the very poorly served Type 1 cities to the partially served Type 3 cities.

To ensure continuity with the problem analysis the suggested interventions are framed within the three pillars of the SDA framework – the enabling environment, developing services and sustaining services.

4.3.2. Type 1 city: Poor FSM

In Type 1 cities, for instance in Dhaka, Bangladesh and Tegucigalpa, Honduras where the service delivery framework is non-existent and there is virtually no FSM service, the challenges are overwhelming. Having identified that the scale of the problem is so large it can be difficult to identify where to commence with effective interventions. With the understanding that the context in each city is unique, and that interventions must be appropriate for the specific situation, Figure 18 includes recommendations for critical interventions in cities where there is currently no formal FSM service.

In Type 1 cities, infrastructure investments alone, unsupported by changes in the enabling environment are unlikely to be effective particularly given the challenge of 'linking' elements of the supply chain together. Thus for example, additional treatment capacity will not reduce illegal discharge of FS into the environment as collection and transport remain unregulated and out of control. Critical interventions in Type 1 cities are thus likely to focus around a combination of strengthening key elements of the enabling environment (by engaging with local and national government) with targeted interventions to strengthen the upstream elements of service delivery. These may include introducing a community consultation and planning process before making any infrastructure investments and improving the link between households and private pit emptiers. For example, through a combination of efforts to stimulate demand for better regulated FSM services from households and business development support to the private sector. The initial focus would therefore be on introducing hygienic emptying and transport of sludge to reduce critical public health risks where people live and developing the capacity of private sector emptying and transport service providers.

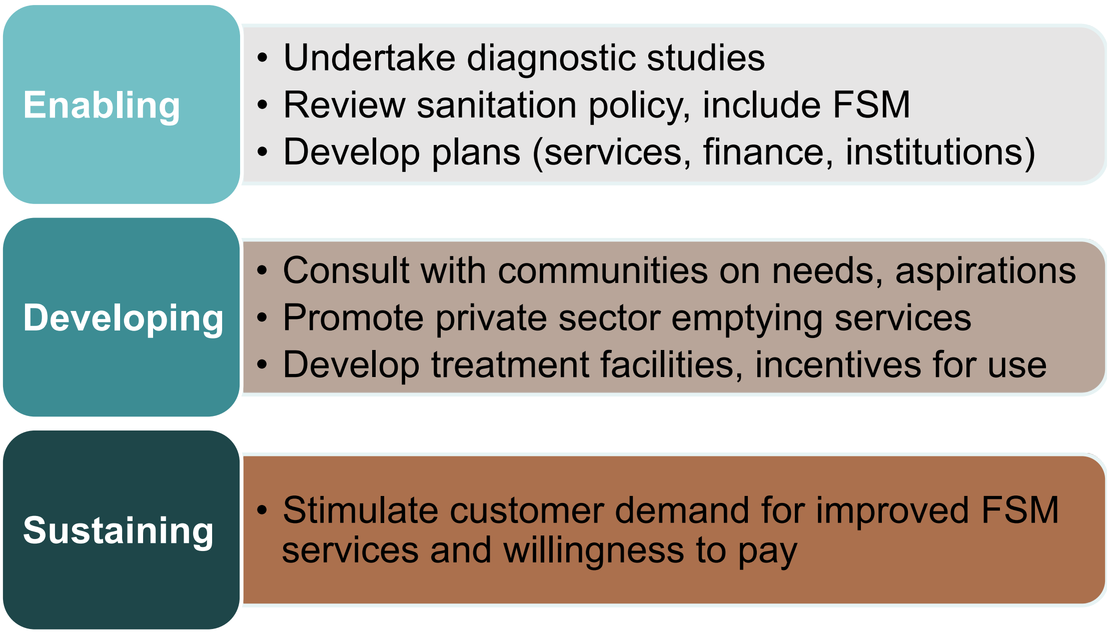

Figure 18: Type 1 city, critical interventions for immediate impact

In this way a Type 1 city could improve their understanding of FSM while making marginal improvements in service delivery and building the foundation for subsequent more long-term improvements.

4.3.3. Type 2 city: Improving FSM

In Type 2 cities, for instance Kampala, Uganda, the interventions may be more ambitious and tailored to build on capacity that already exists. Key interventions would focus on building public sector capacity to oversee and monitor service delivery while establishing appropriate norms and standards for FSM. There may also still be key policy interventions needed, and in particular operational tools such as regulatory instruments to support and incentivise the private sector and encourage greater confidence in this market segment – this should in turn attract further private investment to financially viable elements of the service. A market analysis and development of 'at-scale business models' for the private sector which encourage complete service-chain delivery (for example, by creating positive financial incentives for pit emptiers to carry waste to the desired location for treatment) would also be recommended. There may therefore be some critical public investments to be made to ensure the adequacy of sustainable treatment and disposal capacity.

Figure 19 summarises these possible key interventions in Type 2 cities that are designed to strengthen the framework for delivering services with an incremental development of the actual service delivery.

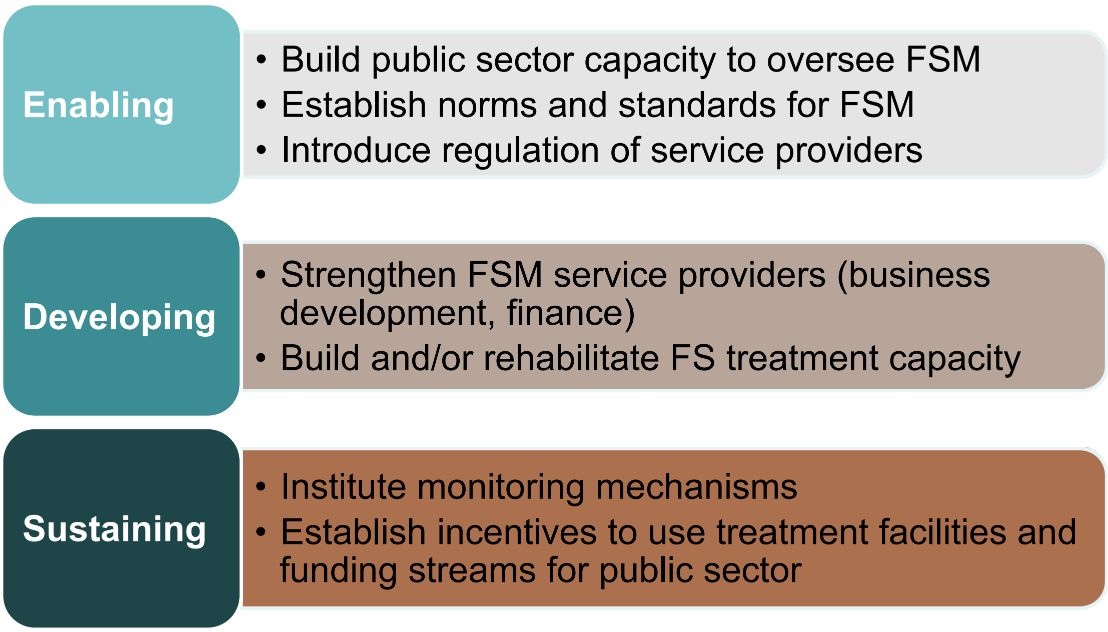

Figure 19: Type 2 city, key interventions to strengthen framework and services

4.3.4. Type 3 city: Partial FSM

Figure 20 summarises appropriate interventions in Type 3 cities where the focus would be shifting to consolidation of existing services, for instance in Dumaguete, Philippines; Palu, Indonesia; and Dakar, Senegal. In cities such as these the basis for strong investment should be in place and is being supported along the service chain and at-scale across the city. With infrastructure and service delivery generally in place, then a focus on improving regulation may be appropriate to ensure that all stakeholders act in accordance with the way the system has been designed and planned. The introduction of penalties for undesirable behaviour may therefore become more relevant at this stage. Indeed, where areas of the city remain unserved – for instance low-income neighbourhoods - it may be necessary to introduce specific pro-poor financial arrangements.

Finally, a key area of focus once a city reaches this point would be on improvements to the downstream disposal arrangements and, where possible, reuse of the nutrients, water and energy value of fecal sludge.

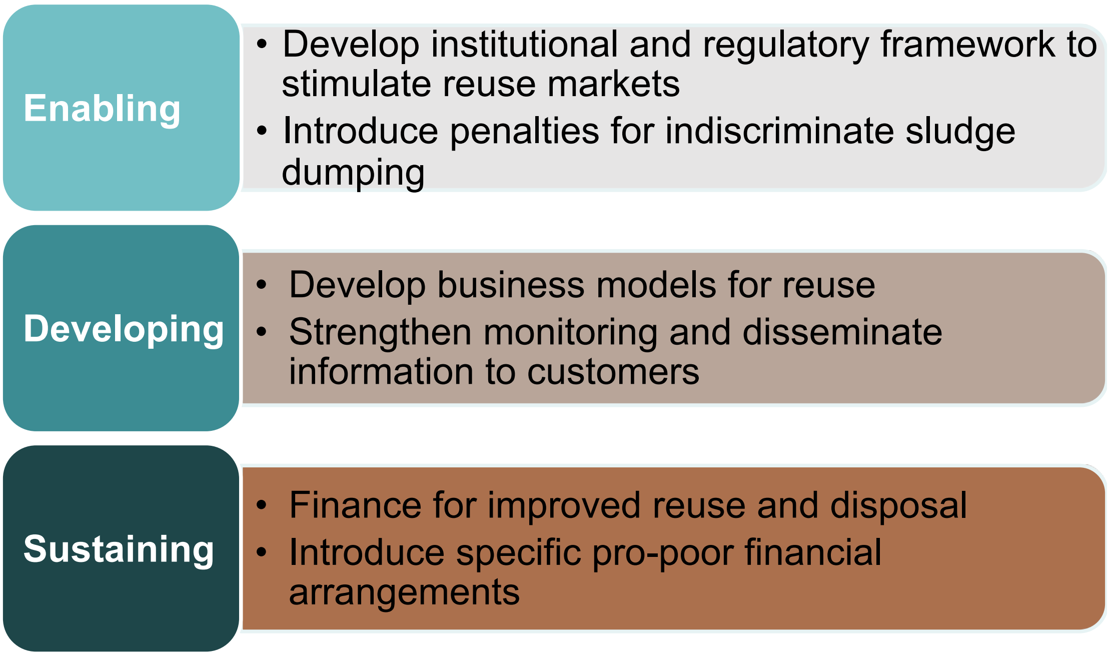

Figure 20: Type 3 city, appropriate interventions to consolidate service and develop reuse

4.4. Tool development and further research

4.4.1. Introduction

The case studies and the study analysis illustrate how cities struggle to understand or describe the physical and organizational processes that are taking place in the arena of FSM. Therefore, in this section we identify both the importance of appropriate tools to enable improved understanding of FSM service in any given city and some of the significant knowledge gaps that remain in this field which are seen as barriers to progress.

4.4.2. Improved diagnostic tools

In general, the challenge of improving FSM services is generally over-simplified and underestimated. A more systematic approach to the analysis of Fecal Sludge Management could significantly improve the capacity of operations and its clients to identify and design effective operations in urban sanitation.

There is a strong potential in further developing and improving the modified SDA/service chain concept with respect to FSM. The strength of the SDA framework is that while it gives a *strategic* overview of the situation it can nevertheless point the way towards specific *tactical* interventions along the service chain. The two dimensions of the analysis complement each other well and combining them in this way will help decision-makers understand the strengths and weaknesses of the FSM system in any given city.

Secondly, it is important to get a full understanding of the volume of fecal sludge generated and the various pathways it takes from containment to disposal. The capacity of emptying, transport, treatment and reuse/disposal infrastructure in the majority of city case studies is shockingly low – the poor outcome of which is evident. Having said that, it is clear that broad simplistic assumptions, that all fecal waste from containment systems that are not connected to a city's sewer network needs emptying, transport and treatment or that the rates of sludge production are homogenous across a city – are misplaced. For instance, where sludge remains safely buried in the containment system – users having covered over the pit when it is full – or where the container's characteristics and/or soil conditions dictate that in the short- to medium-term the container does not require emptying should both be considered as safe and satisfactory systems of disposal (although the former may well only be appropriate for the urban fringe and not for dense urban slums).

The development of these diagnostic tools would therefore greatly enhance the ability of operational teams to make rapid assessments of FSM capacity and could have a significant positive impact on the scale and poverty impact of interventions in urban sanitation.

4.4.3. Knowledge gaps

It is clear that significant knowledge gaps remain in this field and this relates not only to areas where there is no information or data but also to the fact that many sector specialists have not worked specifically in fecal sludge management. Some of the knowledge management challenges are therefore about disseminating what is known and encouraging creative problem solving in what is essentially a nascent area of work for many development practitioners.

However there are some specific areas where additional information and knowledge and both global and local level could have merit. Leaving aside the specific question of the viability of specific technologies (which is an area of widespread research currently) two other important aspects of the framework for FSM merit some focused additional research and learning:

- The first relates to improved understanding of how value flows through the sanitation *service* chain for improved fecal sludge management. To understand this we need better information about health and economic benefits particularly relating to reuse of treated fecal for agriculture or capture of energy from treatment processes. The value to the economy of public health and environmental improvements could also be a driver for investment in FSM but this is often poorly understood and has limited traction with local government who tend to be driven by more short-term considerations. The second relates to stronger understanding of viable market and business models for fecal sludge. FSM is a more complex service delivery context than conventional sewerage, and it therefore lends itself to more creative institutions and management arrangements. The study observes that much more work could be done to design and deliver effective and sustainable business models for FSM.

- Taken together these two areas relate to a third area of work which concerns an improved understanding of how a range of FSM technological approaches fit best with potential market opportunities and how these can be linked with innovative and effective financial arrangements.
- Finally, more work is needed to understand the range of regulatory approaches and instruments that could be usefully deployed across the service chain to incentivize optimum FSM behaviours and link elements of the service chain together.

5. Conclusion

In this study we carried out a rapid review of the status of fecal sludge management in twelve cities. The study was based on secondary data of variable quality supplemented by interviews with local informants. Despite the poor quality of the available data the study confirms earlier work which suggests that fecal sludge management is a largely neglected aspect of urban sanitation in most cities. This despite the fact that a majority of the urban population in low- and some middle- income countries rely on on-site sanitation and hence fecal sludge management systems to access basic sanitation at home, and most cities would need to implement significant fecal sludge management programmes in order to protect public health and garner environmental benefits.

An apparent focus on networked sanitation means that there has been limited attention to alternative sanitation management strategies, and this appears to be consistent in all regions. The sector is poorly analysed and hence, even where cities are seeking to address the challenge, the solutions often appear to be partial. Since urban sanitation systems require the coordination of household, neighbourhood and city-wide infrastructure and services these partial solutions often fail to result in improved services, at least in the short term. In common with other urban sanitation approaches FSM requires strong city-level oversight and an enabling environment that drives coordinated behaviours across the sanitation service chain. This strong city-level leadership was absent in almost all the cities we looked at.

In the cities where FSM is least developed (our Type 1 cities) interventions probably need to focus on strengthening city level capacity, addressing service delivery gaps at the household level and possibly supporting small scale interventions to demonstrate the viability of a range of management options particularly those relating to emptying and transport of waste. As capacity and the infrastructure endowment grows, in Type 2 cities, interventions can progress towards more sophisticated management of a larger segment of the service chain. Subsequently cities may get into a position where there is capacity to absorb and manage investments in downstream elements of the service chain (treatment and managed re-use), Type 3 cities.

However the sector needs to build capacity and develop tools to enable a systematic analysis of the situation; this report has presented a proposed approach but more work is needed both to refine these tools and support their development and roll out. Significant knowledge gaps remain particularly with respect to optimum management models, regulation and the economic value of improved fecal sludge management.

Fecal sludge management will be a major element in the delivery of sustained and effective urban sanitation for many countries for the foreseeable future and holds out the promise of an alternative paradigm for urban sanitation that has the potential to have a lower energy-, water- and carbon- footprint than conventional networked sewerage. The main challenge now is to embed it as part of the city manager's arsenal for addressing public health and environmental challenges in the future.

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Annexure 1 City Profiles

A.1 Santa Cruz, Bolivia

All data sourced from Ortuste (2012) except where shown.

A.1.1. Summary

Population (millions)	1.7
Percentage of households using on-site sanitation or open defecation	60%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	45% to 59%[8]
Percentage of sewage safely managed	100%
Percentage of fecal sludge from OSS safely managed	9% to 38%

FSM Framework	Poor
FSM Services	Poor
City Type	1

A sewer network that serves nearly half of the city dominates the sanitation service in Santa Cruz. The majority of waste from this network is treated satisfactorily and discharged safely to the environment[9]. The rest of the city 's population use on-site sanitation type facilities and a portion of these households benefit from a private-operator-run pit emptying service that transports and discharges the fecal sludge to the same treatment works provided for the sewer network. However, this FSM service is relatively small and the majority of the fecal waste generated by households using on-site sanitation is held in containment systems of varied quality, many of which do not safely contain the fecal waste and/or cannot be emptied.

A.1.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

Bolivia has had a regulatory framework for the management of water and sanitation since 1997. However, only in the last two years have key steps been taken to implement it properly. In 2009, the Authority for Oversight and Social Control of Drinking Water and Basic Sanitation (Autoridad de Fiscalizacion y Contro; Social de Agua Potable y Saneamento Basico – AAPS) was created. In addition, the Administrative Regulatory Resolution 227/2010 was issued in 2010. This regulates fecal sludge collection services by requiring operators to obtain licences from the AAPS; the approval of tariffs for fecal

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8 This range accounts for the percentage of fecal waste that is contained in single use pits that are not emptied but covered over once full. Burial of waste is considered a safe disposal method but in many cities the number of pits that are managed in this way is unknown. Where data is weak or missing, and for the purpose of this study, best estimates have been used for the percent of fecal waste safely contained; therefore, where applicable, a range of values is shown and the percent safely contained is marked as yellow on the waste flow diagram to indicate the level of uncertainty.

9 From Sanz (2013) although no data available to confirm sewerage network and wastewater treatment plant efficiency.

sludge emptying services; and a requirement that a sanitation service provider must prepare a plan for fecal sludge removal that can be implemented by a service operator.

However, there are gaps in the Regulatory Resolution relating to fecal sludge management and final disposal. For instance, through the resolution, municipal governments have the authority to issue and grant an ‘environmental operators license,’ but once issued there is no mechanism for monitoring fulfilment of the commitments. The institutional framework for FSM is therefore weak but improving; the recent creation of a new regulatory authority and the introduction of administrative regulations are considered to be important steps to creating a more supportive enabling environment although improved planning and FSM-dedicated investment are required to develop the service.

A.1.3. The FSM scorecard

Description of key points in SDA scorecard….

The FSM scorecard for Santa Cruz shows that despite the weak enabling environment an FSM service has developed and is being sustained, albeit only for specific parts of the service chain. Private operators have for a number of years provided a mechanical emptying and transport service to households who use on-site sanitation. Regulation of the service is delegated to AAPS who are tasked with approving the private operators and issuing licences, although importantly there are no legal norms and standards against which to monitor the level of service the operators then provide. (Note: Sanz (2013) reports that norms and standards are currently being drafted.)

In addition to the poor enabling environment, the scorecard shows areas of weakness in a number of areas including expenditure, equity and user outcomes. In particular, there is no quality control or monitoring of the standard or suitability of containment systems used and the adequacy of reuse/disposal arrangements is unsatisfactory in all three blocks of the service delivery assessment. In contrast, while there is no dedicated fecal sludge treatment plant (and there are reportedly no plans to invest in such a facility), treatment is provided through a wastewater treatment plant run by a water and sanitation cooperative - SAGUAPAC - which receives fecal sludge from the private operators’ vehicles. It is reported that this is well run and the quality of effluent is monitored and meets the required standards.

A.1.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

It is estimated that 8% of the population of Santa Cruz practice open defecation while 40% are connected to the city’s sewer network. Over half the population therefore use (or have access to) an on-site type sanitation facility; these are a mixture of individual household or multifamily latrines connected to pits or septic tanks. The quality of these units is variable with “many of them improvised, precarious [and built with little regard for] technical standards” (WSP, 2010).

Emptying:

About 40 private operators provide a mechanical pit emptying service in Santa Cruz, 25 of these are legally established while the remaining 15 are unregistered and the level of service they provide is less clear. Many of these companies have been operating in Santa Cruz for over 10 years and some for as long as 40 years. There are no manual emptiers in Santa Cruz.

The percentage of the population who use on-site sanitation and reportedly use a private operator to empty their containment system is around 15% of the population. This leaves a large percentage of on-site sanitation users whose pits are not, or never have been, emptied. For the purpose of this analysis it seems reasonable to assume that two thirds of these on-site facilities are either not emptied and abandoned unsafely or overflow to the environment when full, while the remainder are either abandoned safely when they fill up (by covering the pit with soil) or have not yet filled and safely contain the waste.

Transport:

From the information available it is understood that the 25 legally established private operators have agreements with SAGUAPAC to discharge fecal sludge at one of their wastewater treatment works. Therefore, it is inferred that 60% of the waste emptied is transported to treatment but the balance (the volume emptied by the 15 non-registered operators) is dumped illegally in the environment.

Treatment:

There is no dedicated fecal sludge treatment plant in Santa Cruz but discharge of fecal sludge to the SAGUAPAC wastewater treatment works stabilization ponds is permitted and the level of service provided by the plant is reportedly high (Sanz, 2013). No information on the size or capacity of the stabilization ponds was available but clearly if the private operators emptying service were to be extended beyond the current level (15% of the non-sewered population) the capacity and performance of the stabilization ponds would eventually be compromised.

Reuse/disposal:

There is no formal reuse of fecal sludge or wastewater in Santa Cruz.

A.1.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, improving FSM service delivery or partial FSM service delivery)

It is estimated that around fifty per cent of the fecal waste generated in Santa Cruz is safely disposed of to the environment. The majority of this is from households connected to the sewer network and from households whose pits have not yet filled up or have filled up and been covered safely. However, this leaves a large volume that is discharged unsafely to the environment. This volume is generated by households who practice open defecation or are users of unsatisfactory on-site sanitation facilities that have either not been emptied and overflow to the environment or have filled up and abandoned unsafely when full.

The current FSM service provided is poor but the large number of operators and the length of time that many of them have been operating suggests that with some timely interventions further households would quickly benefit.

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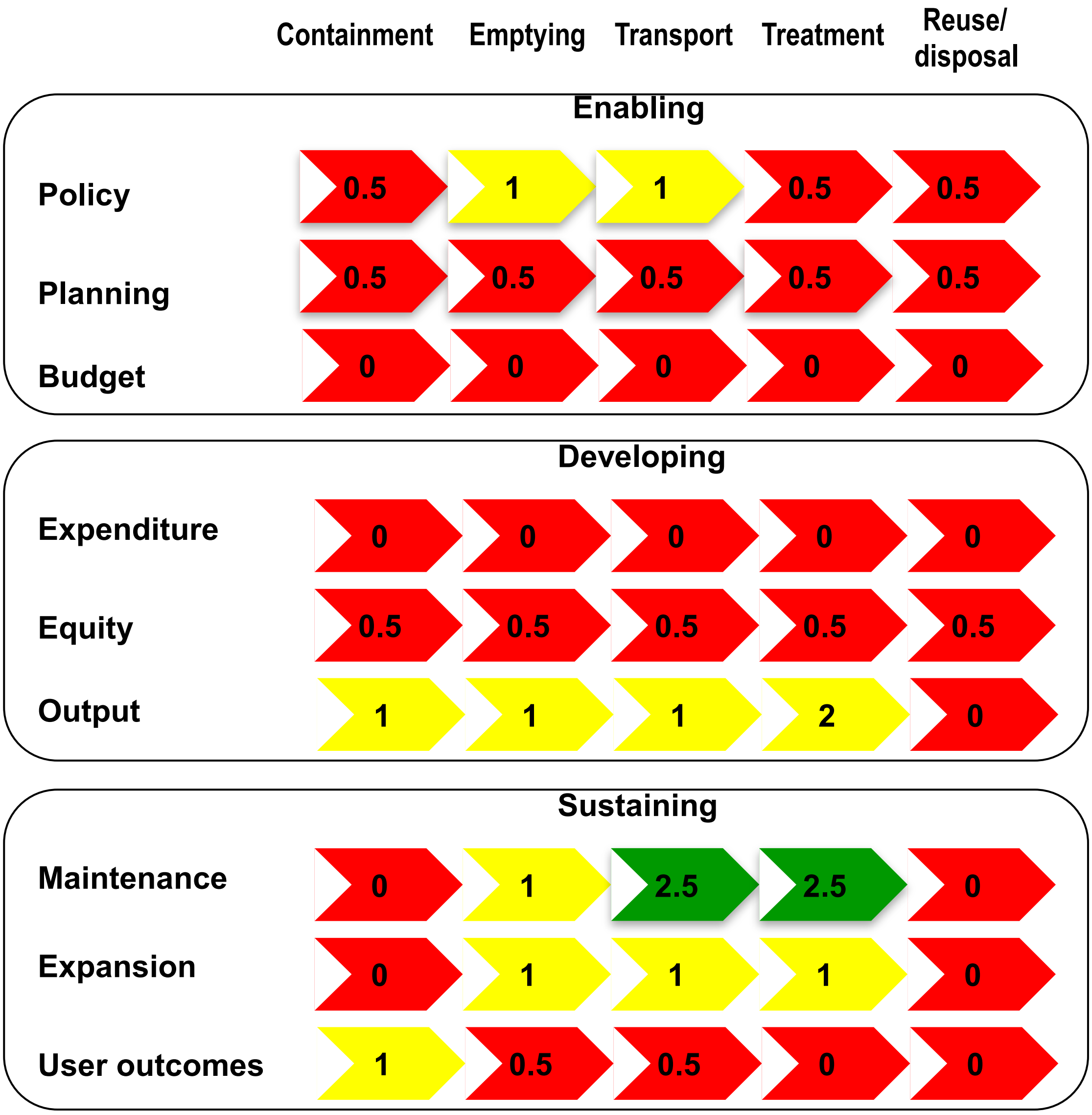


Figure 21: FSM scorecard for Santa Cruz, Bolivia

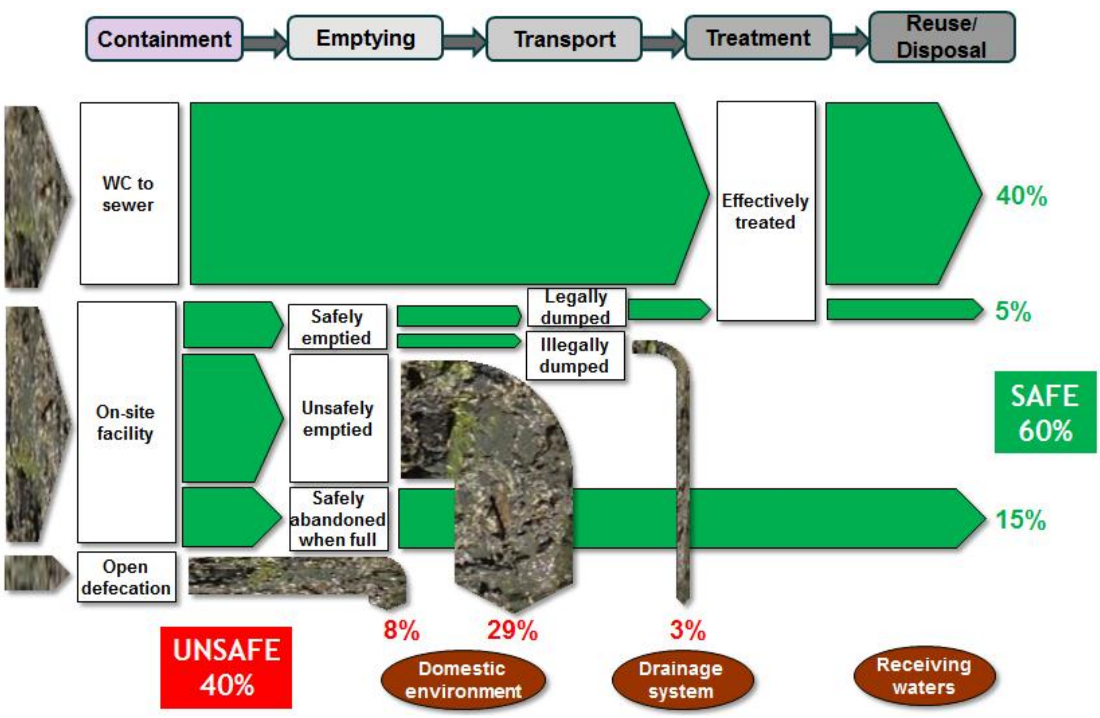
Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 45% to 59%**
Sewered (off site centralised or decentralised)	40%	100%	100%	100%	**40%**
On-site containment - permanent/emptiable	37%	21%	60%	100%	**5%**
On-site containment - single-use/not emptied/safely abandoned (see note 1)	15%	100%	100%	100%	**15%**
Open defecation	8%	0%			
Unsafe: 41% to: 55%		**37%**	**3%**	**0%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:

1. Single-use/not emptied/safely abandoned on-site containment is considered a safe disposal method but data available is poor so total 'safe' and total 'unsafe' are both shown as ranges.

2: All sources shown in waste flow diagram below.

Figure 22: Fecal waste flow matrix for Santa Cruz, Bolivia



Sources: Open defecation a nominal 8% (JMP (2012) for urban Bolivia).
Sewered percentage (40%) from Ortuste (2012) Table 4.1, page 20. Therefore OSS = 52%.
Percent emptied mechanically (15% of OSS) from Ortuste (2012) Table 6.10, p.43
Percent delivered to SAGUAPAC treatment plant (60% of emptied) from Ortuste (2012) text and Table 6.1, p.33.
No data but inferred that sewerage and all waste treatment is 100% efficient (Sanz, 2013).
No data but inferred (from Ortuste (2012) p.20) that two-thirds of remaining pits and tanks are abandoned unsafely or overflow to environment when full and one-third of remaining pits are covered safely when full.

Figure 23: Fecal waste flow diagram for Santa Cruz, Bolivia

A.2 Tegucigalpa, Honduras

All data sourced from Ortuste (2012) except where shown.

A.2.1. Summary

Population (millions)	1.3
Percentage of households using on-site sanitation or open defecation	19%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	6% to 11%
Percentage of sewage safely managed	8%
Percentage of fecal sludge from OSS safely managed	0% to 25%

FSM Framework	Poor
FSM Services	Poor
City Type	1

The sanitation service in Tegucigalpa is essentially a failed sanitation service chain with only a fraction of the waste generated being treated and disposed of safely. The majority of the waste (an estimated 81%) is contained and transported in a sewer network that discharges largely untreated wastewater into the environment (Ramirez, 2013). The FSM service is poor with none of the sludge emptied from on-site sanitation being treated and disposed of (or reused) safely while only a small volume of fecal waste is contained safely in traditional pit latrines and septic tanks.

A.2.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

At the national level, the National Autonomous Water and Sewerage Service (SANAA) is the operator responsible for water and sanitation services. Since 2003 and the promulgation of the Decrees 118-2003 and 180-2003, a process of decentralisation has been ongoing. These Decrees transfer responsibility for water and sanitation (although not explicitly for fecal sludge management) to the municipalities (including Tegucigalpa City Government) but progress has been slow. A new Framework Law on Water, which regulates the discharge of wastewater into receiving water bodies, does not cover the collection of and disposal of fecal sludge, which remains unregulated.

A.2.3. The FSM scorecard

Description of key points in SDA scorecard….

The FSM scorecard for Tegucigalpa shows that improvement is required in all three pillars. The lack of a supportive enabling environment at national and local level, with weak policy, planning and budgetary capacity, is at the root of the problem. In addition, the low scores in the developing and sustaining pillars across all parts of the sanitation service chain indicate the low level of involvement of the city government in managing the collection and disposal of fecal sludge.

A.2.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

It is estimated that 3% of the population of Tegucigalpa practice open defecation while 81% are connected to the city's sewer network. The remaining 16% have access to an on-site type sanitation facility; the majority use traditional pit latrines while around one quarter of on-site users have septic tank type systems.

Emptying:

Only a small percentage (approximately 12%) of the non-sewered households use a mechanical pit emptying service. This service is provided by three private companies and also by the water and sanitation provider (SANAA); these companies focus on the industrial, commercial and middle- and upper- income residential customers – neglecting the peri-urban areas. There is no manual emptying in Tegucigalpa. For the purpose of this analysis it seems reasonable to assume that two thirds of the on-site facilities are not emptied and are either abandoned unsafely or overflow to the environment and the remainder are either abandoned safely when they fill up by covering the pit with soil or have not yet filled and currently safely contain the waste.

Transport:

The four sludge collection companies are authorised to transport the waste to sanitary landfills sites or it is dumped illegally. Nevertheless, since disposal to landfill sites is not a safe solution all the sludge emptied from pits (around 2% of fecal waste generated) is disposed of unsafely.

Treatment:

There is no fecal sludge treatment plant in Tegucigalpa and none of the exhausted sludge is taken to the SANAA operated wastewater treatment plant.

Reuse/disposal:

There is no formal reuse of fecal sludge or wastewater in Tegucigalpa.

A.2.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, improving FSM service delivery or partial FSM service delivery)

Overall, the management of fecal sludge in Tegucigalpa is very poor. None of the fecal sludge emptied from pits is treated and only the small proportion contained in covered abandoned pits is safely disposed of. Furthermore, since only 8% of the waste generated from households connected to the sewer network is treated (Ramirez, 2013) it is estimated that as much as 90% of the waste generated in Tegucigalpa is unsafely reused or disposed of to the environment.

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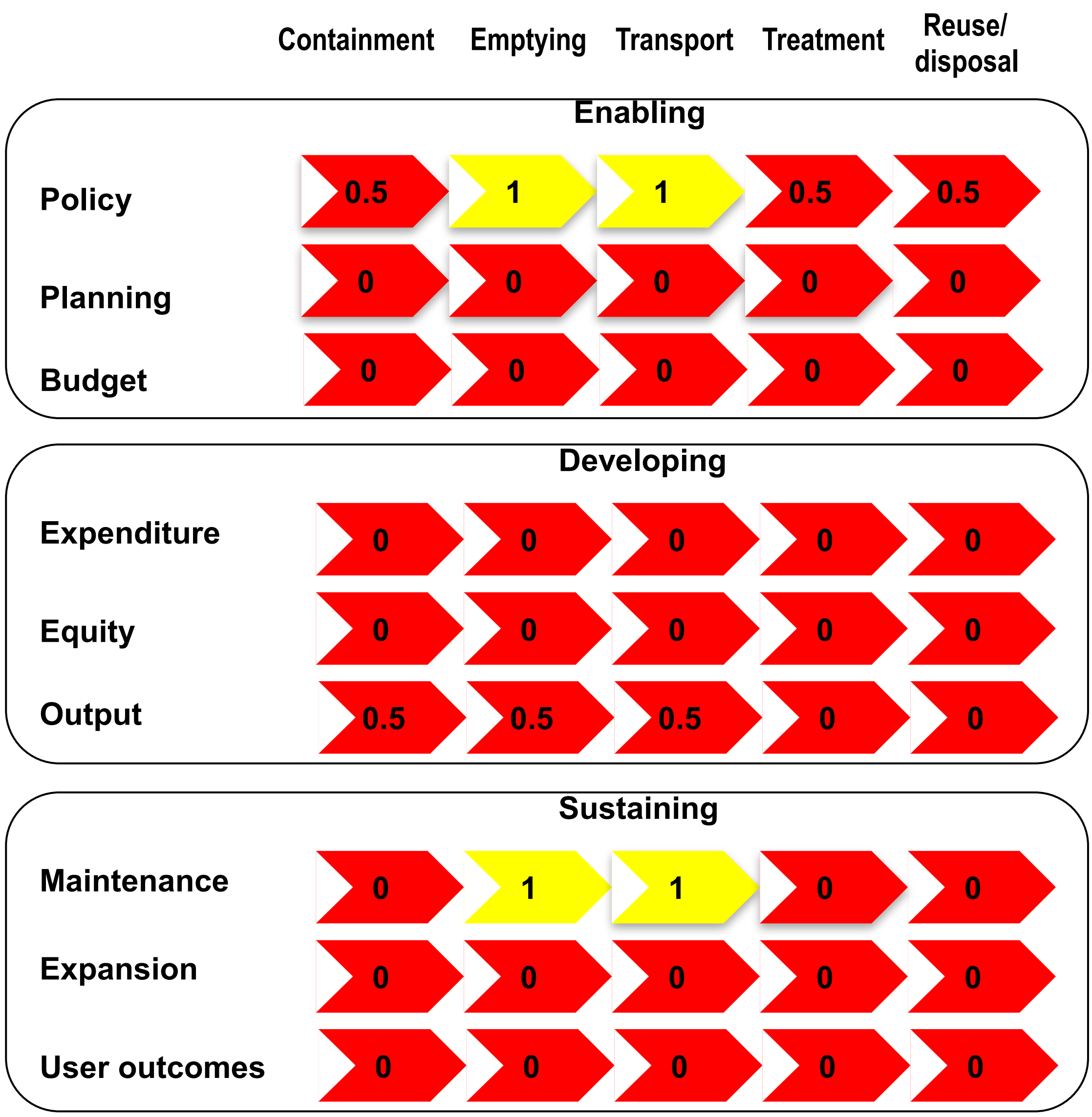
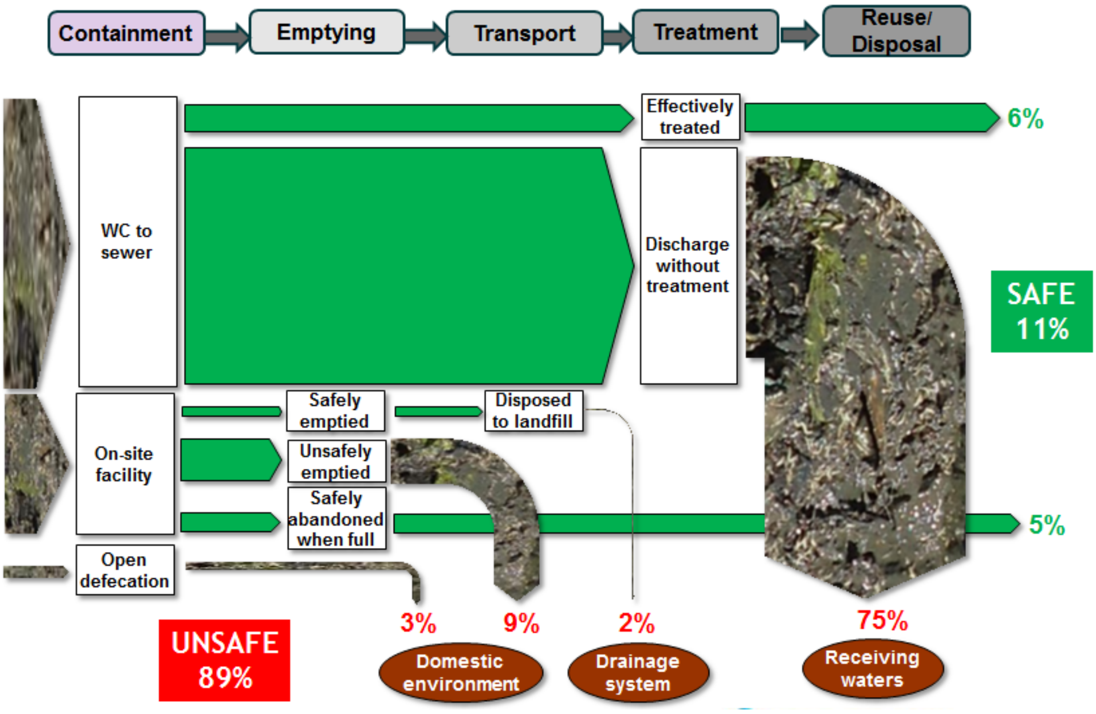


Figure 24: FSM scorecard for Tegucigalpa, Honduras

Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 6% to 11%**
Sewered (off site centralised or decentralised)	81%	100%	100%	8%	**6%**
On-site containment - permanent/emptiable	11%	17%	0%	0%	**0%**
On-site containment - single-use/not emptied/safely abandoned (see note 1)	5%	100%	100%	100%	**5%**
Open defecation	3%	0%			
Unsafe: 89% to: 94%		**12%**	**2%**	**75%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:
1. Single-use/not emptied/safely abandoned on-site containment is considered a safe disposal method but data available is poor so total 'safe' and total 'unsafe' are both shown as ranges.
2: All sources shown in waste flow diagram below.

Figure 25: Fecal waste flow matrix for Tegucigalpa, Honduras



Sources: Open defecation is a nominal 3% (JMP (2012) for urban Honduras).
Sewered: 81% from Ortuste (2012) Table 4.1, page 20; and 8% is treated (Ricardo Mareina Ramirez (2013) Email).
Therefore balance is OSS at 16%
Mechanically emptied: 12% of OSS from Ortuste (2012) Table 6.10, p.43
Disposed of in sanitary landfills: 100% of mechanically emptied from Ortuste (2012) p.31 "fecal sludge is discharged into sanitary landfills..."
Inferred (from Ortuste (2012) p.20) that two-thirds of remaining pits and tanks are abandoned unsafely or overflow to environment when full and one-third are covered safely when full.

Figure 26: Fecal waste flow diagram for Tegucigalpa, Honduras

A.3 Managua, Nicaragua

All data sourced from Ortuste (2012) except where shown.

A.3.1. Summary

Population (millions)	2
Percentage of households using on-site sanitation or open defecation	61%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	33% to 52%
Percentage of sewage safely managed	82%
Percentage of fecal sludge from OSS safely managed	1% to 30%

FSM Framework	Poor
FSM Services	Poor
City Type	1

A sewer network serves nearly forty per cent of households in Managua and the waste transported in this system is treated in a wastewater treatment plant. This leaves over half the city's households reliant on various on-site sanitation systems and a tiny minority of these households benefit from an FSM service.

A.3.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

In Nicaragua institutional responsibility for FSM is unclear and the situation in Managua is no different, although there are indications of improvement in the city as the organisational structure has been put in place. The restricting factor is that there is a limited legal framework within which the FSM organisations responsible can operate.

Both the institutional and legal framework covering water and sanitation in Nicaragua is mainly geared towards drinking water but it is starting to develop for sanitation. ENACAL, Nicaragua's state water and sewerage utility, is the mandated provider of sanitation services, while the INAA is the regulatory agency responsible for the control of drinking water and sanitary sewerage services in Managua. Other ministries involved in FSM include the Ministry of Health (MINSA) and the Ministry of Environment and Natural Resources (MARENA). The former has oversight of sanitary conditions in fecal sludge management while the latter is responsible for environmental oversight with respect to pollution of soils, subsoils, aquifers and surface water bodies. However, specific regulations and norms and standards for FSM are currently lacking. In order to address this issue, FSM-focused regulations, norms and standards are currently being drafted and it is envisaged that this will help engender a more supportive enabling environment in the future. In the short-term, and combined with these ongoing initiatives, a focus on FSM-specific investment along with improved planning of these investments is required to enable the current small-scale service to develop.

The Managua City Government does not play an active role in the city's FSM service; their role being limited to registering the private companies who carry out mechanical pit emptying, issuing licences and collecting taxes – the Municipality do not monitor the operational performance of the companies.

A.3.3. The FSM scorecard

Description of key points in SDA scorecard….

In Managua, the private sector provides a limited pit-emptying and transportation service, which delivers fecal sludge to an ENACAL–run treatment plant. The success of this private sector led activity is indicated by the slightly higher scores for emptying and transport in the maintenance element of the sustaining building block. However, looking both down and across the scorecard it is evident that this is the only bright point on an otherwise low-scoring FSM scorecard.

Overall, the service delivery is weak across all parts of the chain and in all three elements of the FSM framework. The poor enabling environment being the root cause of the lack of a functioning at-scale FSM service.

A.3.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

It is estimated that 4% of the population of Managua practice open defecation while 39% are connected to the city's sewer network. Over half the population therefore use (or have access to) an on-site type sanitation facility; these are "simple [pit] latrines or septic tanks or chambers" and the quality of these containment systems is highly variable: a relatively recent World Bank study (WSP 2008 in Ortuste, 2012) of a sample of Managua households reported that a large majority of the on-site sanitation facilities were found to be inadequate and many were unhygienic.

Emptying:

Ten privately operated companies in Managua provide emptying services. Five of these are formally registered with ENACAL to deliver fecal sludge to the treatment works. The companies are well established and have been in business for between 10 and 45 years; they were originally set up to provide plumbing and water vending services but have expanded into the pit-emptying business.

However, only 2% of the households using on-site sanitation type facilities use these privately run mechanical pit-emptying services. This leaves a large percentage of on-site sanitation users whose pits are not emptied. For the purpose of this analysis it seems reasonable to assume that two thirds of these on-site facilities are either not emptied and abandoned unsafely or overflow to the environment when full, while the remainder are either abandoned safely when they fill up (by covering the pit with soil) or have not yet filled and safely contain the waste.

There are reportedly no manual pit emptiers in Managua.

Transport:

From the information available it is understood that six of the emptying companies discharge fecal sludge at ENACAL's wastewater treatment plant, which infers that the other four companies dispose of their waste by illegal dumping. Therefore, less than 2% of the waste generated from households using on-site sanitation reaches the city's treatment plant.

Treatment:

There is no dedicated fecal sludge treatment plant in Managua but discharge of fecal sludge to the ENACAL-run wastewater treatment plant is permitted. The treatment consists of "thickening, digestion, pressing and drying in sheds". No information on the size or capacity of the treatment plant is available but clearly if the private operators emptying service were to be extended beyond the current level (less than 2% of the non-sewered population) the capacity and performance of the treatment would need to be upgraded.

Reuse/disposal:

There is no formal reuse of fecal sludge or wastewater in Managua.

A.3.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, improving FSM service delivery or partial FSM service delivery)

Overall, and making allowances for poor operation and maintenance of the sewer network and dysfunctional treatment, it is suggested that at least half of the fecal waste generated in Managua is unsafely reused/disposed of to the environment. The majority of this waste is from households not connected to the sewer network who use some form of on-site sanitation. The small scale FSM service in Managua serves around only 2% of the on-site sanitation users and therefore has limited impact on public health or the environment.

References

Ortuste, F. R. (2012). *Living without Sanitary Sewers in Latin America. The Business of Collecting Fecal Sludge in Four Latin American Cities*.

WSP (2008). *Poverty and Sanitation: An Analysis of the Linkage between Poverty and Access to Basic Sanitation in Latin America.*

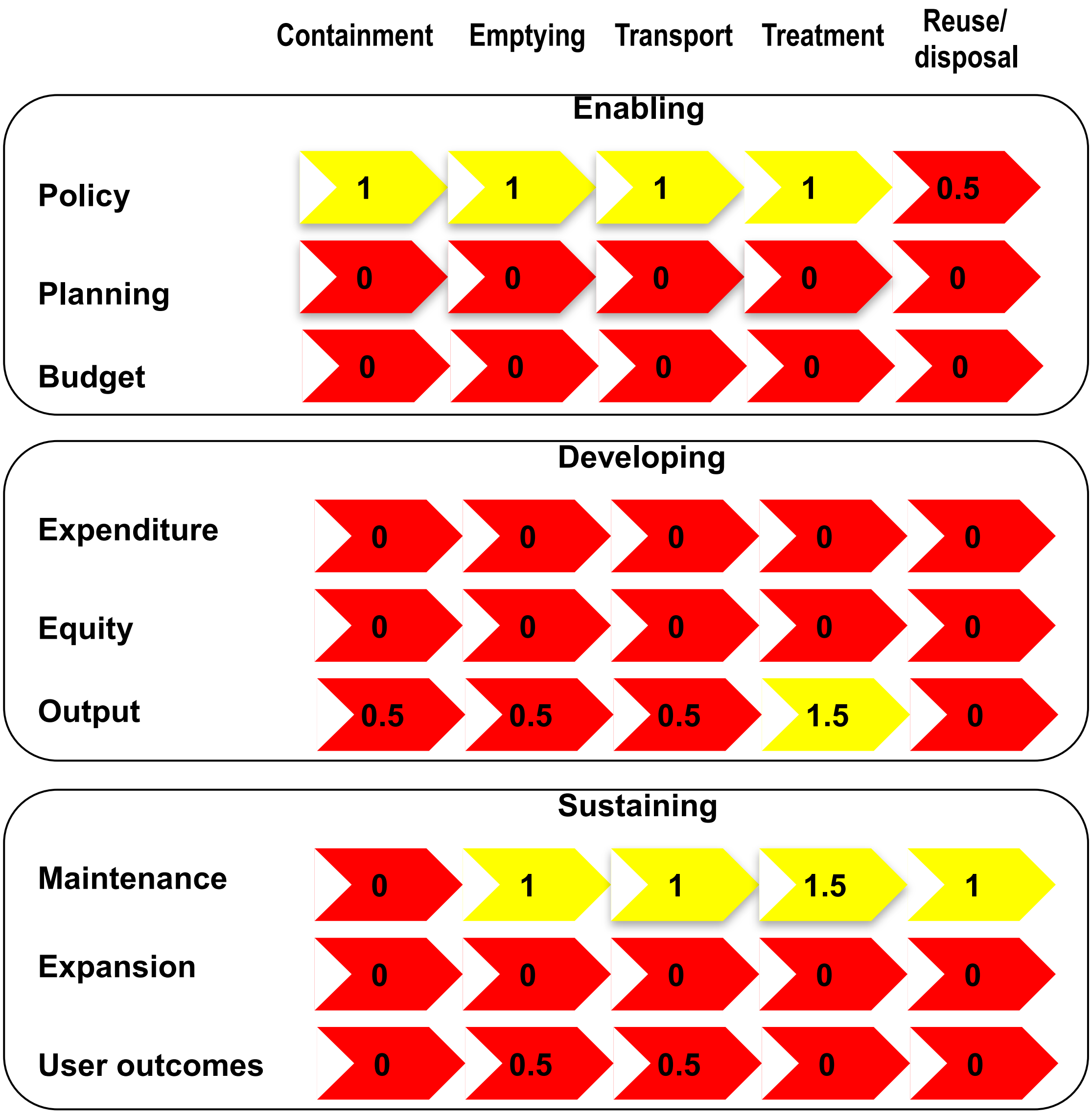


Figure 27: FSM scorecard for Managua, Nicaragua

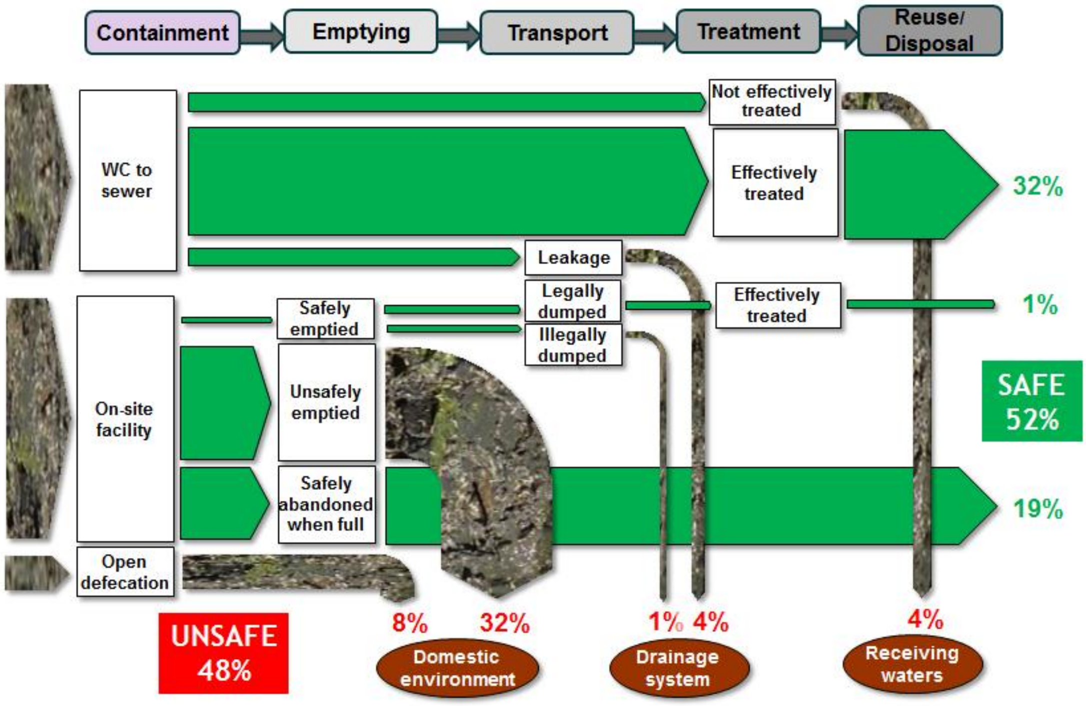
Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 33% to 52%**
Sewered (off site centralised or decentralised)	40%	100%	90%	90%	**32%**
On-site containment - permanent/emptiable	33%	3%	50%	100%	**1%**
On-site containment - single-use/not emptied/safely abandoned (see note 1)	19%	100%	100%	100%	**19%**
Open defecation	8%	0%			
Unsafe: 48% to: 67%		**40%**	**5%**	**4%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:

1. Single-use/not emptied/safely abandoned on-site containment is considered a safe disposal method but data available is poor so total 'safe' and total 'unsafe' are both shown as ranges.

2: All sources shown in waste flow diagram below.

Figure 28: Fecal waste flow matrix for Managua, Nicaragua



Sources:	Open defecation: 4% for urban Honduras (JMP (2012)). Sewered: 39% from Ortuste (2012) Table 4.1, page 20. Assume nominal 10% dysfunctional sewerage and nominal 10% for dysfunctional treatment. Emptied mechanically: 2% of OSS from Ortuste (2012) Table 6.10, p.43 Delivered to ENACAL treatment plant: 60% of emptied mechanically (1% of OSS) from Ortuste (2012) p.33, Table 6.1 and also see text on page 33. Inferred (from Ortuste (2012) p.20) that two-thirds of remaining pits and tanks are abandoned unsafely or overflow to environment when full and one-third are covered safely when full.

Figure 29: Fecal waste flow diagram for Managua, Nicaragua

A.4 Maputo, Mozambique

All data sourced from Muximpua and Hawkins (2011) except where shown.

A.4.1. Summary

Population (millions)	1.9
Percentage of households using on-site sanitation or open defecation	90%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	8% to 26%
Percentage of sewage safely managed	4%
Percentage of fecal sludge from OSS safely managed	8% to 28%

FSM Framework	Poor
FSM Services	Poor
City Type	1

A large proportion of Maputo's population lives in low-income settlements, often in areas with high water table. Greater Maputo comprises Maputo City and Matola. There is no sewerage network in Matola; in Maputo City, about 10% of households have sewer connections, while the remainder depend on septic tanks and latrines of different types and qualities (WSUP/IWA, 2011).

A.4.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

Nationally, sanitation is the responsibility of the National Water Directorate (DNA). In Maputo, the assets and responsibilities of the DNA are in the process of being transferred to the Water and Sanitation Department (DAS) of the Municipal Council (CMM). DAS manages the city's stormwater drainage, sewerage network, wastewater treatment plant and de-sludging of septic tanks and pits but is currently severely under-funded and under-resourced for these roles. In 2009 a new asset-holding company, the *Administração de Infraestruturas de Abastecimento de Água e Saneamento* (AIAS), was created with responsibility for water supply assets in secondary towns and sanitation assets in all urban areas including Maputo. Water supply is regulated by a national regulator, *Conselho de Regulação da Água* (CRA) and in 2009 CRA was also tasked with the regulation of sanitation services. However, as yet the modalities of how AIAS and CRA will perform their respective tasks remain undefined (WSUP, 2012).

A.4.3. The FSM scorecard

Description of key points in SDA scorecard….

The FSM service provided in Maputo is poor as indicated by the low scores in the enabling, developing and sustaining aspects of the FSM scorecard. The relatively high scores for the policy element of the enabling block indicates that the institutional framework is largely in place and significantly the recently agreed National Urban Water and Sanitation Strategy does include FSM. However, the strategy is new and has not yet been operationalized. Therefore, in terms of delivering an FSM service the responsible organisations remain ineffective with little planning and no budgetary allocation for FSM services – hence the poor level of service as indicated in the developing and sustaining blocks. A degree of limited progress is being made by donor-supported local community organisations that have set up small-scale pit-emptying operations but these are not yet operating at scale, and remain dependent on donor support (WUSP, 2011).

A.4.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

It is estimated that 1% of Maputo residents practice open defecation while around 10% are connected to the city's sewer network. The remaining 89% of households use some form of on-site sanitation (Hawkins, 2013). A minority of these are water closets connected to septic tanks but most commonly they are pour flush latrines, improved latrines with a concrete slab or traditional latrines built from tyres, barrels, and/or timber. The quality of construction, particularly of the traditional latrines which are often built by the householders themselves, is generally poor with no quality control either by the households or by local government; this results in a risk of collapse and harm to users as well as posing a threat to the environment and public health.

Emptying:

There is a lack of hygienic toilet desludging services in Maputo. The majority of on-site sanitation is found in the poor peri-urban neighborhoods and these latrines are either emptied manually by individuals or by small-scale contractors with the sludge generally buried in the user's backyard, dumped in the drainage system or in the skips used for secondary collection of solid waste. (Hawkins (2013) estimates that around 60% of non-sewered households carry out this practice and a much smaller percentage (around 20% of pits built by non-sewered households) are not emptied but are buried safely when they become full.)

Some sanitation facilities are emptied mechanically using vacuum trucks but these are mostly septic tanks in the middle-income areas. Two CBOs and one microenterprise, supported by WaterAid and WSUP respectively, also provide mechanical desludging services using small tankers (a VacuTug or a motorized diaphragm pump) and a hand pump (known as a "Gulper"). The municipality also has one vacuum truck but this is often inoperable. It is estimated that around 20% of containment systems in Maputo are emptied mechanically (Hawkins, 2013).

Transport:

Some of the mechanically emptied sludge is transported to treatment but Hawkins (2013) estimates that 25% of the volume emptied is dumped illegally. The reasons for this include the fact that a) the only treatment site is at Infulene which is approximately 9km from Maputo city centre (therefore transportation costs are high) b) the operators have no incentive to deliver the waste to Infulene and c) the CMM does not have the resources to monitor the activity and implement sanctions against illegal dumping.

Treatment:

There is no dedicated fecal sludge treatment plant in Maputo although (as explained above) the discharge of fecal sludge to the Infulene wastewater treatment works stabilization ponds is permitted. However, even then the treatment of the waste that does reach the site is not guaranteed; the site is not maintained at all, and no monitoring is done to assess its effectiveness (Muximpua and Hawkins, 2011). Hawkins (2013) estimates that only 50% of the waste delivered to the site is treated effectively.

Reuse/disposal:

There is no formal reuse of fecal sludge or wastewater in Maputo.

A.4.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, improving FSM service delivery or partial FSM service delivery)

Overall, and making allowances for poor operation and maintenance of the sewer network and dysfunctional treatment, it is suggested that at least three-quarters of the fecal waste generated in Maputo is unsafely reused/disposed of to the environment. The majority of this waste is from households not connected to the sewer network who use some form of on-site sanitation. The small scale FSM service in Maputo is poor; it serves less than a fifth of the users of the users of on-site sanitation and safely treats and disposes of less than half of the waste that they generate.

References

WUSP (2012). *Sanitation surcharges collected through water bills: a way forward for financing slum sanitation? Discussion Paper. Water and Sanitation for the Urban Poor (WUSP). London, UK.*

WSUP/IWA (2011). *Integrating Faecal Sludge Management (FSM) Into Urban Sanitation Planning. Discussion Paper. Water and Sanitation for the Urban Poor (WUSP). London, UK.*

Muxímpua, O., and Hawkins, P. (2011). *Building Blocks For Effective Faecal Sludge Management In Peri-Urban Areas : The Role Of Small-Scale Service Providers In Maputo: Paper Prepared For FSM2, Durban, South Africa* (pp. 1–11).

Hawkins P. (2013). *Personal communication*.

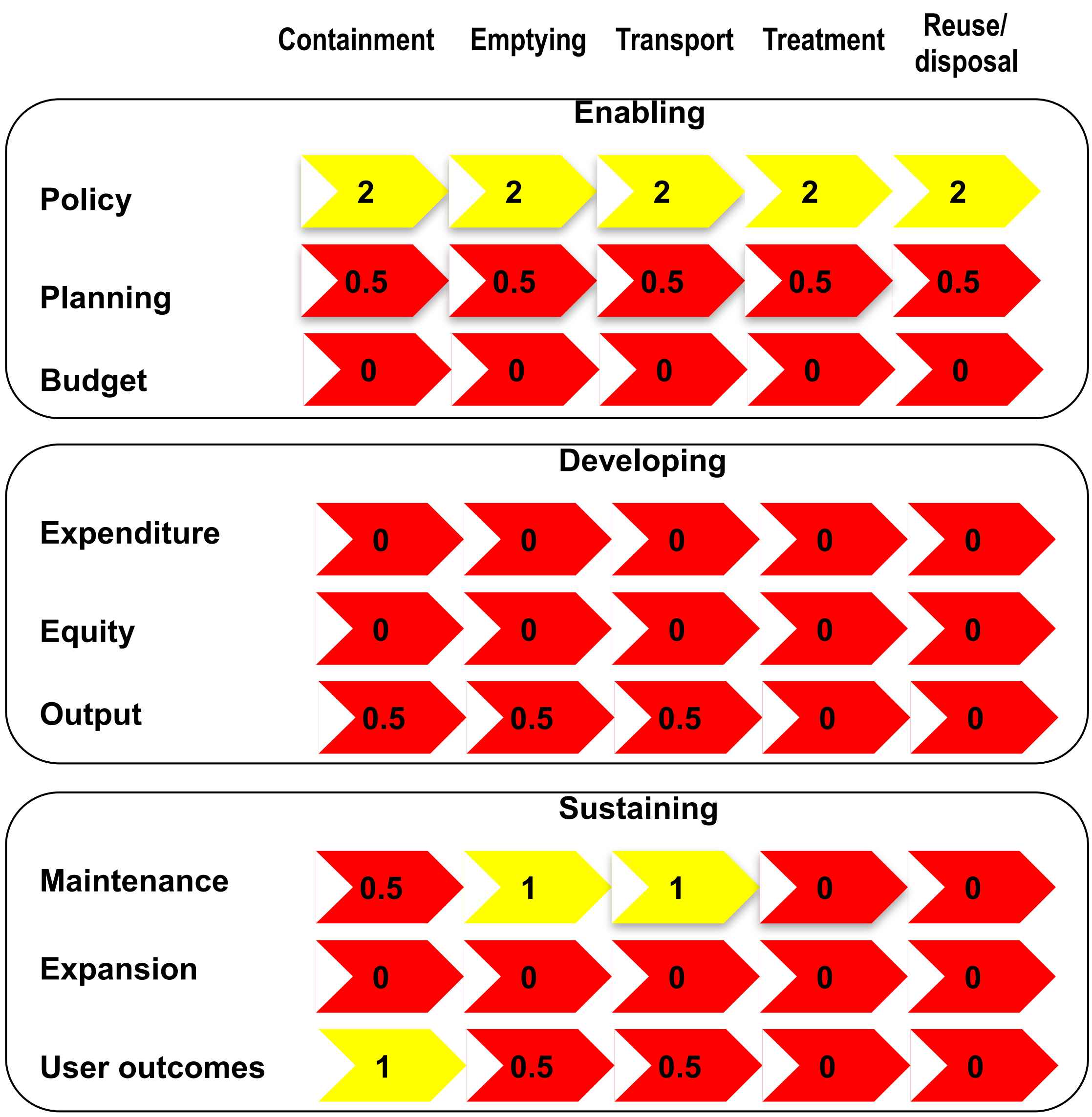
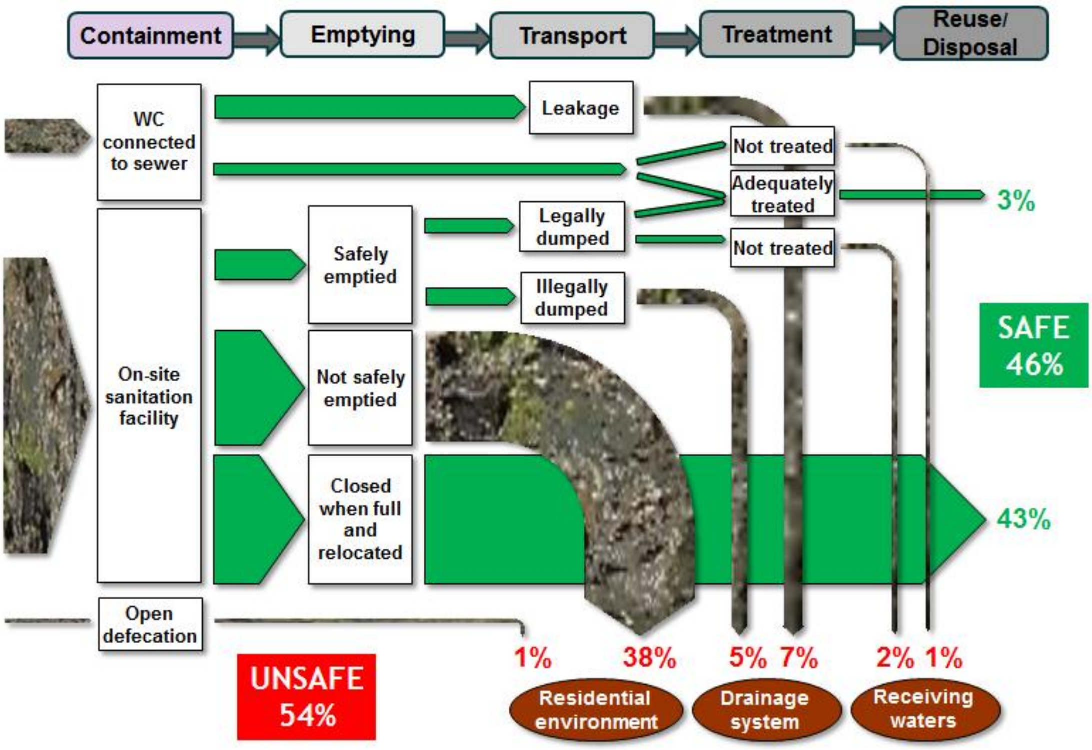


Figure 30: FSM scorecard for Maputo, Mozambique

Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 46%**
Sewered (off site centralised or decentralised)	9%	100%	25%	50%	**1%**
On-site containment - permanent/emptiable	47%	20%	48%	50%	**2%**
On-site contanment - single-use/not emptied/safely abandoned	43%	100%	100%	100%	**43%**
Open defecation	1%	0%			
Unsafe: 56%		**39%**	**12%**	**3%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Figure 31: Fecal waste flow matrix for Maputo, Mozambique



Sources:	From Hawkins (2013) unless otherwise stated. Sewered: 10%; on-site sanitation: 89%; and open defecation: 1%. (Note: Maximpua and Hawkins (2011) quote sewered percentage as 15% but not all households are connected). Dysfunctional sewerage: 75%; and defective treatment: 50% For on-site sanitation: not emptied (cover and forget) is 20% of OSS; mechanically emptied is 20% of OSS; and manually emptied: 60% of OSS (100% illegally dumped). Illegal dumping: 25% of mechanically emptied Defective treatment: 50% of transported to treatment.

Figure 32: Fecal waste flow diagram for Maputo, Mozambique

A.5 Dakar, Senegal

All data sourced from Scott (2010) except where shown.

A.5.1. Summary

Population (millions)	2.7
Percentage of households using on-site sanitation or open defecation	75%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	21% to 31%
Percentage of sewage safely managed	14%
Percentage of fecal sludge from OSS safely managed	25% to 39%

FSM Framework	Improving
FSM Services	Partial
City Type	3

Sewerage coverage in Dakar is high by comparison with most African cities (25% considering the agglomeration as a whole), with an extensive sewerage system that covers significant areas of the city, although with currently limited coverage of lower-income districts (WUSP, 2012); however, the majority of households use on-site sanitation, notably pour-flush latrines discharging to septic tanks or pits. The FSM service for these households is strengthening as a result of improved planning, investment and a focus on providing a city-wide sanitation service in Dakar; although performance is perhaps lagging behind the development of the enabling environment.

A.5.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

Sanitation in Senegal is under the responsibility of the Ministry of Urbanisation and Sanitation. Through a service contract, the state delegates the responsibility for implementation and management of national sanitation policies to a national sanitation utility, the Office National de l'Assainissement du Sénégal (ONAS), created in 1995.

In 2002, the Programme d'assainissement dans les quartiers périurbains (PAQPUD) was launched with World Bank support. PAQPUD was a major sanitation programme with the aim of improving sanitation services in low-income districts outside central Dakar, through heavily subsidised construction of a) on-site sanitation facilities (mainly two-pit pour-flush latrines) and b) settled sewerage networks (WSUP, 2012).

In 2008, a revised code of sanitation was agreed explicitly stating the roles and responsibilities relevant to the PAQPUD developments. In the same year ONAS signed a new contractual agreement with the state where take a greater responsibility for fecal sludge management and treatment, including establishing a framework for the licensing of the fecal sludge entrepreneurs (Scott, 2010).

ONAS aims to provide sanitation services throughout Dakar and works alongside private pit emptiers although its capacity and commitment to fulfil these responsibilities in practice are limited. Nonetheless, WSUP (2012) observe that ONAS is one of the few utilities in sub-Saharan Africa to accept responsibility for FSM in low-income communities.

A.5.3. The FSM scorecard

Description of key points in SDA scorecard….

The FSM scorecard for Dakar shows that the enabling framework is in place and there is relatively good improvement in the developing and sustaining pillars. The World Bank PAQPUD project has been instrumental to this success through infrastructure investments from containment to treatment and this has had a positive influence. However, the challenge remains to develop and sustain progress following completion of the project.

The key remaining weaknesses appear in 'sustaining' treatment and overall in the lack of positive management of reuse and disposal – which clearly remains a need in all three pillars of the scorecard.

A.5.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

It is estimated that 25% of households in Dakar are connected to city's main sewerage network[10], approximately 2% continue to practice open defecation and the remaining 73% of households use some form of on-site sanitation. These are predominantly pour flush latrines discharging to septic tanks (56%) or pit latrines of various types (11%) (Scott, 2010).

Emptying:

Manual emptying by contractors (known locally as "*baay pelle*") continues to be the most common desludging method employed in Dakar, with as much as 40% of the fecal waste produced being handled manually. However, for the purpose of this analysis it is considered that a proportion of this waste (estimated to be approximately one-quarter) is not emptied but buried safely by households when a pit fills up. Nevertheless, the vast majority is still unsafely removed from the pit and buried locally with great risk to both public health and the environment.

EDE and H_2O (2011) report that there are 50 private operators using mechanical emptying technologies to desludge tanks and pits. These mechanical operators have organised themselves into a pit emptiers association (*Association des Acteurs de l'Assainissement du Sénégal* - A.A.A.S. started in 2007); the manual emptiers remain less organised and tend to operate more locally. It is estimated that 46% of the fecal waste produced by households using on-site sanitation is emptied mechanically and that this includes households in low-income neighbourhoods.

Transport:

The private operators are charged a fee for dumping sludge at the fecal sludge treatment plant, this and the distance from the city centre to the plant deter many drivers from discharging their loads legally and they choose to dump the waste illegally. It is estimated that 30% of the exhausted sludge is dumped illegally.

Treatment:

There are three fecal sludge treatment pints in Dakar built under the PAQPUD project. The capacity of these plants is difficult to ascertain from literature but EDE and H2O report that they now "deal with loads far beyond their capacity" and it is estimated that due to dysfunctional treatment 25% of the sludge delivered is discharged untreated.

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[10] Scott (2010) observes that a handful of semi-collective settled sewage schemes have been installed across several areas of Greater Dakar, first by the NGO ENDA-RUP and subsequently as part of the national sanitation strategy for urban areas. However, the coverage of these is limited compared to the main city network.

Reuse/disposal:

There is no formal reuse of fecal sludge or wastewater in Dakar.

A.5.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, improving FSM service delivery or partial FSM service delivery)

While the FSM service in Dakar has developed significantly over the last 10 years the waste flow diagram shows that despite these improvements it is estimated that only 50% of the fecal sludge collected is actually treated before disposal; equivalent to 25% of the total fecal waste generated by households using on-site sanitation. While there is some doubt about the proportion of waste that is safely buried and does not need treating it is clear that the current provision in Dakar can be considered to be a partial FSM service.

References

WUSP (2012). *Sanitation surcharges collected through water bills: a way forward for financing slum sanitation? Discussion Paper. Water and Sanitation for the Urban Poor (WUSP). London, UK.*

EDE and H_2O. (2011). *Landscape Analysis & Business Model Assessment In Fecal Sludge Management: Extraction & Transportation Models In Africa – Senegal*.

Scott, R. (2010). *Unbundling Tenure Issues for Urban Sanitation Development*. Loughborough University of Technology.

	Containment	Emptying	Transport	Treatment	Reuse/ disposal
Enabling					
Policy	1.5	2.5	2.5	1.5	1
Planning	3	3	3	3	0
Budget	1.5	1.5	1.5	1.5	0
Developing					
Expenditure	1.5	1.5	1.5	1.5	0
Equity	1.5	1.5	1.5	1.5	0
Output	1.5	1.5	1.5	1	0
Sustaining					
Maintenance	1.5	1.5	1.5	1	0
Expansion	1	1.5	1.5	1	0
User outcomes	2	1	1	0	0

Figure 33: FSM scorecard for Dakar, Senegal

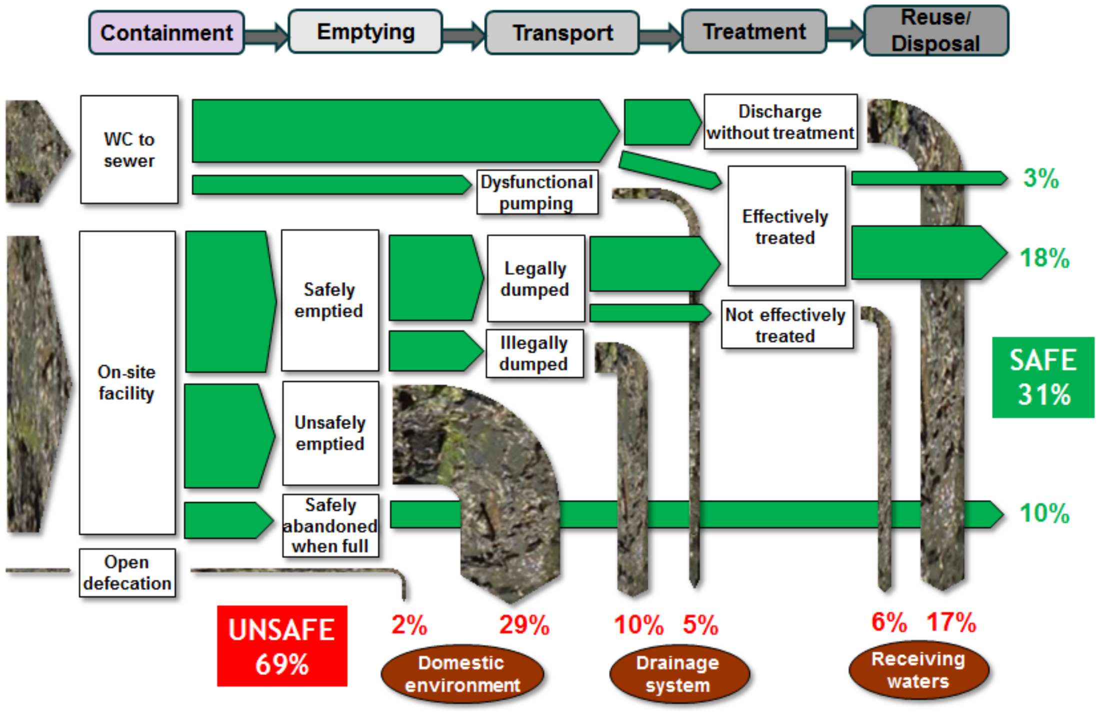
Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 21% to 31%**
Sewered (off site centralised or decentralised)	25%	100%	80%	15%	**3%**
On-site containment - permanent/emptiable	63%	53%	70%	75%	**18%**
On-site containment - single-use/not emptied/safely abandoned (see note 1)	10%	100%	100%	100%	**10%**
Open defecation	2%	0%			
Unsafe: 69% to: 79%		**31%**	**15%**	**23%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:

1. Single-use/not emptied/safely abandoned on-site containment is considered a safe disposal method but data available is poor so total 'safe' and total 'unsafe' are both shown as ranges.

2: All sources shown in waste flow diagram below.

Figure 34: Fecal waste flow matrix for Dakar, Senegal



Sources: Adapted from Scott (2010) and as otherwise stated.
Sewered: 25%; on-site sanitation: 73%; and open defecation: 2%.
Dysfunctional pumping 20% of sewered (Hawkins, 2013); discharged without treatment 66% of sewered; treated 14% of sewered.
For on-site sanitation: not emptied (cover and forget) 14% of OSS; mechanically emptied 46% of OSS; and manually emptied 40% of OSS.
Illegal dumping: 30% of mechanically emptied
Defective treatment: 25% of transported to treatment.

Figure 35: Fecal waste flow diagram for Dakar, Senegal

A.6 Kampala, Uganda

All data sourced from WSP (2008) except where shown.

A.6.1. Summary

Population (millions)	1.5
Percentage of households using on-site sanitation or open defecation	91%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	19% to 40%
Percentage of sewage safely managed	78%
Percentage of fecal sludge from OSS safely managed	12% to 37%

FSM Framework	Improving
FSM Services	Poor/Improving
City Type	2

The sanitation sector in Uganda is under-funded and, despite the fact that at the national level the institutional and legal framework is largely in place, poor regulation, a lack of enforcement and the limited functionality of the city's treatment works have all had a negative impact on Kampala's environment and the health of its residents. The majority of households in Kampala use on-site sanitation as the city's sewerage network covers less then a tenth of the population but Kampala City Council is itself under-resourced and has limited capacity to discharge its mandate for on-site sanitation.

A.6.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

The institutional framework for sanitation service delivery in Uganda is defined although the interface between the various stakeholders in some areas is somewhat blurred and the emphasis remains on sewerage. ; Recent developments indicate an increased understanding of the importance of FSM.

Responsibility for providing and managing sewerage in the country rests with the National Water and Sewerage Corporation (NWSC) while on-site sanitation is the responsibility of municipalities. The Kampala City Council (KCC) being mandated to manage on-site sanitation in Kampala.

The Ministry of Environment (NEMA) through the Directorate of Water Resources Management (DWRM) carries out regulation of the sector. NEMA manages and enforces environmental legislation using national waste management regulations while wastewater discharge and sewerage regulations are also in place. However, in Kampala (and generally in Uganda) NEMA focuses on management of solid and hazardous wastes and leaves supervision of FSM to the KCC. The KCC meanwhile has limited capacity to implement their mandate and also focuses on solid waste – spending 90% of their sanitation budget on solid waste (Mutono, 2013). As a result private emptiers have emerged to fill the gap in service while treatment plants in Kampala are run by the NWSC.

Recognising the need for change and the importance of on-site sanitation, FSM is now being incorporated within new strategies and programmes. For instance, the current

Kampala Sanitation Master Plan has provision for constructing sludge treatment facilities as well as improving the collection of sludge, while a new European Union–funded project in Kampala is dedicated to developing an integrated city-wide on-site sanitation concept with an emphasis on FSM (Mutono, 2013).

A.6.3. The FSM scorecard

Description of key points in SDA scorecard….

The FSM scorecard for Kampala shows that the framework is being developed and parts of it are in place, particularly at the level of policy and planning. There is however, clearly, inadequate budget to facilitate significant development of infrastructure except in treatment.

Improvements in treatment capacity are expected following recent expenditure (and reports suggests that more are planned (Mutono, 2013)). Emptying and transporting fecal sludge is taking place although on a limited scale; the private sector-led mechanical pit emptying service shows signs of improvement and could potentially become consolidated to deliver some of the needed services. Overall areas of weakness remain in equity and output and especially in containment and reuse/disposal.

A.6.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

It is estimated that only 9% of households in Kampala are connected to city's main sewerage network, approximately 1% continue to practice open defecation and the remaining 90% of households use some form of on-site sanitation – a mix of latrines, septic tanks and cess pits. However, there are no enforced standards guiding their construction resulting in poor workmanship and subsequent malfunction of these facilities.

Emptying:

Manual emptying is common in Kampala and it is estimated that one-third of waste from households using on-site sanitation is emptied and buried or dumped locally in open drains. Latrines in the low-income more densely populated areas are often heavily loaded, poorly built, badly maintained and access to enable emptying is often impossible. An estimated 25% of the waste from households using on-site sanitation is left to overflow into the environment when the container is full and unsafely abandoned. It is recognised that some households do prevent contamination of the environment and protect public health by safely covering pits when they fill up – i.e. by safely abandoning them. There is no data to suggest what the percentage is but for the purpose of this analysis it is considered that a quarter of pits are abandoned safely in this manner.

The KCC owns five vacuum trucks and carries out a limited amount of mechanical pit emptying. Private companies known locally as 'cesspool operators' do the majority of mechanical emptying. There are approximately 27 cesspool operators who are all members of a Private Pit Emptiers Association (PEA). In total it is estimated that the KCC and the private operators empty around a fifth of the fecal waste generated in Kampala.

Transport:

The cesspool operators are charged a user fee for delivering sludge to the Bugolobi treatment site. The KCC and NWSC assert that, in order to avoid paying the fee and to reduce their transportation costs, at times the cesspool emptiers illegally discharge waste into the environment. In the absence of any data it is assumed that 10%of the mechanically emptied sludge is dumped illegally by the operators before it reaches treatment.

Treatment:

The cesspool operators transport fecal waste to the Bugolobi treatment plant. The plant has recently been revamped to handle at least 200m^3 per day of sludge but the limited functionality of the plant has been a serious problem in Kampala and for the purpose of the analysis it has been assumed that the treatment process is only 75% efficient – it is anticipated that this will improve following the rehabilitation. Mutono (2013) reports that in addition to Bugolobi a new FSTP at Lubigi will handle 400m^3/day when complete while two other FSTPs are planned. These sites will greatly increase NWSC's fecal sludge treatment capacity.

Reuse/disposal:

There is no formal reuse of fecal sludge or wastewater in Kampala.

A.6.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, limited FSM service delivery or partial FSM service delivery)

Overall in Kampala at least 60% of the fecal waste generated remains untreated and while there is some doubt about the proportion of fecal waste from on-site sanitation that is safely buried by households it is clear that the majority of the untreated waste is from the large number of on-site sanitation facilities. Although some of the FSM framework is in place the actual level of service being delivered is lagging behind the establishment of the enabling environment and the scale of the service is currently limited. The cesspool operators are providing households with an emptying service and the majority of sludge emptied is being treated and safely disposed of but only 14% of fecal waste generated from on-site sanitation is treated.

References

WSP (2008). *Market Analysis Of On-Site Sanitation & Cesspool Emptying Services in Kampala*.

Mutono, S. (2013). *Personal communication*.

	Containment	Emptying	Transport	Treatment	Reuse/ disposal
Enabling					
Policy	2.5	1.5	1.5	1.5	1.5
Planning	2	1	1	1.5	1
Budget	0	0	0	1.5	0
Developing					
Expenditure	0	0	0	1.5	0
Planning	0	0	0	0	0
Budget	0.5	0	0	1	0
Sustaining					
Maintenance	0	1	1	0	0
Expansion	0	1	1	0	0
User outcomes	1.5	0.5	0.5	0	0

Figure 36: FSM scorecard for Kampala, Uganda

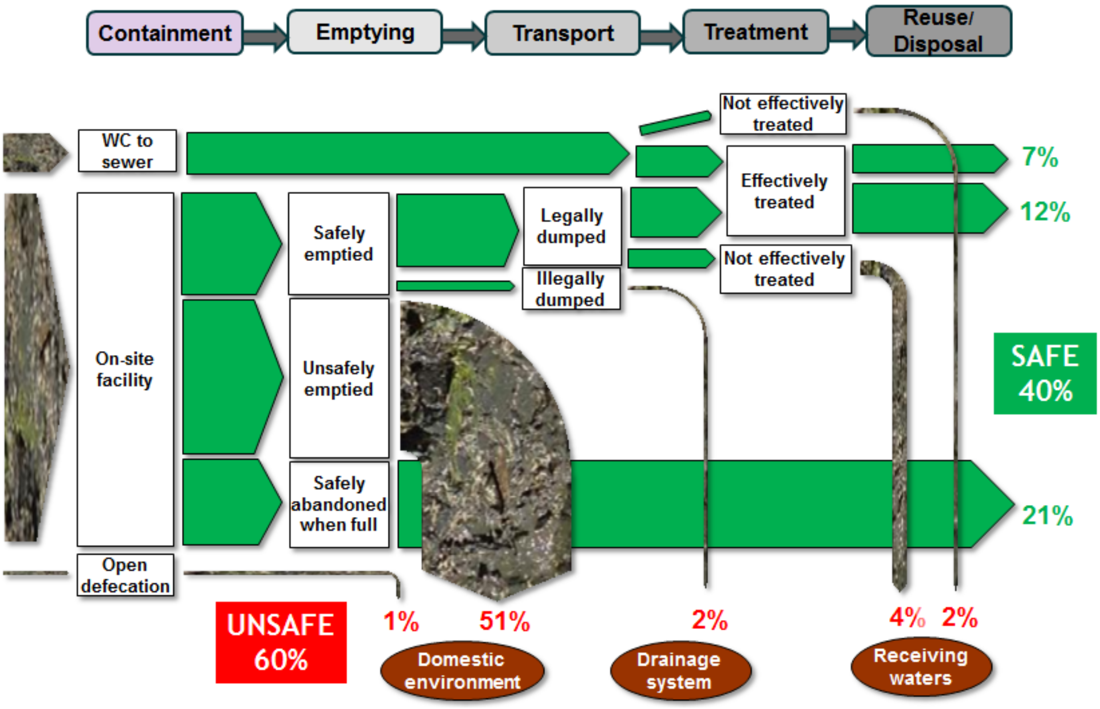
Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 19% to 40%**
Sewered (off site centralised or decentralised)	9%	100%	100%	80%	**7%**
On-site containment - permanent/emptiable	69%	26%	90%	75%	**12%**
On-site containment - single-use/not emptied/safely abandoned (see note 1)	21%	100%	100%	100%	**21%**
Open defecation	1%	0%			
Unsafe: 60% to: 81%		**52%**	**2%**	**6%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:

1. Single-use/not emptied/safely abandoned on-site containment is considered a safe disposal method but data available is poor so total 'safe' and total 'unsafe' are both shown as ranges.

2: All sources shown in waste flow diagram below.

Figure 37: Fecal waste flow matrix for Kampala, Uganda



Sources:	From WSP (2008) unless otherwise stated. Sewered: 9%; on-site sanitation: 90%; and open defecation: 1%. Dysfunctional treatment: 20% of sewered (nominal) For on-site sanitation: not emptied (cover & forget) 25% of OSS; mechanically emptied 20% of OSS; manually emptied 30% of OSS (100% illegally dumped or buried); not emptied and abandoned unsafely 25% of OSS (all Mutono, 2013). Illegal dumping: 10% of mechanical emptying (nominal) Dysfunctional treatment: 25% of transported to treatment (nominal)

Figure 38: Fecal waste flow diagram for Kampala, Uganda

A.7 Dhaka, Bangladesh

All data sourced BMGF (2011b) except where shown.

A.7.1. Summary

Population (millions)	16
Percentage of households using on-site sanitation or open defecation	80%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	2%
Percentage of sewage safely managed	12%
Percentage of fecal sludge from OSS safely managed	0%

FSM Framework	Poor
FSM Services	Poor
City Type	1

The sanitation service in Dhaka is extremely poor with virtually all of the fecal waste generated being reused/disposed of unsafely to the environment. The sewer network covers only a small proportion of city and due to dysfunctional sewerage and treatment all but a fraction of the sewage is discharged untreated to the Buriganga River. There is no FSM service chain; the majority of households use a mix of pits, septic tanks and cess pits which are connected/overflow to the river via Dhaka Corporation's storm sewers open drains or local sewer networks.

A.7.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

The statutory responsibility for the sanitation sector in Bangladesh is vested in the Ministry of Local Government, Rural Development and Cooperatives (MoLGRD), while the functional responsibility is delegated to the Department of Public Health Engineering (DPHE) in all rural and urban areas except Dhaka and Chittagong (GoB, 2008).

In Dhaka, the institutional framework for delivery of WASH-related services is complex, with responsibility split between two municipal entities – Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC) – and Dhaka Water and Sewerage Authority (DWASA) an agency which reports directly to national government. DWASA is an autonomous public body under the MoLGRD, with the mandate to provide water supply and sewerage services to Dhaka's residents; meanwhile the DNCC and DNSCC are responsible for solid waste management, surface drainage and implementation of on-site sanitation in their respective areas. However, while solid waste and surface drainage services are managed, neither Corporation discharges its responsibility for on-site sanitation; consequently there is no organisation within the city that is responsible for disposal of fecal waste generated by those who do not have a sewer connection – estimated to be 80% of the 16 million population. Responsibility for environmental monitoring falls under the auspice of the district office of the Department of Environment but their focus remains restricted to drinking water quality and air quality monitoring and they pay little attention to pollution of surface water bodies by fecal sludge.

A.7.3. The FSM scorecard

Description of key points in SDA scorecard….

Urban sanitation policy in Bangladesh is focused on ensuring access to a sanitary latrine for all households by 2015 using technology options from pit latrines to water borne sewerage (GoB, 2008). However, while it is widely acknowledged that urban sanitation is currently unsatisfactory the management of FS downstream of the latrine is not covered by policy and there are no targets set for improving its management. The GoB focus is primarily on promotion of latrine use and improving coverage rates with little planning or capital investment downstream of the household level.

The FSM scorecard for Dhaka highlights how poor the FSM service delivery is. Looking down the scorecard the scores are very low, and looking across this is true for all aspects of the service chain. There is no investment planning or budgetary allocation at the national level and there is little indication that the MoLGRD is taking steps to improve the situation. Therefore, the sector remains undeveloped and any FSM service operates in Dhaka (and other cities) without regulations, laws, ordinances or bye-laws.

A.7.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

It is estimated that 1% of the population of Dhaka practice open defecation while 20% are connected to the DWASA sewer network. The balance use a mix of pit latrines, septic tanks and cess pits which are connected to open drains and crude informally-constructed sewers. Owners have modified these containment systems so that rather being "on-site" facilities the fecal waste overflows when the container is full and is carried to the river via open drains and local sewers (and even the Corporation storm sewer network) so there is little or no demand for desludging.

Emptying:

There being little demand for emptying only 10% of non-sewered households use an emptying service. The majority of these (90%) use manual emptiers who bury or dump the sludge in the local environment (BMGF, 2011b and confirmed by Tayler, 2013).

Mechanical sludge emptying is provided by two non-governmental organisations (Dustha Shystha Kendra (DSK) (since 2001) and Population Services and Training Centre (PSTC) (since 2009)) with financial support from WaterAid, Bangladesh. They use small mechanical emptiers known as 'Vacutugs' that can access the narrow lanes along which many poor households in the slum areas are situated. However, each NGO only has one machine and it is estimated that less than 1% of fecal waste generated in Dhaka is emptied by this method.

Transport:

The NGOs report that since there is no fecal sludge treatment or disposal facility they discharge fecal sludge to the Corporation's storm sewer network at locations agreed with Corporation officials. This material therefore also remains untreated and is disposed of unsafely to the environment. There are no private operators who use mechanical pit emptying vacuum type trucks in Dhaka.

Treatment:

There is no fecal sludge treatment plant in Dhaka and it is reported that none of the exhausted sludge is taken to the city's only wastewater treatment plant at Pagla.

Reuse/disposal:

There is no formal reuse of fecal sludge or wastewater in Dhaka.

A.7.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, limited FSM service delivery or partial FSM service delivery)

Overall the management of fecal sludge in Dhaka is virtually non-existent - all of the fecal sludge emptied from pits remains untreated and the remainder which is not emptied overflows from the various containment systems to be unsafely reused/disposed of to the environment.

References

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BMGF (2011B). *Landscape Analysis and Business Model Assessment in Faecal Sludge Management: Extraction and Transportation Models in Bangladesh - Final Report*.

Tayler, W. K. (2013) *Personal communication*.

	Containment	Emptying	Transport	Treatment	Reuse/ disposal
Enabling					
Policy	1	0.5	0.5	0	0
Planning	0	0	0	0	0
Budget	0	0	0	0	0
Developing					
Expenditure	0	0	0	0	0
Equity	0	0	0	0	0
Output	0	0	0	0	0
Sustaining					
Maintenance	0.5	0.5	0.5	0	0
Expansion	0	0	0	0	0
User outcomes	0.5	0.5	0.5	0	0

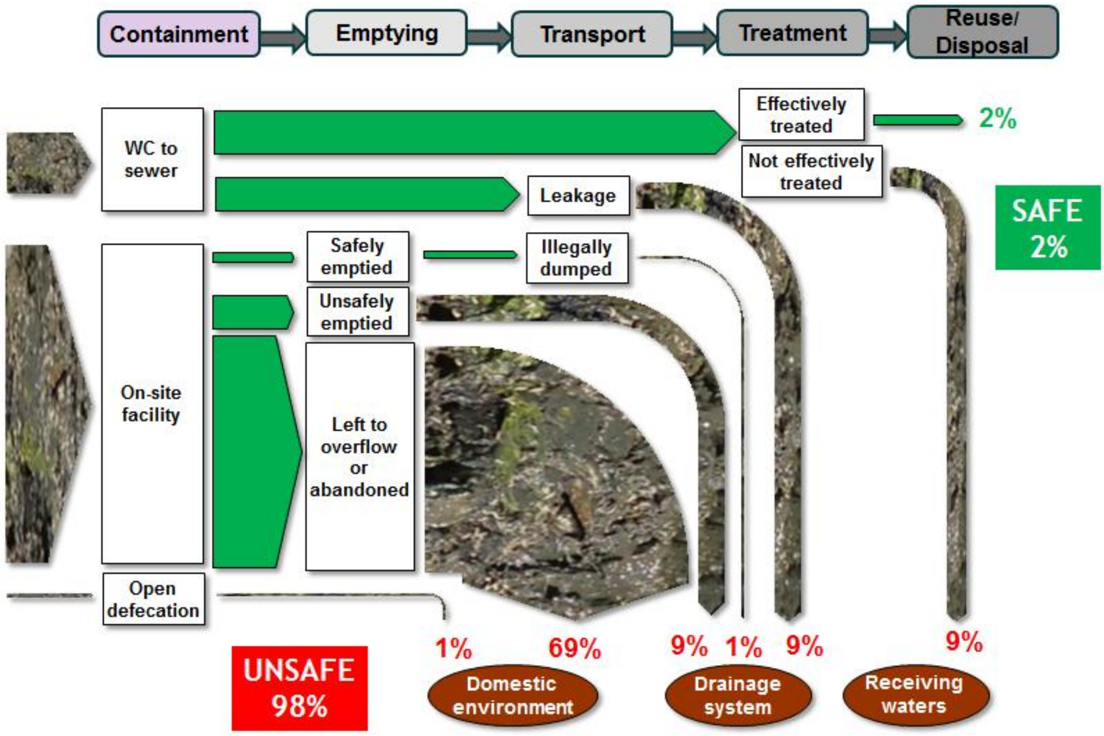
Figure 39: FSM scorecard for Dhaka, Bangladesh

Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 2%**
Sewered (off site centralised or decentralised)	20%	100%	55%	18%	**2%**
On-site containment - permanent/emptiable	79%	1%	0%	0%	**0%**
On-site containment - single-use/not emptied/safely abandoned	0%	100%	100%	100%	**0%**
Open defecation	1%	0%			
Unsafe: 98%		**79%**	**10%**	**9%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:

1: All sources shown in waste flow diagram below.

Figure 40: Fecal waste flow matrix for Dhaka, Bangladesh



Sources: BMGF (2011B) unless stated otherwise.
Open defecation: 1% (BMGF, 2011b and JMP, 2012 for urban Bangladesh)
Sewered 20% (BMGF, 2011b); dysfunctional sewered 45% of production; treatment 12% of sewered (Tayler, 2013)
Non-sewered population: 78%; emptied by NGOs 1% of production; manual emptying 10% of production; not emptied and overflows to environment 89% of production (BMGF, 2011b and Tayler, 2013).

Figure 41: Fecal waste flow diagram for Dhaka, Bangladesh

A.8 Delhi, India

All data sourced from BMGF (2011d) except where shown.

A.8.1. Summary

Population (millions)	16.3
Percentage of households using on-site sanitation or open defecation	25%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	34%
Percentage of sewage safely managed	45%
Percentage of fecal sludge from OSS safely managed	0%

FSM Framework	Poor
FSM Services	Poor
City Type	1

The sanitation service in Delhi is very poor with only a third of the waste generated being treated and disposed of safely. The city's FSM service is extremely unsatisfactory with none of the sludge emptied from on-site sanitation being treated and disposed of (or reused) safely.

A.8.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

In 2008, the Ministry of Urban Development (MOUD) issued the National Urban Sanitation Policy (NUSP). The policy sets goals to: raise awareness and promote behavior change; achieve ODF cities; develop citywide sanitation plans; and provide 100% safe confinement, transport, treatment and disposal of human excreta and liquid wastes. The NUSP mandates states to develop state urban sanitation strategies and work with cities to develop city sanitation plans. Furthermore, it explicitly states that cities and states must issue policies and technical solutions that address onsite sanitation, including the safe confinement of fecal sludge (USAID, 2010).

Nevertheless, the NUSP is relatively new and FSM in India continues to receive little attention and inadequate funding. The Urban Local Bodies (ULBs) who are mandated with responsibility for sanitation in cities are critically understaffed and underfunded.

The provisions for regulating sewage management exist under environmental laws that cover water and disposal of wastewater but management of on-site sanitation and fecal sludge is not covered, except in specifying prohibition of its discharge into water bodies. By default, FSM is covered under Municipal Wastes (Handling and Management) Rules 2000 but separate regulation does not exist and guidelines and enforcement laws are completely absent. This lack of existing local and state policies and management practices is restricting the ULBs capacity to manage FS.

A.8.3. The FSM scorecard

Description of key points in SDA scorecard….

The FSM scorecard for Delhi highlights that framework is weak in all three building blocks. The 2008 NUSP provides a foundation for FSM at the national but weak planning and budgetary capacity are restricting improvements at the city level. Significantly there are no dedicated fecal sludge treatment plants in the whole of India. The nationally led focus on increasing sanitation coverage – which has resulted in high levels of access to sanitation - is indicated by the slightly higher scores for the containment element of the service chain. However, the generally low scores in the developing and sustaining blocks indicate the low level of involvement of the ULBs (city governments) in managing the collection and disposal of fecal sludge.

A.8.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

It is estimated that 1% of the population of Delhi practice open defecation while 75% are connected to the city's sewer network[11]. The remaining 24% have access to an on-site type sanitation facility with the use of traditional pit latrines and septic tank type systems being roughly equal. However, the quality of the containment systems is variable and commonly, in order to avoid having to empty pits and tanks, the owners adapt their facility to allow them to overflow in to open drains and local sewers that discharge into the municipalities storm water sewers.

Emptying:

It is estimated that 29% of the non-sewered households use a mechanical pit emptying service provided by around 35 small 'one-truck' private companies. The service they provide is variable and they operate without any control. Importantly, they do not need a profession-specific license to operate and the Municipal Corporation of Delhi (MCD) does not regulate or supervise their activity.

The Constitution of India has banned manual emptying (known as scavenging) and requires cities to provide scavengers with alternative, dignified work. BMGF (2011d) reports that the prevalence of manual pit emptying has reduced considerably in Delhi in recent years but the practice does continue. Current estimates suggest that around 4% of Delhi households who use on-site sanitation use a manual pit emptier who then buries or dumps the waste locally. Manual emptying remains an occupation carried out by members of the scheduled castes (regardless of whether or not they are government or private employees) and this cultural practice has resulted in low levels of political and societal interest in sanitation and FSM in particular (USAID, 2010).

Transport:

The mechanical sludge emptying companies transport the fecal waste to the three sanitary landfills sites or dump the waste illegally in open drains and on open fields. Nevertheless, since disposal to landfill sites is not a safe solution all the sludge emptied from pits (around 7% of fecal waste generated) is disposed of unsafely.

Treatment:

There is no fecal sludge treatment plant in Delhi and none of the exhausted sludge is taken to the various wastewater treatment plants.

Reuse/disposal:

There is no formal reuse of fecal sludge or wastewater in Delhi.

A.8.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, limited FSM service delivery or partial FSM service delivery)

Overall the management of fecal sludge in Delhi is poor with all of the fecal sludge emptied from pits remaining untreated and unsafely reused/disposed of to the

[11] Note: actual coverage of the sewer network is hard to ascertain and varies greatly from 20% (IBNET); 55% (Wall Street Journal, 2012); 73% (Delhi Jal Board, 2004); to 75% (BMGF (2011d)

environment. Furthermore, since only 45% of the waste generated from households connected to the sewer network is treated, it is estimated that at least two-thirds of the total waste generated in Delhi is unsafely reused or disposed of to the environment.

References

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Wall Street Journal (2012). *Website of livemint and the Wall Street Journal. Available at:* http://www.livemint.com/Politics/jEeuBjNuANQNiqF4nuf5EM/Only-55-of-Delhi-homes-connected-to-sewerage-system.html. Accessed on 5 March 2013.

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CPCB (2004). *Status Of Sewerage And Sewage Treatment Plants In Delhi. Central Pollution Control Board. GoI, India.*

	Containment	Emptying	Transport	Treatment	Reuse/ disposal
Enabling					
Policy	1	1	1	0.5	0.5
Planning	0	0	0	0	0
Budget	0	0	0	0	0
Developing					
Expenditure	0	0	0	0	0
Equity	0	0	0	0	0
Output	0.5	0.5	0.5	0	0
Sustaining					
Maintenance	0.5	1	1	0	0
Expansion	1	0	0	0	0
User outcomes	0.5	0.5	0.5	0	0

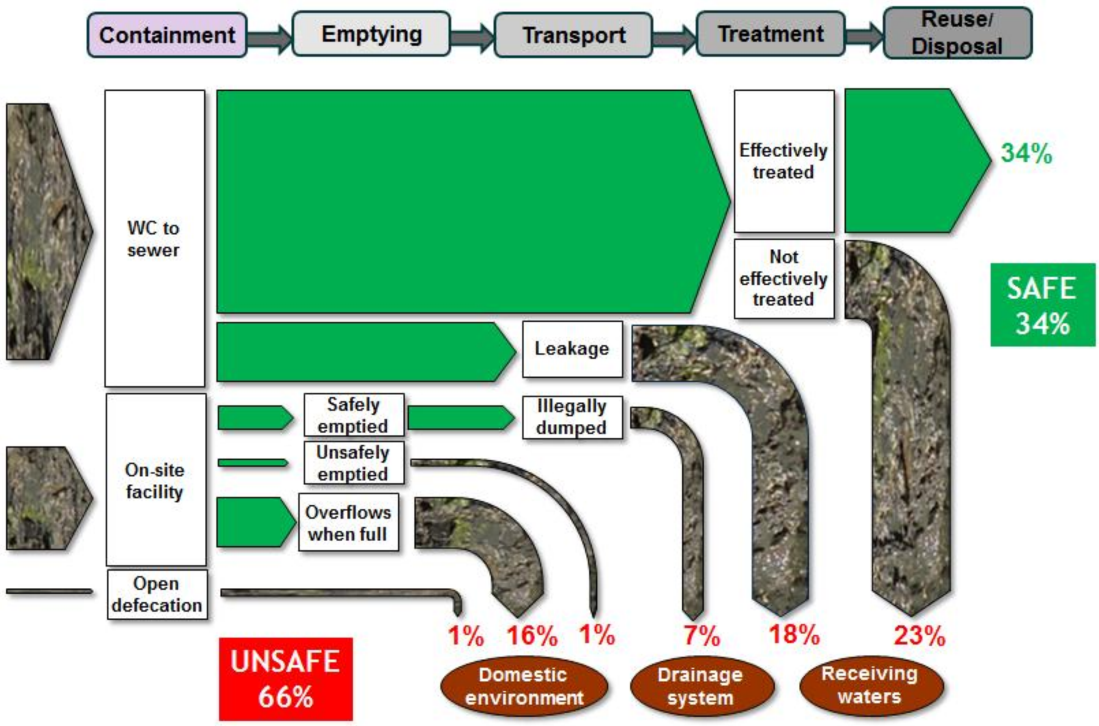
Figure 42: FSM scorecard for Delhi, India

Fecal waste flow matrix Type of system	% of FW	*of which* *safely collected*	*of which* *safely delivered*	*of which* *safely treated*	**Safe: 34%**
Sewered (off site centralised or decentralised)	75%	100%	76%	60%	**34%**
On-site containment - permanent/emptiable	24%	29%	0%	0%	**0%**
On-site containment - single-use/not emptied/safely abandoned	0%	100%	100%	100%	**0%**
Open defecation	1%	0%			
Unsafe: 66%		**18%**	**25%**	**23%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:

1: All sources shown in waste flow diagram below.

Figure 43: Fecal waste flow matrix for Delhi, India



Sources:	Open defecation is a nominal 1% (BMGF 2011 (d)); p.24.
	Sewered 75% and non-sewered 24% from BMGF (2011d); Table 2.1.
	Sewerage production that is treated: 45% (CPCB, 2004) p.2.
	Manually emptied (4% of OSS) and percent mechanically emptied (29% of OSS) from BMGF (2011d); p.42
	Mechanically emptied and disposed of in sanitary landfills (100%) from BMGF (2011d) p.38.
	Not emptied (67% of OSS) (BMGF (2011d) p.42 and allowed to overflow to environment (BMGF 2011d) p.38.

Figure 44: Fecal waste flow diagram for Delhi, India

A.9 Phnom Penh, Cambodia

All data sourced from Frenoux et al (2012) except where shown.

A.9.1. Summary

Population (millions)	1.6
Percentage of households using on-site sanitation or open defecation	75%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	0%
Percentage of sewage safely managed	0%
Percentage of fecal sludge from OSS safely managed	0%

FSM Framework	Poor
FSM Services	Poor
City Type	1

The sanitation service in Phnom Penh is poor. A sewer network serves a quarter of the city but all of the wastewater collected is discharged untreated to the local river network. The city's FSM service is provided by the private sector who provide a mechanical pit emptying service; however, the service is unregulated and uncontrolled and none of the waste removed is treated effectively. Consequently, one hundred percent of the fecal waste generated in the city is reused/disposed of unsafely to the environment.

A.9.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

The institutional framework for sanitation service delivery in Phnom Penh is unclear with several ministries involved but with poorly defined roles and responsibilities between public health issues, drainage and sanitation management issues.

In urban areas of Cambodia (including Phnom Penh) the Ministry of Public Works and Transport (MPWT) is responsible for urban drainage and sanitation. However, the MPWT is under-resourced for the task with a low capacity for investment and limited skills for managing services. The other significant ministries include: the Ministry of Environment (MoE) which is in charge of water pollution control and environmental protection; the Ministry of Land Management and Urban Planning (MoLMUP) which is responsible for construction standard control and issuing of construction permits; and the Ministry of Industry Mines and Energy (MIME) which is in theory responsible for urban sanitation at the household level and issuing of licenses for sanitation operators, but it remains inactive in this role.

The legal framework is weak. The 2003 National Policy on Water and Sanitation is the only document that frames urban sanitation. However, urban sanitation remains low on the political agenda and there is no strategic plan or laws to detail or enforce this policy (Tsitsikalis, 2012). Invariably, where sanitation issues are addressed, the focus is on providing sewerage and not FSM.

A.9.3. The FSM scorecard

Description of key points in SDA scorecard….

The FSM scorecard for Phnom Penh highlights that the framework is weak. FSM is not covered by national policy and there are no targets, strategies or political will to address the challenge. In Phnom Penh, the sub-sector remains unplanned and devoid of investment with a poor FSM service, resulting in the low scores shown both down and across the scorecard. Private pit emptiers provide a low level of service to a limited number of households and this is recognised by the marginally improved scores for emptying and transport in the output and maintenance elements of the developing and sustaining blocks respectively.

A.9.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

It is estimated that 3% of Phnom Penh's population practice open defecation while the majority (61%) use a pit or septic tank type containment facility which is then in-turn connected to a combined sewer system. Approximately 25% of the population connect directly to the sewer network (without using a pit or tank) while estimates suggest that the remaining 11% of the population use on-site sanitation only. The quality of all pits and septic tanks (regardless of whether or not they are connected to the sewer network) varies enormously and there is no control over the type and/or quality of containment constructed.

Similarly, the sewer network is old, poorly maintained and blockages and flooding are common (Kopitopoulous, 2005 in Frenoux et al, 2012).

Emptying:

Only 22% of the population report that they have ever emptied their pit or tank using a mechanical emptying truck operated by a private operator (locally known as an ETO (extraction and transportation operator)). The majority of owners have a containment system that overflows to the local sewer network and/or have never emptied their pit or tank. Of the minority who use only an on-site sanitation system less than 1% report that they have ever emptied their tank or pit but even then this material is then dumped in the local environment. There are 24 manual and 19 mechanical ETOs in Phnom Penh. There is little data on the manual emptiers' activities but Frenoux et al (2012) observe that they are mostly involved in sewer cleaning rather than pit emptying.

Transport:

The 19 mechanical ETOs operate 31 vacuum trucks to remove and (in theory) transport sludge to the authorised wetland treatment site. However, it is reported (Frenoux, 2013) that only one of the operators discharges waste at the site, the remainder all discharge illegally; so avoiding the disposal fee and the 10km round-trip to the wetland pumping station. (The MPWT also operate 10 trucks but these are used for sewer cleaning and not pit emptying).

Treatment:

There is no treatment facility in Phnom Penh for wastewater or sludge. The wetlands provide natural removal of biological contamination of the waste discharged to them; however their capacity for treatment is low; only 56% of suspended solids are settled before reaching the river and metal elements (Cadmium, Lead, Copper and Zinc) significantly exceed the WHO standards (Takeuchi Tomonori, 2005 in Frenoux et al, 2012). Furthermore, Nareth et al (2008) (also in Frenoux et al, 2012) indicate that 10% of wastewater is directly discharged into the Tonle Sap and Mekong rivers.

Reuse/disposal:

There is no formal reuse of treated fecal sludge or wastewater. However, the land downstream of the wetlands is used extensively for agriculture (it supplies approximately

20% of the demand for fruit and vegetables in Phnom Penh); farmers use the untreated (or at best only partially treated) wastewater and sludge as irrigation water.

A.9.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, limited FSM service delivery or partial FSM service delivery)

The FSM service in Phnom Penh is very poor. Private sector pit emptiers provide an unregulated, uncontrolled mainly mechanical pit emptying service. However, none of the waste emptied waste is treated effectively, instead it is dumped illegally in the local environment or discharged into wetlands. The sewage collected by the sewer network is also discharged directly into the wetlands and river system without any treatment. The wetlands provide at best only partial treatment and are largely ineffective. Importantly, the land downstream of the wetlands is used extensively for agriculture and use of this largely untreated wastewater and fecal sludge for crop irrigation is of great concern.

References

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Frenoux, C. (2013*). Personal communication.*

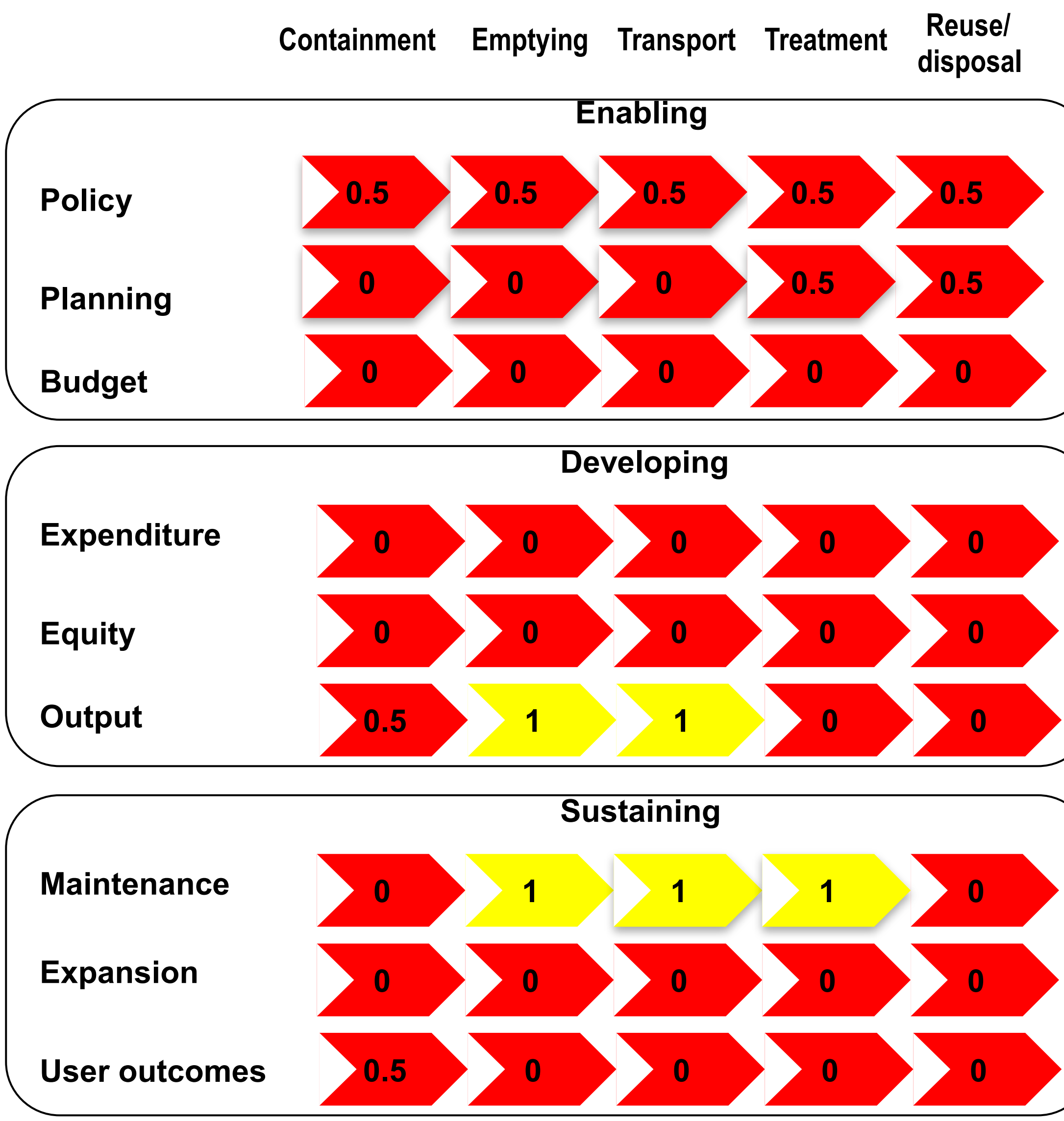


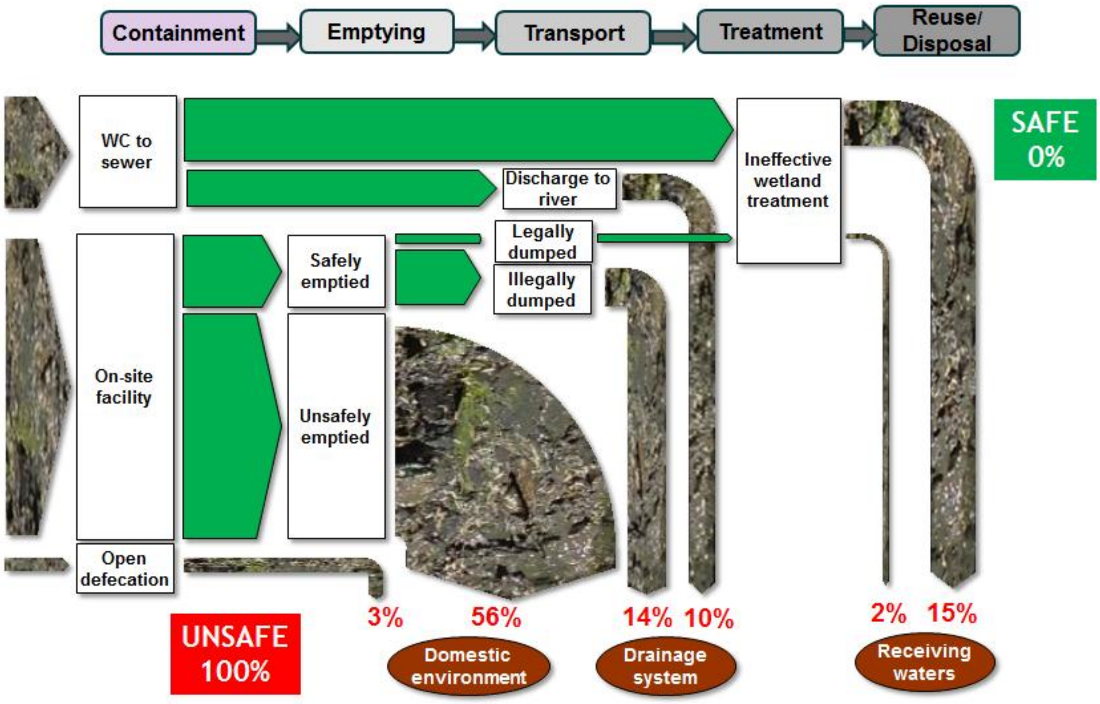
Figure 45: FSM scorecard for Phnom Penh, Cambodia

Fecal waste flow matrix Type of system	% of FW	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: %**
Sewered (off site centralised or decentralised)	25%	100%	60%	0%	**0%**
On-site containment - permanent/emptiable	72%	22%	12%	0%	**0%**
On-site containment - single-use/not emptied/safely abandoned	0%	100%	100%	100%	**0%**
Open defecation	3%	0%			
Unsafe: 100%		**59%**	**24%**	**17%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:

1: All sources shown in waste flow diagram below.

Figure 46: Fecal waste flow matrix for Phnom Penh, Cambodia



Sources: Frenoux et al (2012) unless otherwise stated.
Sewered directly 25%; Mix of pits connected to sewers 61%; on-site only 11%; open defecation 3% (all Frenoux et al 2012, Table 3, p.2)
Mechanical emptying 22% of OSS; illegal dumping 88% of mechanlcally emptied (Frenoux, 2013)
Only treatment is provided in wetland (Choeung Ek Lake) which provides some biological treatment but is largely ineffective.

Figure 47: Fecal waste flow diagram for Phnom Penh, Cambodia

A.10 Palu, Indonesia

All data sourced from Tayler (2013) except where shown.

A.10.1. Summary

Population (millions)	0.35
Percentage of households using on-site sanitation or open defecation	100%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	up to 86%
Percentage of sewage safely managed	NA
Percentage of fecal sludge from OSS safely managed	up to 95%

FSM Framework	Improving
FSM Services	Partial
City Type	3

Most households in Indonesia cities use on-site sanitation (62%) while access to sewerage is low (2.3%); treatment of collected sludge does however lag far behind (4%) (USAID, 2010). There is no sewer network in Palu and it is estimated that over 90% of the households have access to on-site sanitation. These households are served by a local government run FSM service which collects, treats and disposes of the sludge effectively. The demand for the service is low and this is due in part to the type of containment used, the high percolation rate and the local trend for building large tanks that take a long time to fill.

A.10.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

In Indonesia, sanitation is fragmented across the ministries of health, infrastructure, planning and the environment each of which has developed laws that impact on sanitation practices. The major national agencies include the National Development Planning Agency (BAPPENAS), Ministry of Public Works (MPW), Ministry of Health (MoH) and Ministry of Environment (MoE) while at the local level key agencies include the Local Environment Agency (BLH), the Sanitation Agency (Dinas Kebersihan dan Pertamanam – DKP) and Water Utilities (Perusahaan Daerah Air Minum –PDAM). The fragmentation and overlap of authority among so many agencies makes it difficult to create integrated plans for sewerage and FSM development. These national agencies have not provided sufficient policy guidance or funding for cities to develop the necessary institutional and physical capacity and, despite the fact that 66 percent of urban residents use on-site sanitation, in many cities the institutional and legal framework for septage collection, treatment and disposal remains disorganized (USAID, 2010).

Nevertheless, there is evidence that the Government of Indonesia accepts that on-site sanitation will continue to be the norm in urban areas apart from in densely populated areas. These will be served by local ‘communal’ sewered systems discharging to ‘DEWATS’ treatment plants. Both local sewerage and on-site systems will require provision for septage removal, transport and treatment. This is recognised in the Government of Indonesia’s *Acceleration of Sanitation Development in Human Settlements (PPSP*) Program. Furthermore, as part of its commitment to on-site and decentralised systems, the Ministry of Public Works (*Menteri Pekerjaan Umum* or *PU)* will make substantial investments in septage treatment through 2014. Over 150 septage treatment facilities (*Instalasi Pengolahan Lumpur Tinja* or IPLT) were built in Indonesia during the 1990s and by 2009 fewer than 10% of these facilities were still operational; rehabilitation of these facilities is a key challenge to improving FSM service delivery in Indonesia.

Palu's septage is managed by a local technical implementation unit (*unit pelaksana teknis daerah or UPTD*) which falls under Palu Kota's Cleansing and Landscaping Agency. Solid waste management is the responsibility of a separate UPTD under the same agency.

A.10.3. The FSM scorecard

Description of key points in SDA scorecard….

The FSM scorecard for Palu shows that the core of the enabling environment is in place although fragmentation and overlap of authority means that further improvement is required. Overall, there is also significant improvement in the developing and sustaining pillars. The national focus on rehabilitation of treatment plants is evident in the high scores for this part of the chain, while locally in Palu the expenditure, output and maintenance elements all highlight the good level of service being provided to households accessing the service.

Significant areas of weakness remain in the lack of expansion planning to serve the rest of the city and particularly in reuse/disposal which remains a clear need in all three pillars.

A.10.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

Sanitation coverage in Palu is over 91%, provided through up to 70,000 household latrines and 45 communal sanitation facilities (known as MCK units). All sanitation is on-site and most households use pour-flush water closets that discharge to a single compartment open-bottomed tank (locally known as a cubluk) rather than a septic tank with drain field or soakaway. The Ministry of Public Works (PU) provides guidance on on-site sanitation but there are no systems and regulations for implementing this guidance. In low-income areas, some tanks are inaccessible to conventional sludge tankers. Recognizing this problem, residents build large tanks, hoping to defer the need for tank emptying into the distant future. Indeed, tank capacities vary from less than $2m^3$ to over $12m^3$.

Emptying:

The septage management UPTD operates two $4m^3$ capacity sludge tankers, both of which date from 2006 and are in reasonable condition. Together, these tankers desludge an average of about 1400 tanks per year, meeting current demand and operating efficiently, close to their maximum capacity. However, even considering a three-year emptying cycle this amounts to less than a tenth of the pits in Palu – demand for pit emptying is therefore low.

Transport:

The two tankers haul the emptied sludge to a septage treatment facility. There are no reports of waste being illegally discharged en-route and it is understood that the plant receives 100% of the sludge emptied.

Treatment:

The PU constructed a septage treatment facility (*Instalasi Pengolahan Lumpur Tinja* or IPLT) about 12 years ago as a 'model' facility. It consists of an Imhoff tank, intended to separate the solid and liquid portions of sludge, sludge drying beds for the solid portion and a series of waste stabilization ponds to treat the liquid portion. The design capacity of the IPLT is 72m^3/d. Low demand for tank emptying services means that it currently receives less than a third of this loading. Nevertheless, and following rehabilitation of the plant, the plant is understood to be treating the sludge satisfactorily and 100% of the sludge emptied is currently treated before disposal.

Reuse/disposal:

There is no formal reuse of treated fecal sludge in Palu.

A.10.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, limited FSM service delivery or partial FSM service delivery)

The FSM service delivery framework in Palu is improving and a 'partial' level of service is being delivered to the city's households. Despite the low volumes of sludge emptied and treated (9% of the total fecal waste generated) it is suggested that an additional 77% of the total fecal waste generated is currently safely contained. This situation is satisfactory in the short-term but it may be less so in the medium to long-term. Regular desludging is important for conventional septic tanks receiving all household wastewater since neglecting it will result in clogging of drain fields and soakaways, failure of the percolation mechanism and flooding from the tank. The same or worse problems might be expected from the commonly used open-bottomed type tanks if they clog up, stop percolating and flood[12]. A regular desludging programme would reduce this possibility but the data suggests that this would require deployment of additional vacuum trucks; there is, however, excess capacity within the treatment facility to cope with an increase in flow.

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[12] Tayler (2013) also observes that the lack of demand for tank emptying suggests that percolation failure is less common than might be expected.

	Containment	Emptying	Transport	Treatment	Reuse/ disposal
Enabling					
Policy	2	2	2	1.5	0.5
Planning	2.5	1.5	1.5	2.5	0
Budget	1	1.5	1.5	2.5	0
Developing					
Expenditure	0	3	3	3	0
Equity	1.5	1	1	0.5	0
Output	1.5	2.5	2.5	2.5	0
Sustaining					
Maintenance	1	2.5	2.5	2.5	0
Expansion	1	0	0	0	0
User outcomes	2	2	2	2	0

Figure 48: FSM scorecard for Palu, Indonesia

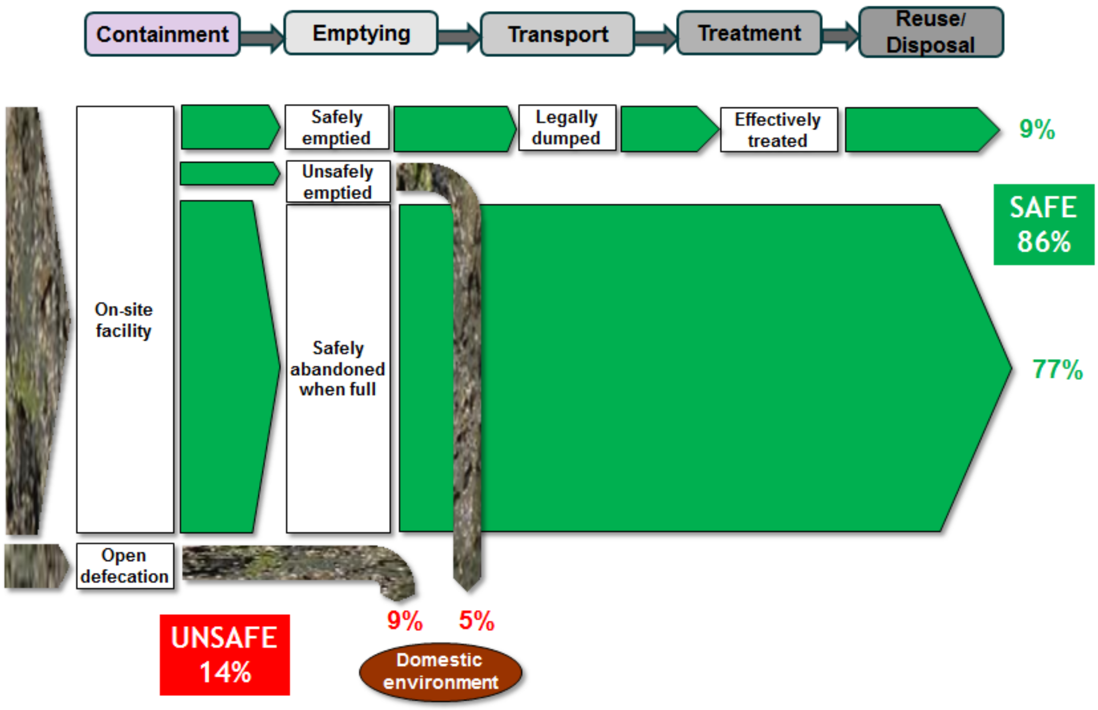
Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 9% to 86%**
Sewered (off site centralised or decentralised)	0%	100%	60%	0%	**0%**
On-site containment - permanent/emptiable	14%	65%	100%	100%	**9%**
On-site containment - cubluks (see note 1)	77%	100%	100%	100%	**77%**
Open defecation	9%	0%			
Unsafe: 14% to: 91%		**14%**	**0%**	**0%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:

1. 90% of the containers in Palu are either built very large and will take a long time to fill; and/or are open-bottomed pits (known as cubkuks) which percolate very efficiently, so accumulation rates are low. The fecal waste in these containers is therefore considered to be 'safely disposed of' but the exact number is unclear, therefore the total values are shown as ranges.

2: All sources shown in waste flow diagram below.

Figure 49: Fecal waste flow matrix for Palu, Indonesia



Sources: All from Tayler (2013) except where stated.
On-site sanitation 91% of households; open defecation 9% of households.
Mechanical emptying by municipality 10% of OSS; not emptied 85% of OSS.
Emptied and discharged to the environment 5% of OSS (nominal amount from Tayler, 2013a)

Figure 50: Fecal waste flow diagram for Palu, Indonesia

A.11 Dumaguete, Philippines

A.11.1. Summary

Population (millions)	0.12
Percentage of households using on-site sanitation or open defecation	100%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	78% to 92%
Percentage of sewage safely managed	NA
Percentage of fecal sludge from OSS safely managed	80% to 95%

FSM Framework	Improving
FSM Services	Partial
City Type	3

In Dumaguete, an FSM system has recently been introduced to serve the whole city. The project has been implemented with technical assistance from USAID under their Local Initiatives for Affordable Wastewater Treatment (LINAW) programme. Cost-sharing partnership has been established between the City Government, who operate and maintain the FSTP, and the local Water District who collect and transport the FS to treatment. Both contribute towards capital and operating costs. The arrangement is the first of its kind in the Philippines (CGoD2, nd). While the system is relatively new it is estimated that at present as much as 80% of the fecal waste generated in the city is safely managed; however, further data and ongoing monitoring to confirm this analysis.

A.11.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

Despite the prevalence of on-site sanitation, the Philippines has limited capacity to collect and treat fecal sludge. Recognizing this the national government introduced the 2004 Clean Water Act (CWA) which called upon local government units (LGU) and water districts to manage fecal sludge. However, only a few cities have responded to the challenge and generally many local municipalities in the Philippines lack the capacity and political will necessary to design and implement FSM (USAID, 2010). Under the CWA the Philippines has comprehensive national regulations on FSM and requires the Department of Environment and Natural Resources (DENR), the Department of Public Works and Highways (DPWH), and the Department of Health (DOH) to support LGUs in developing sanitation infrastructure including that for managing waste from on-site sanitation.

A key part of the Clean Water Act is the National Sewerage and Septage Management Program (NSSMP) which the Philippine government has recently approved (in June 2012) to promote FSM alongside sewerage projects (Robbins et al, 2012). Drafting of the NSSMP was begun in 2005 (USAID, 2010) and although it has taken a long time to be finalized it is hoped that it will accelerate progress by, for instance, providing technical assistance and targeted training to build capacity of local officials to undertake FSM programmes (Roberts et al 2012).

A.11.3. The FSM scorecard

Description of key points in SDA scorecard….

The FSM scorecard for Dumaguete shows that the core of the enabling environment is in place, although the policy element is clearly much more advanced than the planning and budget components. The developing pillar is improving fast and this highlights the recent introduction of the new FSM service led by the City government and Water District partnership. The service is so new that at this stage there is little data on which to measure the outcomes. Nevertheless, the sustaining pillar does indicate that uptake by households has been good and that from containment to treatment the service is improving. However, areas of weakness remain in reuse/disposal – this will need to be addressed in the future.

A.11.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

In Dumaguete it is estimated that 3% of the population practice open defecation (UNICEF/WHO, 2012) while the remainder have access to on-site sanitation. There is no sewerage in Dumaguete. The Dumaguete City Government (CGoD2, nd) reports that before the implementation of the LINAW project there were over 20,000 (of 25,000) poorly-designed and badly maintained septic tanks in Dumaguete which were a potential risk to public health and the environment. Under the LINAW project, a public information campaign was executed to raise public awareness of the benefits of improved sanitation. The campaign included workshops, posters, fliers and consultations with the community (CoGD1, 2012). Robbins et al (2012) indicates that there is strong evidence to suggest that the promotions helped improve household willingness to pay for fecal sludge management in Dumaguete. However, there are no details on the current condition of the 25,000 septic tanks in Dumaguete following the sanitation promotion and it is not known how many are now emptiable.

Emptying:

The Water District operates seven second-hand vacuum trucks which provide the city FS emptying service; the trucks emptied over 5,000 containment systems in the first 17 months of operation from May 2010 (CGoD1, nd). Robbins et al (2012) report that the FSM system is designed so that all containment systems are emptied once every five years.

However, the intervention in Dumaguete is relatively new. At this stage, and from the data available, it is not clear a) how many of the 25,000 containers in the city are emptiable or b) how many of the households will choose alternative desludging services. For the purpose of this analysis it is assumed that a nominal 5% of households will have their pits emptied by private contractors who then discharge the contents to the environment. Furthermore, owners who have built large pits in order to avoid the need for costly and inconvenient desludging or owners who have open-bottom pits that percolate efficiently may also choose not participate in the scheduled desludging programme; here it is assumed that a nominal 15% of the households' containers will not be emptied, however, this fecal waste is considered safely contained (at least in the short to medium term).

There is no manual emptying in Dumaguete.

Transport:

The Water District's seven tankers haul the emptied sludge to a fecal sludge treatment facility (FSTP) (Robbins et al, 2012). There are no reports of waste being illegally discharged en-route and it is understood that to date the plant has received 100% of the sludge emptied by the Water District operated service.

Treatment:
The City Government is responsible for operation and maintenance of the FSTP. The plant is designed to process all of the FS generated from both households and business establishments (CGoD2, nd). The capacity of the FSTP (a series of waste water stabilisation ponds and a sludge drying bed) is 80m^3/day and the current daily flow is 40% to 60% of capacity (Robbins et al , 2012). A second treatment plant – a decentralized wastewater treatment system (DEWAT) - receives fecal waste from a public toilet in the market (CoGD2, nd). The general impression (World Bank, 2012) of the septage treatment facilities is that their operation is generally good, the systems are being utilized and treated effluent is of acceptable standards; for this analysis it is therefore assumed that 100% of the fecal waste received in each plant is currently treated before disposal.

Reuse/disposal:
There is formal reuse of the treated fecal sludge generated from the dying beds, which is distributed free of charge to farmers as a soil improver; the City Government also makes use of both the treated sludge and the treated effluent from the DEWAT unit in their municipal parklands (CoGD2, nd).

A.11.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, limited FSM service delivery or partial FSM service delivery)
A regular desludging programme has only been in operation in Dumaguete since May 2010. The programme is based on a five-yearly emptying cycle and until the first full cycle has been completed it will be difficult to fully assess level of service reported by the City Government and how many households it is actually reaching. With this in mind it is suggested that a 'partial' level of service is being delivered to the city's households.

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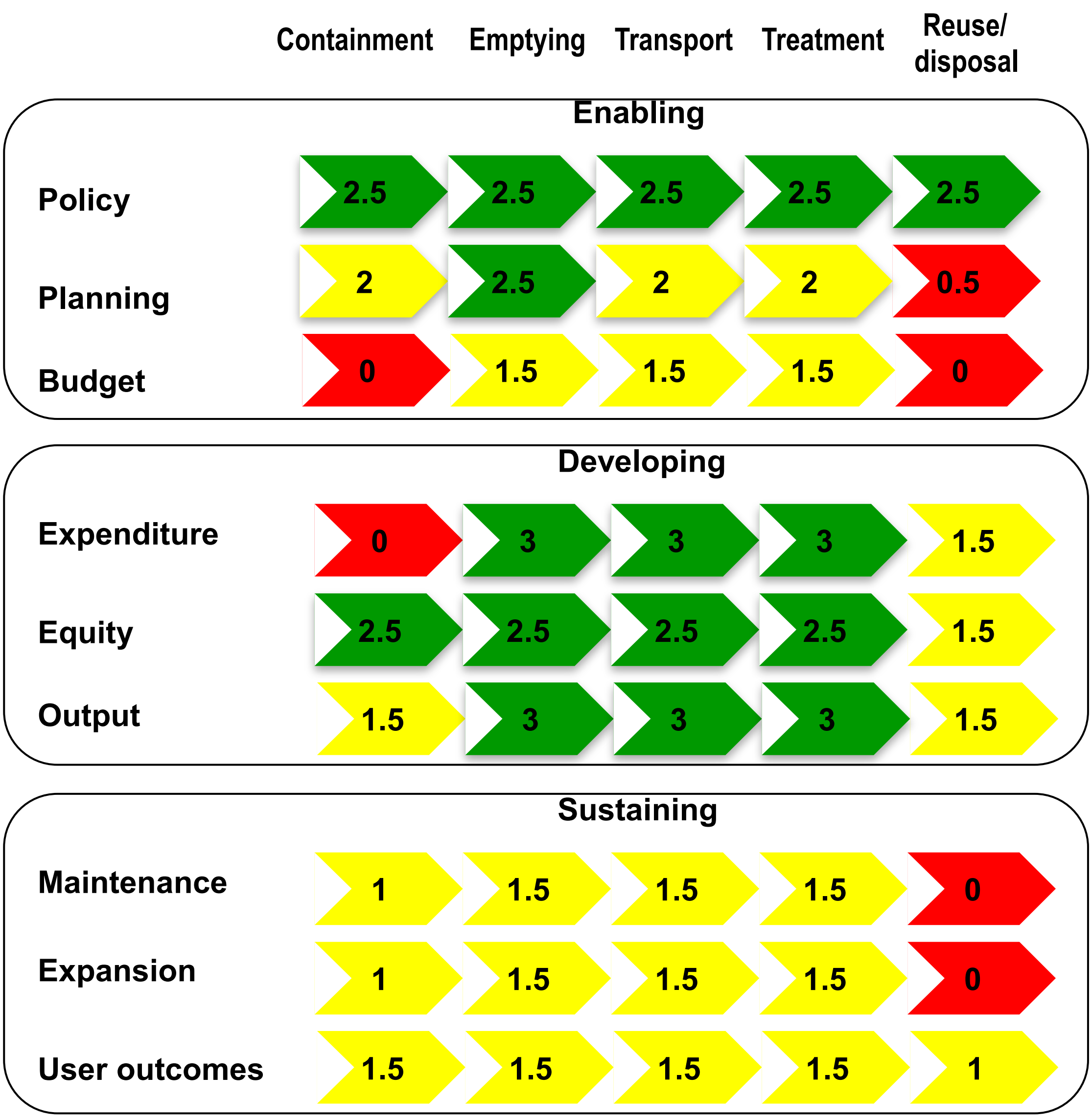


Figure 51: FSM scorecard for Dumaguete, Philippines

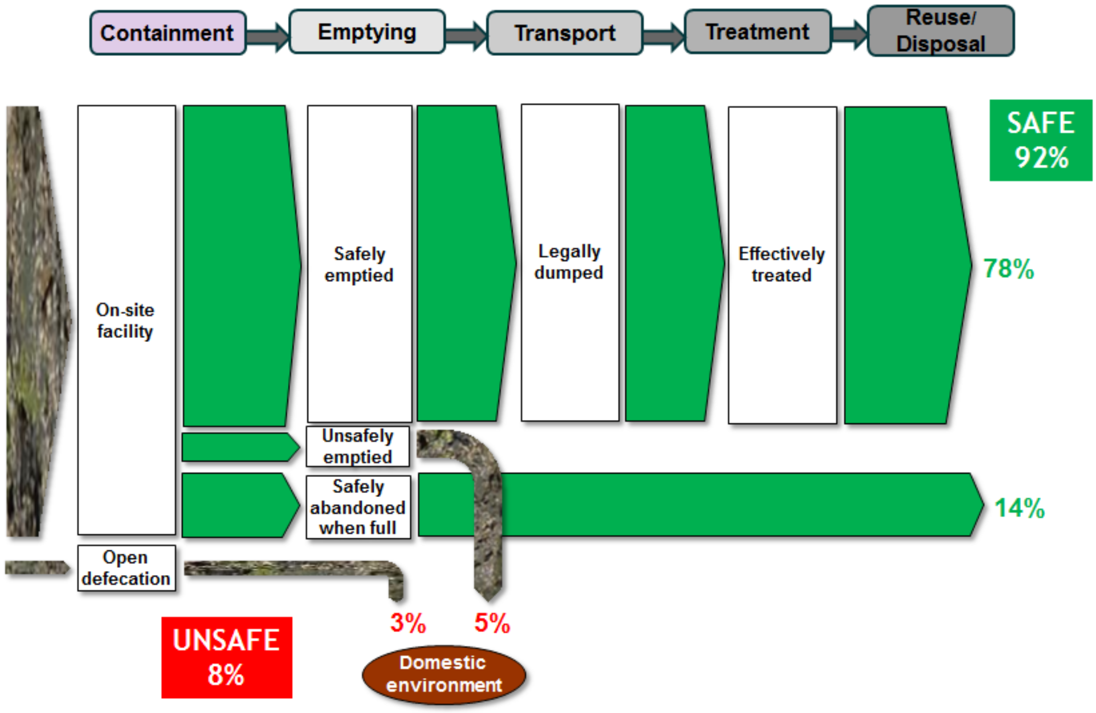
Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 78% to 92%**
Sewered (off site centralised or decentralised)	0%	100%	60%	0%	**0%**
On-site containment - permanent/emptiable	83%	93%	100%	100%	**78%**
On-site containment - single-use/not emptied/safely contained (see note 1)	14%	100%	100%	100%	**14%**
Open defecation	3%	0%			
Unsafe: 8% to: 22%		**8%**	**0%**	**0%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:

1. The "single-use/not emptied/safely contained" on-site containment refers to large tanks (or pits) built in order to avoid the need for costly and inconvenient desludging and/or leach pits that percolate very efficiently. In neither case is desludging considered to be required in the short- to medium-term.
These are both considered safe disposal methods but data available is poor so total 'safe' and total 'unsafe' are shown as ranges.

2: All sources shown in waste flow diagram below.

Figure 52: Fecal waste flow matrix for Dumaguete, Philippines



Sources: Open defecation 3% of households (UNICEF/WHO, 2012). On-site sanitation used by the remaining 97% of households. Mechanical emptying by municipality 80% of OSS (from CGoD1, nd); not emptied and safely contained 15% of OSS (nominal); emptied and discharged to the environment by private emptiers 5% of OSS (nominal).

Figure 53: Fecal waste flow diagram for Dumaguete, Philippines

A.12 Manila, Philippines

A.12.1. Summary

Population (millions)	15.3
Percentage of households using on-site sanitation or open defecation	88%
Percentage of total fecal waste (sewage and fecal sludge) safely managed	39% to 44%
Percentage of sewage safely managed	78%
Percentage of fecal sludge from OSS safely managed	35% to 40%

FSM Framework	Improving
FSM Services	Improving
City Type	2/3

Two water utilities provide water and sanitation services in Manila under concession contracts. The Manila Water Company (MWCI) were assigned to operate the East Zone with 23 cities/municipalities serving around 6.1 million people; and the Maynilad Water Services Inc (MWSI) the West Zone with 16 cities/municipalities serving around 9.2 million people. The concessions were signed in 1997 with a contract length of 25 years and have now been extended for a further 15 years to 2037. Initially, little progress was made with improving sanitation coverage, the focus was on sewerage alone which still only serves 9% of the combined service areas. However, since 2005 and through the adoption of a more affordable strategy involving the use a septage management programme (primarily using households' existing septic tanks) the concessionaires are now accelerating coverage and are currently targeting full coverage by 2037(World Bank, 2012a). In addition to the concessionaires some municipalities also deliver services within the service area.

A.12.2. Institutional framework

Brief summary of who is responsible for urban sanitation in the country and in the city if different…

Despite the prevalence of on-site sanitation, the Philippines has limited capacity to collect and treat fecal sludge. Recognizing this the national government introduced the 2004 Clean Water Act (CWA) which called upon local government units (LGU) and water districts to manage fecal sludge. However, only a few cities have responded to the challenge and generally many local municipalities in the Philippines lack the capacity and political will necessary to design and implement FSM (USAID, 2010). Under the CWA the Philippines has comprehensive national regulations on FSM and requires the Department of Environment and Natural Resources (DENR), the Department of Public Works and Highways (DPWH), and the Department of Health (DOH) to support LGUs in developing sanitation infrastructure including that for managing waste from on-site sanitation.

A key part of the Clean Water Act is the National Sewerage and Septage Management Program (NSSMP) which the Philippine government has recently approved (in June 2012) to promote FSM alongside sewerage projects (Robbins et al, 2012). Drafting of the NSSMP was begun in 2005 (USAID, 2010) and although it has taken a long time to be finalized it is hoped that it will accelerate progress by, for instance, providing technical assistance and targeted training to build capacity of local officials to undertake FSM programmes (Roberts et al 2012). Within the Manila Metro area one municipality, Marikina, has pressed ahead with improved FSM (Roberts et al, 2012 and USAID, 2010).

A.12.3. The FSM scorecard

Description of key points in SDA scorecard….

The FSM scorecard for Manila shows that the framework in the Philippines is being developed and parts of it are in place, particularly at the level of policy and planning. However, the budget allocations are clearly inadequate and the low levels of FSM infrastructure development in cities outside of Manila (and a small number of pilot project cities) confirm this. The pilot projects are predominantly donor-led, have been successful (Roberts et al, 2012) and have concentrated on the emptying, transport and treatment components as confirmed by the improving scores in the developing pillar. In Manila, the concessionaires have also focused on emptying, transport and treatment and their services are also developing. However, further work is required to expand services to all customers within their respective zones. In addition, areas of weakness remain in improving containment and with introducing formal reuse of treated fecal sludge and its proper disposal.

A.12.4. FSM along the sanitation service chain

A brief description of each part of the chain….

Containment:

In Manila it is estimated that 3% of the population practice open defecation (UNICEF/WHO, 2012) while 9% have a sewerage connection, the remainder (88%) have access to on-site sanitation, primarily in the form of septic tanks (USAID, 2010).

Emptying:

The two concessionaires carry out emptying of septic tanks in their respective zones. In addition the municipality of Marikina encourages the emptying of septic tanks within its own municipality boundary which lies within the MWCI area (USAID, 2010). Both concessionaires operate a regular desludging service on a five-year emptying cycle. Around 100,000 pits per year are emptied peer year in the MWCI area while MWSI empties around 40,000 pits per year (estimated from data in World Bank, 2012a and World Bank, 2012). Based on an occupancy rate of five persons per household they therefore provide an emptying service to approximately 34% of the population.

The balance of the population are assumed to use private companies who provide an emptying service in Manila but they dispose of all the fecal waste in waterways, drains and onto open land (USAID, 2010). In addition, when pits become full, some are left unemptied and abandoned unsafely - overflowing to the local environment – while others are covered by the users and safely contain the fecal waste. In the absence of data, it is assumed that private operators empty 45% of the remaining facilities, 45% fill up and are either abandoned unsafely (in the case of pit latrines) or are allowed to overflow; while 10% provide safe containment. There is no manual emptying in Manila.

Transport:

The MWCI uses 50 vacuum trucks for emptying and transport of the fecal waste to treatment (the number of trucks that MWSI uses is not known). In the absence of data on the quality of service provided it is assumed that the concessionaires illegally dump a nominal 5% of the amount emptied.

Treatment:

The MWCI operates two FSTP with a combined installed capacity of 814m^3/day, these currently operate at a daily flow rate of 40 to 50% of their capacity. A single FSTP with an installed capacity of 250m^3/day operates at a daily flow rate of 85% capacity in the MWSI zone (Robbins et al, 2012). A nominal treatment efficiency of 95% is assumed for all three FSTPs.

Reuse/disposal:

Roberts et al (2012) indicates that MWCI have initiated the formal reuse of treated fecal sludge but the details are not clear. There are no reports of formal reuse being developed by MWSI.

A.12.5. Outcome

An overview or summary of the situation (i.e. poor FSM service delivery, improving FSM service delivery or partial FSM service delivery)

Overall in Manila the two concessionaires safely dispose of approximately two-fifths of the fecal waste generated in the city. The FSM systems used by the two companies provide effective emptying, transport and treatment services but it is estimated that around half the users of on-site sanitation use private operators who dump waste in the environment or abandon their pits when they fill up or allow their full septic tanks to overflow. The FSM service in Manila is therefore considered to be 'improving' as there are some services and some framework is in place.

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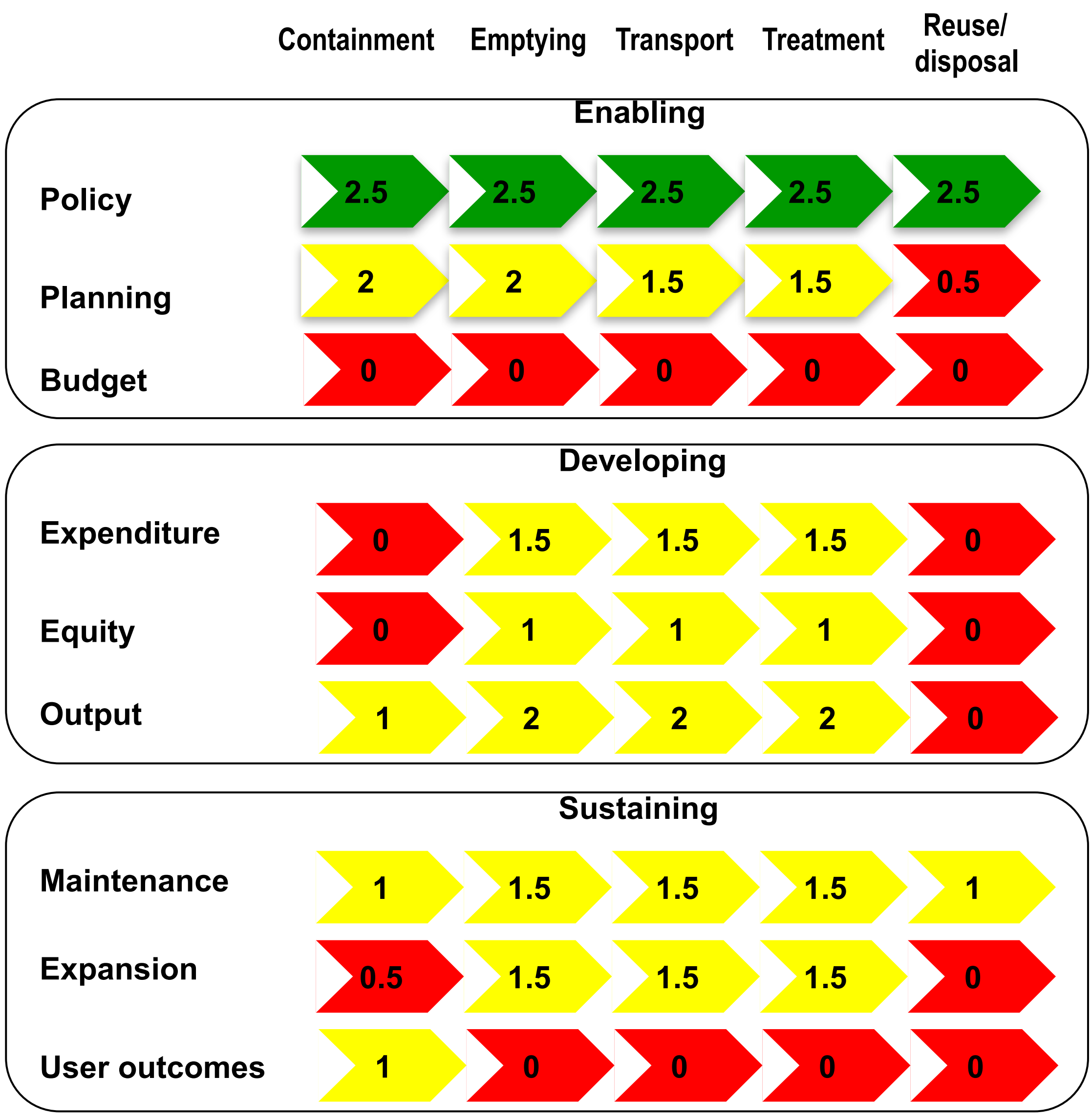


Figure 54: FSM scorecard for Manila, Philippines

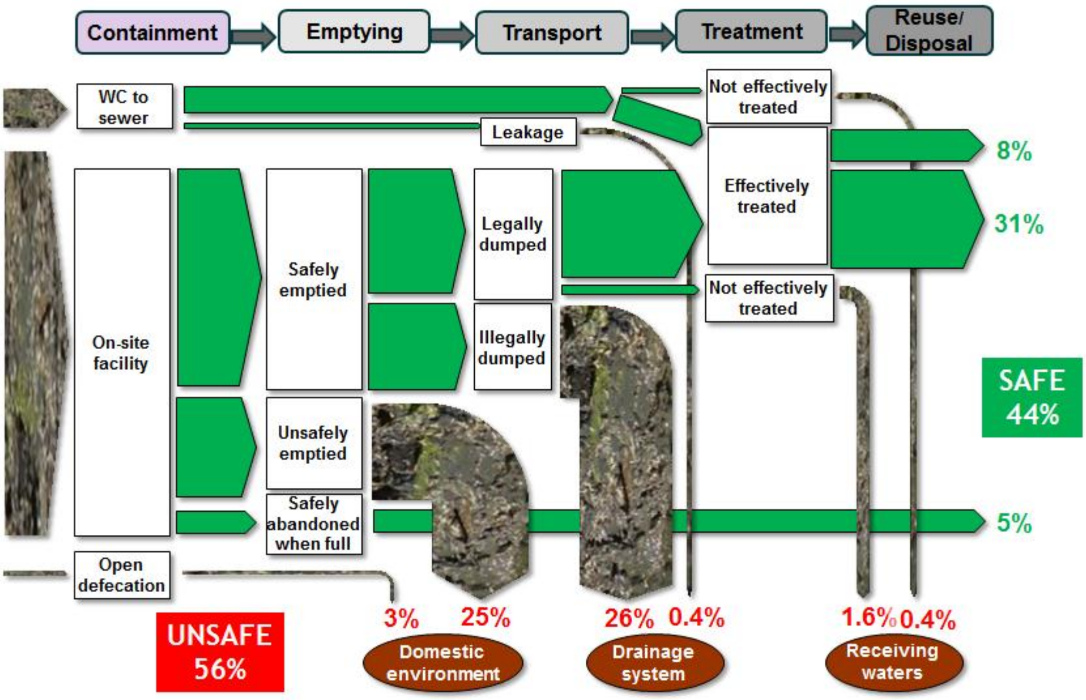
Fecal waste flow matrix Type of system	*% of FW*	*of which safely collected*	*of which safely delivered*	*of which safely treated*	**Safe: 39% to 44%**
Sewered (off site centralised or decentralised)	9%	100%	95%	95%	**8%**
On-site containment - permanent/emptiable	83%	70%	56%	95%	**31%**
On-site containment - single-use/not emptied/safely abandoned (see note 1)	5%	100%	100%	100%	**5%**
Open defecation	3%	0%			
Unsafe: 56% to: 61%		**28%**	**26%**	**2%**	
Affected zones		*local area & drainage*	*drainage system*	*receiving waters*	

Notes:

1. Single-use/not emptied/safely abandoned on-site containment is considered a safe disposal method but data available is poor so total 'safe' and total 'unsafe' are both shown as ranges.

2: All sources shown in waste flow diagram below.

Figure 55: Fecal waste flow matrix for Manila, Philippines



Sources:	Open defecation is 3% from (UNICEF/WHO, 2012 for urban Philippines); sewered 9% (WB 2012a); balance is OSS (88%) Emptying by concessionaires 34% of FW (estimated from data in WB, 2012a Annex 5; WB, 2012 Annex 2a; and USAID, 2010) Assume nominal 5% losses for dysfunctional sewerage and 5% losses for dysfunctional sewage treatment. Assume nominal 5% losses for dysfunctional transport and 5% losses for dysfunctional FS treatment. Assume balance (54% of FW) is either: not emptied and safely contained (nominal 10%); mechanically emptied by private sector and dumped illegally (45%); or not emptied and abandoned unsafely (45%)

Figure 56: Fecal waste flow diagram for Manila, Philippines

Annexure 2: Small-scale local service provider capacity

The study confirmed that small-scale private operators play a key role in delivering mechanical emptying and transportation services in at least eight of the cities (three LAC countries; the three African countries; Phnom Penh, Cambodia; and Delhi, India). In six of these cities it is reported that the private sector alone carries out emptying (in the other two cities the municipality or the local water and sanitation provider also provides a service – albeit limited). The number of private companies operating in each city ranges from three in Tegucigalpa, Honduras to over 50 in Dakar, Senegal (see Table 5). While small-scale donor-led CBO initiatives which focus on improving services to the low-income neighbourhoods are also active in Dhaka, Bangladesh and Maputo, Mozambique. Overall, it is estimated that in the region of 21% of fecal waste generated by on-site sanitation in the eight cities is emptied by small-scale service provider-owned mechanical vacuum trucks.

In general these are informal services that remain unregulated and uncontrolled, consequently illegal dumping by the operators is not uncommon. In addition, private operators are sometimes charged for dumping at waste treatment sites (for example in Dakar, Senegal) which has an adverse impact on the operation as it disincentives proper disposal. In cities where illegal dumping is common the study found that on average in the region of 30% of the fecal sludge emptied by private operators was dumped illegally.

However, in Kampala, Uganda and Dakar, Senegal the pit emptiers have formed associations in order to strengthen their position within the institutional framework. WSP (2008) also notes that such an association (known as the Private Emptiers Association (PEA) in Kampala) could improve the market power of its members and facilitate establishment of minimum industry operating standards. As a result the PEA has received recognition from and now interacts with the National Water and Sewerage Corporation (NWSC) (who are responsible for sanitation service delivery in Kampala) - the corporation having accepted that the association is a critical link in the provision of FSM services in Kampala. Indeed, the PEA members currently empty approximately 20% of all fecal waste generated from on-site sanitation in Kampala and only a nominal amount is dumped illegally – indicating that private operators can be effectively integrated into the FSM service and play a significant role as a service provider.

Table 5: Small-scale local service provider capacity in the 12 cities

Region	Latin America & Caribbean			Africa		
Country	**Bolivia**	**Honduras**	**Nicaragua**	**Mozambique**	**Senegal**	**Uganda**
City	**Santa Cruz**	**Tegucigalpa**	**Managua**	**Maputo**	**Dakar**	**Kampala**
No of small-scale service providers	40	3	10	3	50	27
Total no. of mechanical emptying vehicles	Over 40	4	13	No data	150	27

Region	South Asia		East Asia			
Country	**Bangladesh**	**India**	**Cambodia**	**Indonesia**	**Philippines**	
City	**Dhaka**	**Delhi**	**Phnom P**	**Palu**	**Dumaguete**	**Manila**
No of small-scale service providers	2	35	19	NA	NA	No data
Total no. of mechanical emptying vehicles	2	35	31	NA	NA	No data

Sources: all data sources provided in city profiles in Annexure 1.