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BUSINESS MODELS FOR RURAL FECAL SLUDGE MANAGEMENT (FSM)

A DESK REVIEW

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Cover Photo Credit:	Desludging vehicles at an officially sanctioned sludge disposal site near Kaolack, Senegal (FSG)

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TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

ADP	Alternating Dual Pit Toilet
AWS	Area-Wide Sanitation
BASA	Bangladesh Association for Social Advancement
BCC	Behavior Change Communication
BORDA	Bremen Overseas Research and Development Association
CBO	Community-Based Organization
CDD	Consortium for DEWATS Dissemination
CWIS	City-Wide Inclusive Sanitation
DEWATS	Decentralized Wastewater System
FS	Fecal Sludge
FSM	Fecal Sludge Management
FSTP	Fecal Sludge Treatment Plant
GESI	Gender Equality and Social Inclusion
HH	Household
IEC	Information and Education Campaign
ILO	International Labor Organization
INR	Indian Rupee
km	Kilometers
km^2	Square Kilometers
KL	Kiloliters
KPI	Key Performance Indicator
LSP	Lusaka Sanitation Program
LWSC	Lusaka Water Supply & Sanitation Company
m^3	Cubic Meters
mbgl	Meters Below Ground Level
MBS	Market-Based Sanitation
MoU	Memorandum of Understanding
NGO	Non-Governmental Organization
n/a	Not Applicable
O&M	Operations and Maintenance

OSS	On-Site Sanitation
OWSSB	Odisha Water Supply & Sewerage Board
p.a.	Per Annum
PAF	Practical Action Foundation
PB	Public Body
PPE	Personal Protective Equipment
PPP	Public-Private Partnership
PPP$	Purchasing Power Parity (international dollar)
PS	Private Sector
SBC	Social and Behavioral change
SDG	Sustainable Development Goal
SFD	Shit Flow Diagram
SHG	Self-Help Group
SOP	Standard Operating Procedure
SSH4A	Sustainable Sanitation and Hygiene for All
TA	Technical Assistance
UDDT	Urine Diverting Dry Toilet
UN	United Nations
UNICEF	United Nations Children's Fund
UPB	Urban Public Body
USAID	United States Agency for International Development
USD	United States Dollar
US EPA	United States Environmental Protection Agency
VIP	Ventilated Improved Pit
WASH	Water, Sanitation, and Hygiene
WASHPaLS	Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability
WHO	World Health Organization
WSUP	Water & Sanitation for the Urban Poor
WTP	Willingness to Pay
WWTP	Wastewater Treatment Plant

GLOSSARY OF TERMS

Term	Definition
Fecal Sludge Management	
Fecal Sludge Management (FSM)	Solutions for storing, collecting, transporting, treating, and safely reusing or disposing of fecal sludge (FS).
Containment	Systems designed to capture and store human feces originating from non-sewered sanitation systems. Containment systems are considered safe if the sludge does not contaminate the environment and prevents human exposure to feces.
Wet sanitation	Containment systems that require water for flushing (e.g., pour flush toilets).
Dry sanitation	Containment systems that do not require flushing (e.g., pit latrines).
On-site	Property belonging to a household (HH) by formal ownership, lease, or an equivalent property right to occupy. Property includes land adjacent to the housing structure (e.g., yard).
Off-site	Any public or private property other than on-site as defined above.
Emptying	Process of collecting fecal sludge from on-site containment systems.
Transport	Transfer of fecal sludge collected from containment systems to a treatment or disposal site.
Treatment/disposal	Process of deactivating pathogens in sludge and decontaminating any wastewater before reuse or safe disposal into the environment. Alternatively, sludge could be disposed of before treatment (e.g., burial).
Fecal Sludge Treatment Plant (FSTP)	Facilities to treat fecal sludge from on-site sanitation systems, typically characterized by high solid content compared to sewage.
Wastewater Treatment Plant (WWTP)	Facilities to treat greywater (e.g., bathing water) and blackwater (i.e., human waste with high water content). In the context of FSM, a WWTP is used to co-treat fecal sludge with sewage.
Reuse	Productive uses of fecal sludge during or after treatment, such as biogas, compost, and treated effluent.
Environment, health, and safety	Safety of the natural environment, community health, and occupational health and safety of sanitation workers.
Actors involved in sanitation services	
Public body (PB)	Local government, municipality, utility, or an equivalent body formally mandated to provide sanitation services in one or more administrative areas. A public body could be local (e.g., municipal body) to the service area or based in another location (e.g., district administration, utility serving several areas).
Community-based organization (CBO)	A non-profit entity established and operated by a community. In this desk review, a private sector (PS) organization and/or community-based organization (CBO) are collectively referred to as PS/CBO.
Settlements	
Housing density	Dispersion of housing structures within a settlement. The term does not refer to the number of individuals per housing structure.
Rural-mixed	Medium-to-high population settlements within urban catchments or at a distance from urban areas with paved roads, medium-to-high market reach, medium availability and low-to-medium affordability of market-based sanitation (MBS) products and services (WaterAid, Plan International, and UNICEF 2019).
Peri-urban	Subset of rural-mixed settlements that are contiguous with urban settlements.

Term	Definition
Rural growth center	Subset of rural-mixed settlements not contiguous with an urban area and typically situated at a distance.
Rural on-road	Small-to-medium population rural communities connected with rural centers by all-weather roads, low-to-medium population density, low-to-medium market reach, and low availability and affordability for MBS products and services (WaterAid, Plan International, and UNICEF 2019).
Rural remote	Small and remote rural settlements with unpaved roads, low population density, and low market reach and affordability of market-based products and services (WaterAid, Plan International, and UNICEF 2019).
FSM business model	
Business model	An arrangement of activities, resources, and roles of actors that defines how a business creates, delivers, and captures value.
Profitability	Refers to the extent to which revenue generated is more than the expenses incurred to deliver safe FSM.
Viability	A subjective measure of profitability that incentivizes an actor to provide a product or service without external support.
Contract	Formal agreement between a public body and PS/CBO stipulating the roles, responsibilities, and financial terms related to FSM service delivery.
License	The right granted to a PS/CBO by a public body to provide sanitation services subject to compliance with the public body's conditions.
Public-private partnership (PPP)	A collaborative arrangement between a public body and a private sector entity to jointly provide FSM services.
Service protocol/ Standard Operating Procedure (SOP)	Standardized processes to be followed by staff.
Operations and maintenance (O&M)	Ongoing activities and tasks to deliver services to customers and ensure the proper functioning of the infrastructure. It excludes major repairs and parts or equipment replacement every few years.
Government transfer	A source of revenue for a local public body – funds disbursed by higher government entities to a local government or public body restricted to a specific activity or unrestricted use by the recipient.
Own revenue	A source of revenue for a local public body – funds generated directly by the local public body via local taxes, fees, and service charges.
Public investment	Funds provided by a public body or national/provincial government (via another public body or directly) towards capital or O&M expenses of sanitation activities/infrastructure.
Other terms	
BCC	A strategic and systematic approach to promote positive changes in attitudes, beliefs, and behaviors among individuals, groups, or communities.
Demand generation	Activities carried out to drive awareness of safe FSM practices and services.
Demand activation	Sales and marketing activities to persuade customers to purchase a product or service.
Purchasing Power Parity (PPP$)	Local currency units of a country converted into international dollars that reflects their purchasing power for a standardized basket of goods. Product prices expressed in international dollar or purchasing power parity (PPP$) are more comparable across countries than using conventional exchange rates, which are volatile and influenced by several macroeconomic factors.

PREFACE

The United States Agency for International Development (USAID) Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability (WASHPaLS) #2 Activity is a five-year (2021–2026) Activity that aims to strengthen USAID's and partners' water, sanitation, and hygiene (WASH) programming through support for learning and adoption of the evidence-based programmatic foundations needed to achieve Sustainable Development Goal (SDG) 6.2. The project generates and facilitates WASH sector research and learning that result in sustainable, at-scale, and equitable improvements in key services, behaviors, and environmental conditions at the community and household levels. The overarching theme for WASHPaLS #2 learning and research is area-wide sanitation (AWS). In addition to defining and seeking to understand effective implementation of AWS, WASHPaLS #2 implementation research also addresses market-based sanitation (MBS) and social and behavior change (SBC) to reduce pathogen transmission pathways for infants and young children.

While at-scale rural sanitation programming has been undertaken for decades and improving basic sanitation coverage remains the focus in many countries, fecal sludge management (FSM) in rural areas is at a nascent stage. WASHPaLS #2 undertook a desk review, examined several examples of FSM models in varied rural contexts, and interviewed key informants to understand the potential for viable business models for safe FSM in rural areas. This report presents WASHPaLS #2's findings and informs the research agenda on the subject.

EXECUTIVE SUMMARY

Basic sanitation coverage in rural areas of several low- and middle-income countries has progressed significantly over the last decade, especially in Asia. Sustaining the resulting gains in human, environmental, and community health as well as progress towards Sustainable Development Goal (SDG) 6.2 targets requires safely managing the sludge generated in on-site sanitation (OSS) systems. Abandoning full toilets and building new toilets, generally a safe method for managing sludge, is, however, not feasible for all rural households. The alternative solution of emptying toilets by households or service providers is largely characterized by unsafe practices along the sanitation value chain. The private sector (PS) is a traditional actor in the emptying, transport, and disposal/reuse of fecal sludge (FS), primarily in the shape of informal service providers. Yet, limited knowledge of business models for safe fecal sludge management (FSM) in rural areas exists.

By analyzing several examples in Asia and sub-Saharan Africa, interviewing experts, and reviewing the literature, this review sought to understand the market for rural FS services, suitable methods along the sanitation value chain, and viable business models involving the PS for safe FSM in rural areas. However, few examples of safe rural FSM services with PS participation emerged from expert interviews and secondary research. Therefore, the desk review team widened its scope to include examples from peri-urban and medium-high population rural settlements (i.e., towns, rural growth centers, or equivalent local settlement classifications) for lessons that could be applied in the wider rural context. The team reviewed nine cases, including a potential innovation to desludging wet toilets safely, and complemented the findings and guidance with relevant literature. The objective of this review is to contribute to the knowledge base on area-wide safe FSM solutions, which also may include household-managed and government-operated services.

KEY FINDINGS

Demand for paid recurring FSM services, a prerequisite for viable business models, exists in rural areas. Situational assessments in several case examples found that most households prefer hiring service providers over self-emptying their toilets. Households have paid more than their stated willingness to pay (WTP) for this service, likely due to an urgent need to empty toilets. Most households avoid desludging until toilets are full or overflowing, and service provider availability may become more important than price. Demand for recurring desludging services will likely increase in wet sanitation contexts because situational assessments in several of the examples analyzed found most households had never emptied their toilets.

Further, even if households may retrofit an alternating dual pit to enable self-emptying, demand for paid emptying services will likely continue. Emerging evidence points to several challenges with alternating pits, such as incorrect operation by households and functional failures resulting in the need for frequent desludging. As countries develop rural FSM policies, there is an opportunity to ensure they recognize that alternating pit toilets are an unlikely solution for safe FSM in wet rural sanitation contexts.

Rural contexts are more conducive to basic, low-cost treatment methods than to fecal sludge treatment plants (FSTPs). Historically, FSTPs have proven challenging to operate in the mid- to long-term in urban areas. Inconsistent sludge quantity and quality (e.g., solid waste content), inadequate local skills, and insufficient finances for operation and maintenance (O&M) often lead to sub-par treatment or failure. In most examples studied, externally funded technical specialists support O&M and safety monitoring of treatment facilities. FSTPs also entail sizeable capital investments, which are often externally funded. Challenges to O&M and financial constraints are likely exacerbated in rural

areas, which raises questions about the suitability of FSTPs in rural contexts even if initial external financial support is available.

Traditional, basic treatment/disposal methods in rural areas, such as on-site burial and off-site land application and trenching, are better suited to overcoming the challenges of FSTPs. While these off-site treatment/disposal methods require more land than FSTPs, land availability is generally not an issue in rural contexts. Properly designed land application and modified trench methods can overcome hydrogeological constraints (e.g., shallow water tables) to mitigate contamination risks.

Monetizing resource recovery (i.e., the reuse of fecal sludge, typically in agriculture) is largely unsuccessful, raises costs for FSTPs, and is an unreliable revenue source. However, basic treatment methods are cost-effective in realizing the environmental benefits of reusing fecal sludge (e.g., decomposed sludge as a soil conditioner, planting trees/select crops per safety guidelines).

Manual emptying can be made safer with low-cost measures in dry sanitation technology contexts but requires innovation in wet sanitation contexts. Manual emptying is better suited than mechanized and semi-mechanized methods to fully empty dry toilets because of the sludge characteristics (e.g., hardened, solid waste content). Public bodies (PBs; e.g., local government, utility) in sub-Saharan Africa implemented several low-cost measures, such as equipping workers with modified tools and personal protective equipment (PPE) and conducting periodic medical check-ups to ensure worker safety. Such measures amount to approximately two percent of labor costs or one percent of revenue.

By contrast, manually emptying wet toilets (e.g., pour-flush latrines) is hazardous but widely prevalent in many rural contexts despite laws or regulations discouraging unsafe practices. In markets where mechanical emptying services (e.g., vacuum tankers) are absent, technological innovations or guidance on potentially safe grassroot practices (e.g., using farm pumps for desludging) are required to make manually emptying wet toilets safer. Experiments with in-pit treatment by mixing lime with sludge to deactivate pathogens is an innovative method to pre-treat sludge and improve the safety of manually emptying wet toilets. Although a pilot application concluded that pathogen deactivation could not be achieved consistently, the results were largely attributed to households operating alternating dual pit toilets incorrectly and to improper mixing. While more research is needed, the above causes and several other enabling factors, such as the availability of lime in rural markets and material and mixing equipment costs, indicate the potential for incorporating lime treatment in professional manual emptying services.

There are two common public-private partnership (PPP) business models used to deliver safe rural FSM services. Business models for safe FSM tend to be led by public bodies, such that they perform all functions, including last-mile service delivery, or engage PS/community-based organizations (CBOs) through PPPs. Public bodies either *manage* (PB-managed) PS contractors or *facilitate* ('PB-facilitated') private service licensees through a PPP. The PS/CBO's customer and income structure distinguish the two PPP FSM models. As a contractor, a PS/CBO operates and maintains the public body's FSM infrastructure in exchange for assured fees from the public body–the customer. As a licensee, a PS/CBO uses its own equipment to service households and charges them fees, subject to licensing conditions and monitoring by a public body. The desk review did not find any common models in which PS actors alone provide safe FSM services.

The most common PPP models aim to offer customers affordable, safe services with value propositions of better response times and cleanliness. Public bodies price desludging services below the informal market in an effort to acquire customers and compete with informal service providers. On average, the prices of PPP models are 26 percent and 57 percent below informal manual emptier and mechanized desludging providers, respectively. PPP business models strive for quick response time because desludging requests often are urgent and informal emptiers, especially local operators typically respond quickly. PPP business models also assure fulfillment of all requests at the regulated price, contrasting with informal providers who may deny service or charge high prices to distant customers. Cleanliness is integral to PPP FSM models that mandate contractors and licensees to follow service protocols and penalize violations. PS/CBO reporting and public body monitoring are critical to delivering value propositions.

PB-managed models offer advantages in ease of monitoring and progress towards inclusion goals. Public bodies typically contract a single PS/CBO partner and link fees to their performance (e.g., number of households serviced) based on verifiable reports generated by the contractor. The financial incentive to report performance eases monitoring needs by the public body. PB-managed models also incorporate existing or new guidelines on social inclusion, workers' rights protection, or occupational health and safety measures into contracts. Such instances have led to livelihood opportunities for marginalized communities, safety equipment provision, and improved working conditions. Licensing conditions through a PB-facilitated model also mandate reporting and compliance with occupational health and safety standards. However, the desk review could not find evidence on the extent to which licensees complied with regulations or the monitoring practices employed by public bodies as licensors. Monitoring licensees could be challenging for a public body based on common urban experiences. Introducing performance-based subsidies can improve reporting by licensees, but a public body would incur subsidy and verification costs.

A few examples show early indications of profitability, but long-term viability of the service provider is a concern as several integral and enabling costs are unaccounted for or unreported. A few comparable examples report profits for a public body or PS/CBO incurring core costs of emptying and transportation (i.e., labor, fuel, and maintenance). Labor accounts for the majority (55–85 percent) of these costs, followed by fuel (15–28 percent), which is primarily due to small catchment areas and small-capacity trucks. However, actual profitability will be lower (or loss-making) because of treatment-related costs as well as several unreported/unaccounted costs, such as marketing, capital equipment depreciation, and technical consultants (typically donor-funded), among others. Full costing will likely result in long-term deficits and warrant budgetary support by public bodies to sustain services in the interest of public and environmental health. However, most cases examined in the desk review rely on donor funding for several setup and ongoing activities because public bodies (e.g., local governments) tend to be resource-constrained and often depend on government transfers.

Grouping several rural settlements into coherent geographic areas to improve the viability of rural FSM services is under experimentation. The relatively lower population and population density in rural areas affects demand from and the viability of serving a given catchment area. In India, several public bodies, in collaboration with sub-national governments, are experimenting with grouping several rural settlements based on the capacity of and viable distance from a treatment facility. The approach requires spare capacity if utilizing existing infrastructure (e.g., in a nearby urban area), similar sludge and toilet characteristics within a group, and formal alignment among the relevant public bodies in the rural settlements.

GUIDANCE FOR STAKEHOLDERS

Drawing on the findings, the review team sought to identify the rural contexts in which the PPP FSM models would be most relevant, including the key conditions for their implementation as well as measures to possibly broaden their applicability.

The method for treating fecal sludge is a critical factor that influences other value chain stages and the business model.

- PPP FSM models are most applicable in rural settlements where basic treatment methods, such as trenching, are feasible and where investment and O&M capacity exist. In these contexts, the feasibility of basic treatment methods is dependent on the existence of favorable hydrogeological conditions, availability of land, and other characteristics such as population/housing density.
- A subset of peri-urban areas, close to large cities with available fecal sludge treatment capacity and sludge compatibility, may offer opportunities to implement PPP FSM models.
- In other rural settlements, where basic treatment methods or access to existing treatment plants near urban areas are not feasible, FSTPs would also not be feasible due to the high risk of failure of current FSTP technologies in rural areas. Therefore, PPP FSM models would not be applicable in these settlements, which would need to rely on alternative solutions, such as household-managed systems or government-operated models.

The availability of PS/CBOs with requisite capabilities, such as existing FSM enterprises, to participate as contractors or licensees, and sufficiently capacitated public bodies pose additional constraints. However, public bodies can take several measures to broaden the applicability of PPP FSM business models.

- Public bodies can engage with higher-level governments for technical, financial, and regulatory assistance to implement contextually appropriate treatment methods, structure PPPs with PS/CBOs, and minimize their and PS/CBOs' upfront investment.
- Public bodies can group several rural settlements (facilitated by higher-level governments) and channel demand to their contractors/licensees to attract PS/CBOs.
- Where existing local enterprises are absent, public bodies can invite local non-sanitation PS/CBOs or FSM enterprises operating in nearby settlements to provide FSM services.
- Existing systems and resources for record-generation and testing treatment/reuse methods by higher-level governments could lower the monitoring burden for public bodies and strengthen the safety of FSM services.

Considering rural FSM is still in its nascency, the onus is equally on governments to conceptualize, test, and replicate PPP models for safe and sustainable service provision.

1. INTRODUCTION

The private sector (PS) is a traditional actor in collecting, transporting, and disposing of fecal sludge (FS) in low and middle-income countries, with or without state sanction. Several studies exist on the business models and profitability of sanitation service providers providing FSM services to households (HHs). For instance, Chowdhry and Kone (2012) examine the financial performance and drivers of PS operators providing mechanized sludge emptying and transport services. Rao et. al. (2016) catalog and analyze several business models diverse in the institutional arrangements involving public, private, and non-profit actors and linkages along the sanitation value chain. However, the knowledge base primarily focuses on urban areas. Verhagen and Scott (2019) is a notable exception that analyzes organically emerged practices and models in high-density rural areas but finds their sustainability fragile and sludge management unsafe.

In most countries, policies and interventions for safe FSM focus on urban areas emphasizing inclusion, such as Citywide Inclusive Sanitation (CWIS) initiatives. By contrast, safe FSM models for rural markets are less well understood, considering that the focus in many countries remains on increasing basic sanitation coverage in rural areas, primarily through on-site sanitation (OSS) solutions. Although positive, the progress in rural improved sanitation coverage in several countries has elevated stakeholders' concerns about the implications of toilets becoming full. Rural households may abandon full pits and build a new toilet, which is the safest option from an environment, health, and safety perspective. However, there are limitations to this practice. Not all households can afford or have the space to build a new toilet (e.g., new substructure), risking slippage (i.e., reversion to open defecation). Worse, households may resort to unsafe self- or hired-emptying and disposal practices, which negate the gains in environmental health from increasing basic sanitation coverage. Moreover, implementing appropriate FSM solutions is imperative for area-wide sanitation and achieving progress on the Sustainable Development Goal (SDG) 6.2 target that seeks movement toward and attaining safely managed sanitation. Sanitation facilities in rural institutions (e.g., schools, health centers, public buildings) will also require FSM services, thus providing an assured level of demand and contributing to the viability of service providers.

Safe FSM services in rural areas are nascent, as less than two percent of FS is treated at an offsite treatment facility, while the alternative safe method of in-situ disposal is limited, on average, to only 44 percent of FS in rural South and Southeast Asia and 20 percent in sub-Saharan Africa.[1] As governments and development partners embark on safe FSM in rural areas, there is a need to build knowledge on appropriate solutions and models. With this context, the USAID Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability (WASHPaLS) #2 Activity undertook a desk review, examining several examples of FSM in varied rural contexts and interviewing key informants, to understand what viable business models for safe FSM in rural areas may be. The scope for this desk review excludes remote rural[2] contexts, where improving basic sanitation coverage is a priority and PS actors' involvement in on-site management is unlikely or waste disposal will likely be undertaken by households or through community efforts.

[1] WHO-UNICEF JMP 2022 Rural Sanitation Service Levels (by safely managed criteria)

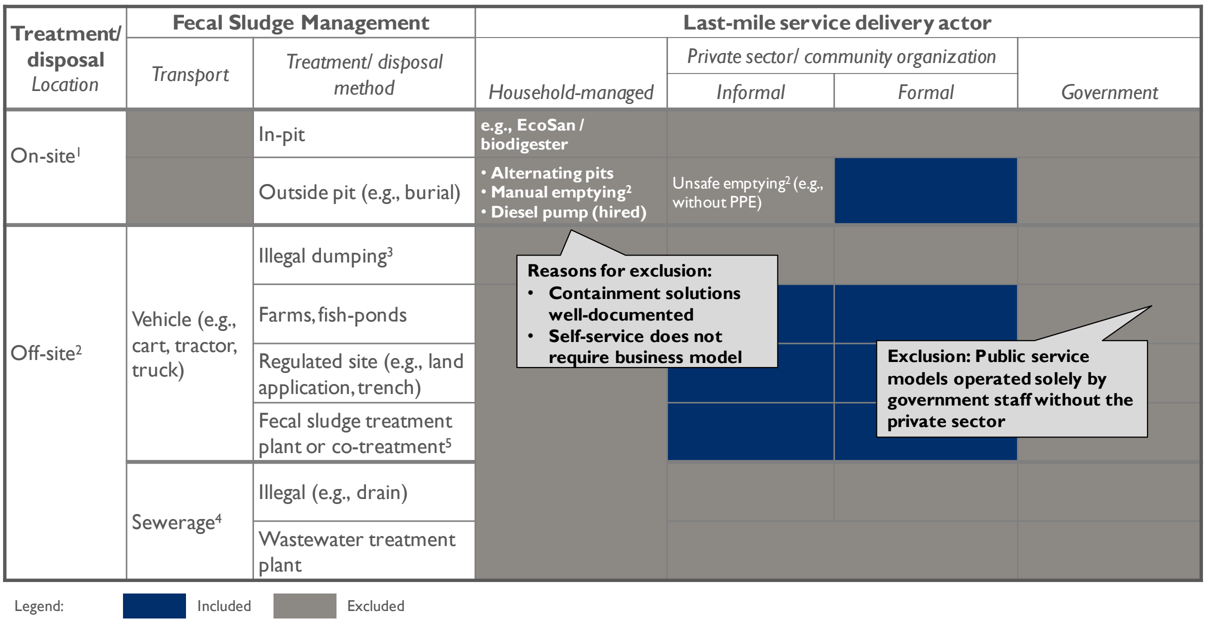
[2] Definition as per WaterAid, Plan International, and UNICEF (2019)

2. APPROACH AND SUMMARY OF EXAMPLES REVIEWED

To identify viable FSM business models in rural areas, the desk review team adopted a case study approach. The team reviewed the available literature and solicited examples from nine experts aiming for diversity in terms of rural context type[3], predominant containment technology (i.e., wet or dry), FSM methods, and the level of PS involvement. The team established the criteria below to help experts recommend suitable examples and then shortlist examples for focused research, including:

- The target market is either rural-mixed, consisting of peri-urban and rural growth centers, or rural on-road settlements based on the typology in the *Guidance on Programming for Rural Sanitation* (WaterAid et al. 2019). The team mapped this typology to the urban-rural classifications by the United Nations (UN) Statistical Commission to establish guidelines on population and population density thresholds as follows:
  - Rural-mixed: Peri-urban areas and large rural settlements/rural growth centers (5,000–50,000 inhabitants) with medium-to-high population density (≥300 inhabitants per square kilometer [km^2])
  - Rural on-road: Small-to-medium communities (500–5,000 inhabitants) with low-medium population density (50–300 inhabitants per km^2)
- PS or community-based organizations (PS/CBO) provide the last-mile service delivery (i.e., emptying, at a minimum) and its selection in a public-private partnership (PPP) is competitive (i.e., other PS/CBOs could have applied or been selected for the PPP).
- FSM methods are designed to safely manage FS across the value chain.

Therefore, we excluded household-managed solutions, including safe options that prevent the need for a business model, and government-owned and operated services (see Figure 1). Such solutions could be considered as part of area-wide sanitation despite their exclusion from this desk review.



Source: FSG Analysis

Notes: 1. On-site treatment – Sludge emptying and treatment/disposal within a household's premises; off-site treatment – Sludge is disposed of or treated at a location outside a household's premises; 2. Assume HHs and informal service providers are unlikely to use safe emptying practices (e.g., protective clothing and equipment) to extract and dispose of sludge on-site without enforced regulations; 3. Unsanctioned/illegal disposal at any off-site location; 4. Sewerage built by the government or a community; 5. At a wastewater treatment plant.

Figure 1: Framework to identify and classify rural examples of safe FSM services for research

[3] Distance from urban cities or towns, population, and population density

The team reviewed the examples identified in the literature and those highlighted by the experts interviewed to ascertain that they met the abovementioned criteria. However, few examples emerged in rural contexts that qualified on all three parameters, confirming that rural FSM is nascent in developing countries. To expand the base of examples, the team relaxed the population or population density criterion but retained the safe FSM and PS/CBO involvement criteria. Although this modification led to considering examples largely in peri-urban/large rural settlements, they provide lessons for application in the wider rural context (see annex A.1). The shortlist consists of the following examples:

- Five examples in settlements qualifying as rural[4], including peri-urban areas:
  - Rural Dhenkanal, India: several rural on-road settlements within 20 kilometers (km) of a small town;
  - Rural eThekwini, South Africa: several rural on-road settlements in an urban municipality
  - Khadak, Nepal: Rural growth center; and
  - Chazanga and Kanyama, Zambia: two peri-urban settlements adjoining the city of Lusaka.
- Three additional examples were identified by relaxing the selection criteria to generate lessons potentially applicable in rural contexts:
  - Leh, India: a small, but *densely populated* town, classified as a rural growth center, with a *sizeable base of commercial customers* (i.e., hotels and households offering homestays[5]);
  - Rural Ganjam district, India: several *rural-mixed* settlements within 20 km of a large city;
  - Sakhipur, Bangladesh: a small, *densely populated* town, classified as a rural growth center; the FSM service is owned and operated by the government, but two non-governmental organizations *(NGOs) practically function as PS/CBO partners* (e.g., equipment finance, joint management of operations); and
- The review identified an ongoing experiment with in-pit treatment using lime by iDE in rural Cambodia that could potentially lead to a business model improving the safety of manually emptying wet toilets.

The team reviewed the available literature and interviewed practitioners and researchers involved in the first five examples. The others were crafted as *caselets*—secondary research to validate the findings or targeted at a specific aspect (e.g., the efficacy of the treatment method in Cambodia).

Analyses of the examples, complemented by the broader literature on FSM, focused on four questions:

1. Does demand for safe FSM as a service exist in rural areas?
2. What methods for emptying, transport, and treatment/disposal are potentially appropriate for rural areas?
3. What are potentially viable business models in rural areas? In which rural contexts could they be applied?
4. What practices further gender equality and social inclusion (GESI) goals?

To assess if demand exists in rural markets, the team focused on the qualitative factors leading households to seek a service provider, such as predominant containment technologies, attitudes toward self-emptying versus hiring a service, and price paid/WTP.

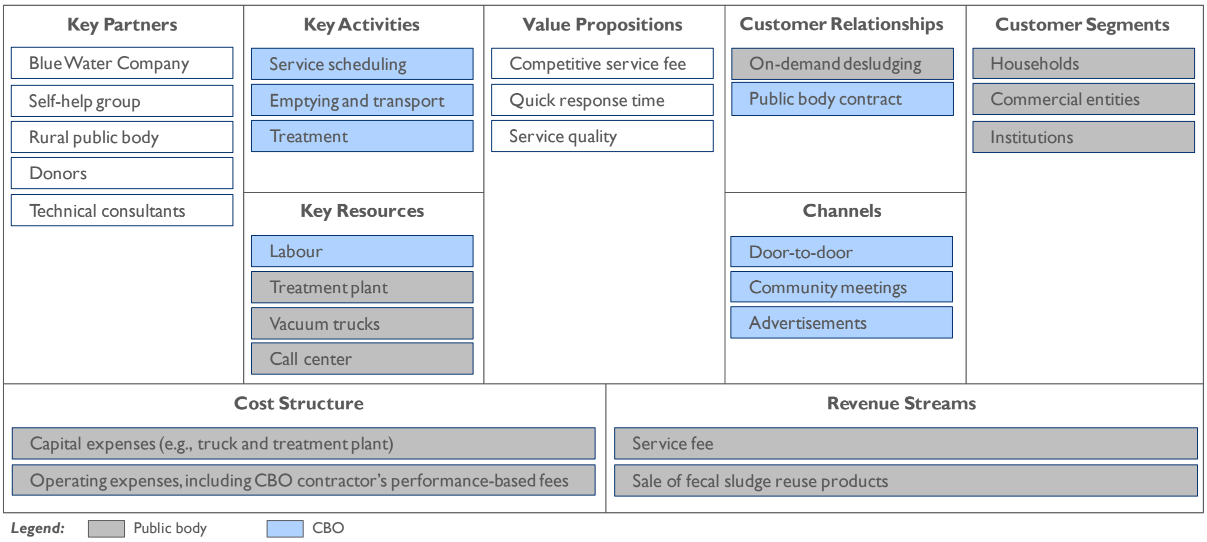
The review team analyzed methods for emptying, transport, and treatment separately from the business models because contextual factors, such as hydrogeological conditions and sludge characteristics, among others, determine the models. Analysis of the treatment method, a critical factor in designing and sustaining FSM services, sought to understand their suitability for rural

[4] Settlement classifications may differ from local administrative classifications, such as town, municipality, etc.
[5] Homestay is similar to a bed and breakfast service or establishment

contexts. The team evaluated the benefits and challenges of the varied methods in terms of applicable hydrogeological conditions, site requirements for off-site treatment/disposal, and setup and operational requirements (e.g., human resource skills/capacity). The analysis intentionally excluded comparing the choice and the technical efficacy of specific treatment/disposal technologies, which are selected based on detailed technical assessments of their operating context and are well documented in the literature.

To understand the business models, the FSM service in each example was mapped in its entirety using the Business Model Canvas.[6] The team identified the roles of the public body, PS/CBO, and any other actor related to the activities, resources, demand activation channels, and finances (see Figure 2 for an illustration). This approach departs from the conventional practice of depicting the business model for a single organization because all the examples are PPPs, and focusing on any one actor would provide an incomplete view of the business model.

Distinct business models emerged based on: a) the institutional arrangements encompassing service, finance, and information flows, and b) the service provider—public body or PS/CBO—from the household customer's perspective. The team compared and contrasted practices related to the value propositions, activities, resources, and customer acquisition channels. Further, the desk review identified practices for progress towards GESI goals in terms of: a) improving environment, health, and safety; b) inclusion of marginalized/vulnerable populations as customers and/or service providers; and c) elevating the social position of sanitation workers.



FSG Analysis

Figure 2: Illustrative mapping of a PPP FSM service business model

The team intended to assess the viability of the examples starting with understanding profitability and its drivers. The analysis was anchored in building a profit and loss statement by identifying and quantifying varied revenue streams and costs. However, data was unavailable for several costs across examples, which is discussed as a major limitation and possible area for further research. Despite this limitation, the team assessed early indications of profitability by considering select costs such as labor, transport, and maintenance that were available from the data collated across the examples and their distribution (i.e., share of total costs).

Findings were synthesized (sections 3 and 4), and guidance was developed on the rural contexts where the PPP business models would be relevant and the steps public bodies could take to broaden

6 A framework to develop or visualize a business model (Osterwalder et al. 2010. *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers.*)

their applicability (section 5). The findings and guidance draw on the broader literature base on FSM to strengthen the analysis considering the limitations in breadth and depth of the examples of rural FSM business models. The desk review concludes with key areas for further research by stakeholders supporting rural sanitation market development (section 6).

The examples reviewed are presented in the following sections; additional information on these examples is provided in Table 1 (following section 2.6). All examples are operational, except in rural eThekwini (South Africa), where the municipality tenders two-year desludging contracts periodically, and in Khadak (Nepal), where the FSM model is undergoing a transition.

2.1 DHENKANAL, INDIA

Dhenkanal is a small town (estimated population of 80,000 in 2021[7]) in the eastern state of Odisha, India. The town and surrounding rural on-road settlements of the same district have shallow water tables and a propensity for flooding.

In 2017, with donor and government funding, the Dhenkanal municipality set up a 27 cubic meter (m^3) per day capacity fecal sludge treatment plant (FSTP) using unplanted drying beds and decentralized wastewater system (DEWATS)[8], a pit/septic tank desludging service using vacuum trucks, and a call center to register and schedule service requests. The municipality contracted Practical Action Foundation (PAF), an NGO, to manage the integrated emptying, transportation, and treatment operations. PAF was mandated to train and transfer the operations to local CBOs—women self-help groups (SHGs)—over a year, per the provincial government's policy. During this interim period, PAF sub-contracted Blue Water Company, a PS social enterprise utility established with support from BORDA, to develop service protocols, manage operations, and train the CBOs for the eventual handover. Consortium for DEWATS Dissemination (CDD) Society, a non-profit specialist in sanitation systems that designed the FSTP, is responsible for monitoring its operation.

In 2020–21, the municipality extended its FSM service to several surrounding rural areas under an urban-rural convergence model facilitated by the district administration and the provincial government.[9] Rural settlements were selected based on their distance from the FSTP (less than 20 km). This was necessary to ensure service viability and customer affordability because rural households bear the additional fuel costs. The selection also accounted for the spare capacity of the FSTP, vacuum truck fleet size, and several administrative factors.

First, PAF and, later, the current CBO-contractor manages day-to-day operations and maintenance (O&M), including the call center, except major repairs and capital expenditures, which are borne by the municipality (see Figure 3). In exchange, the CBO-contractor receives a monthly fee towards wages and expense reimbursement and a pre-determined performance-linked share of revenue/fee collected by the municipality. The CBO receives desludging requests from households at the PB-owned call center, collecting relevant details, such as location and estimated pit capacity, to schedule the service. Requests are assigned to either of the teams operating the two desludging vehicles. For the municipality's convenience, the CBO collects the service fee from customers after job completion and deposits it in the municipality's bank account ring-fenced for the FSM service. The municipality's performance monitoring and payments are based on records of the call center logs, customer-attested service receipts, and FSTP logs maintained in simple spreadsheets.

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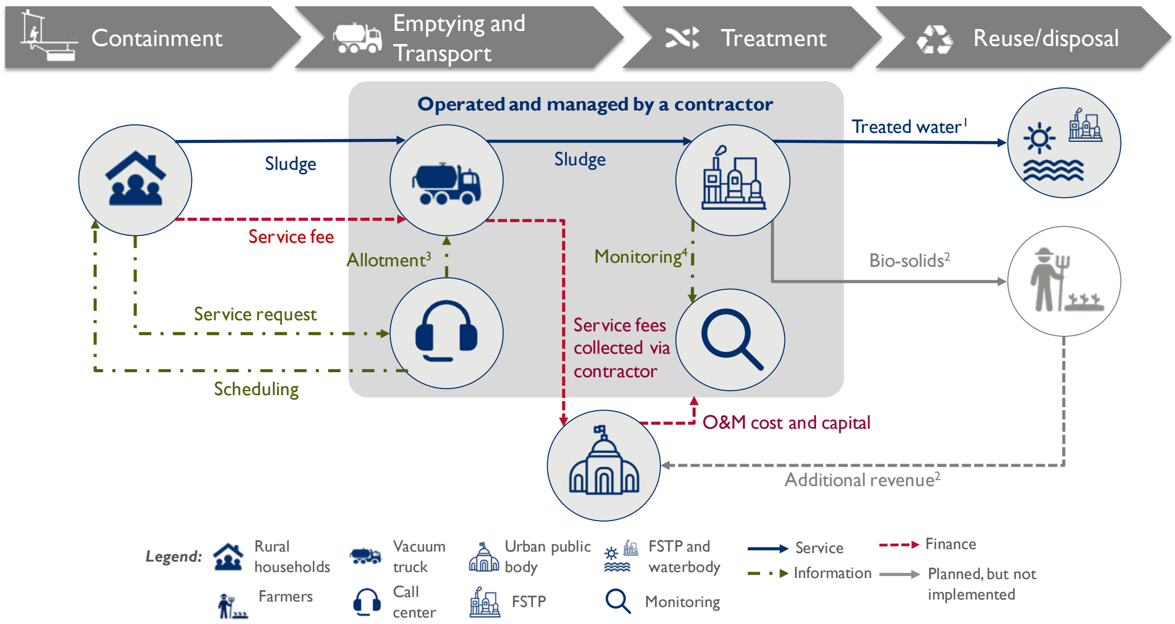
7 Extrapolated using 2011 census population and district decadal growth rate of 11.8 percent

8 DEWATS is a decentralized wastewater treatment approach developed by Bremen Overseas Research and Development Association (BORDA), consisting of a passive design using physical and biological treatment mechanisms such as sedimentation, floatation, aerobic (i.e., anaerobic baffled reactor, anaerobic filter) and anaerobic (i.e., gravel filters, polishing pond) treatment. Several combinations of DEWATS modules are possible and in use globally.

9 The provincial government is responsible for sanitation in urban and rural areas, providing technical support, approving plans, and allocating funds to district administrations and municipalities within districts. As the next level authority, the district administration monitors and assists sanitation programs by rural and urban PBs and therefore facilitated the Memorandum of Understanding (MoU) between the municipality and rural governments of select proximate villages.



Source: FSG Analysis

Notes: 1. Treated water used to irrigate land at the FSTP facility and recharge a nearby water body; 2. Sale of bio-solids was planned but not implemented; 3. Emptying jobs are allotted to either one of the two trucks; 5. CDD Society, a technical partner, monitors the FSTP for compliance with national effluent standards. Sources: Centre for Policy Research. 2020. Operation and Maintenance (O&M) Aspects of Faecal Sludge Management in Small Towns; FSG interviews.

Figure 3: FSM business model in Dhenkanal, India

The urban-rural convergence model is being replicated in several other parts of the Odisha state, while the clustering concept is under pilot for rural settlements beyond 20 km from an urban FSTP.

Rural Ganjam *(caselet):* In the Ganjam district (also in Odisha state), the Behrampur municipality employs a model similar to that in Dhenkanal (i.e., the extension of urban FSM service and infrastructure to surrounding rural areas). However, desludging requests received at its call center are fulfilled by PS operators licensed by the municipality or a CBO-contractor operating the municipality's desludging trucks, call center, and FSTP.

2.2 RURAL eTHEKWINI, SOUTH AFRICA

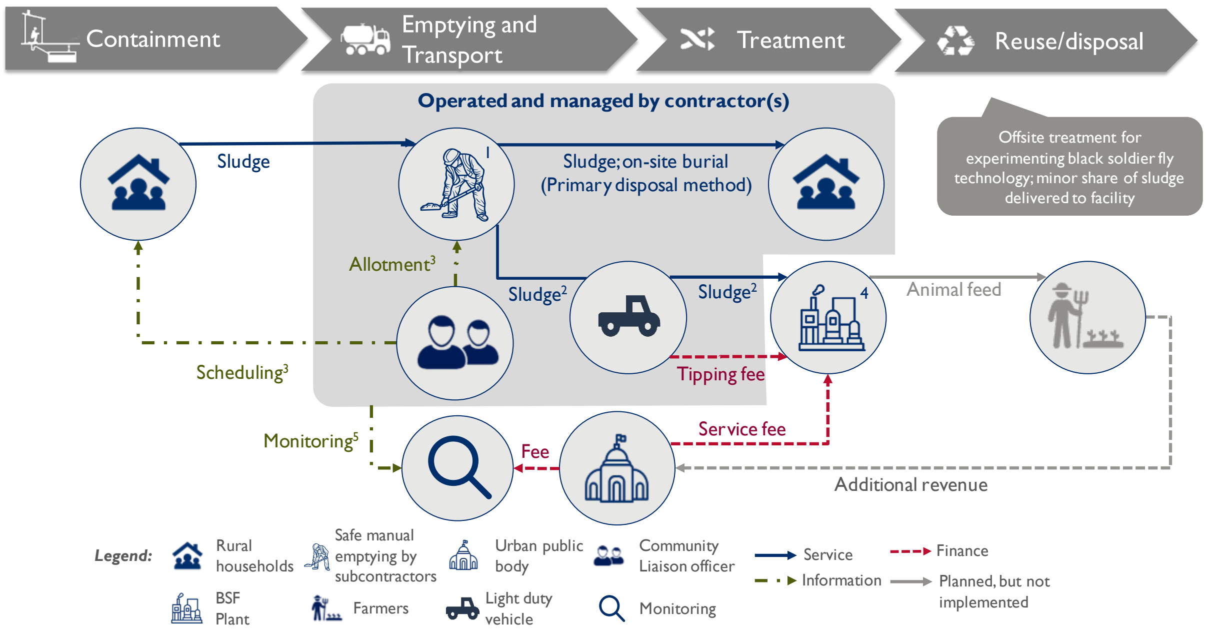
eThekwini is a metropolitan municipality in KwaZulu-Natal, South Africa, comprising a large city and several peri-urban and rural settlements with normal to deep groundwater levels and low flooding propensity. The municipality has a constitutional responsibility to provide sanitation services that are free by law at a very basic level in all urban and rural settlements within eThekwini.

In 2002, the municipality constructed 80,000 Urine Diverting Dry Toilets (UDDTs) free of cost for rural households in response to a cholera epidemic. UDDTs, by design, were intended for self-management by households. However, as the households could not manage the emptying process independently, the municipality launched a free (i.e., fully subsidized) UDDT-emptying service in 2014 to prevent health issues and ensure equity with urban households served by a sewerage network. The municipality's budget permitted a two-year emptying and disposal contract for 50,000 of the 80,000 UDDTs installed; they expected to cover the balance of toilets in another contract.

A PS company won the tender for a managing contractor to train and subcontract small, rural ward-based businesses for last-mile service delivery (see Figure 4). The managing contractor prepared an emptying schedule to service one or several rural wards at a time, covering all target households over a two-year period. The contractor provided equipment and tools, set up (and dismantled) temporary facilities for equipment storage and washing, developed standard operating procedures (SOPs), and coordinated with local councilors for scheduled emptying. The municipality paid a monthly fee to the contractor based on the number of toilets emptied (evidenced by a household-attested record) and the contract rate. The municipality appointed an independent agent to monitor the emptying operations primarily.

The default service included safe manual emptying, on-site burial, and planting a tree of the household's choice. For a minority of houses, if on-site burial was not feasible due to space constraints or household objections, the contractor transported sludge to an FSTP piloting a new treatment technology (i.e., black soldier fly). Biocycle, a PS entity, managed the BSF FSTP generating animal feed from FS. The treatment plant closed eventually because the pilot could not achieve the desired levels of viability.

In 2022, the municipality released a city-wide tender for desludging Ventilated Improved Pit (VIP) toilets (peri-urban areas), UDDTs (rural areas), and septic tanks (peri-urban and rural), split among several zone-based prime contractors.



Source: FSG Analysis

Acronyms: BSF – Black Soldier Fly; Notes: 1. Several sub-contractors and community liaison officers operate under the managing contractor; 2. Transport to the BSF plant was a secondary disposal option; Sludge from sites where on-site burial was not feasible (e.g., space constraints, households objected to on-site disposal) or from wards close to the BSF plant located in Isipingo was transported for treatment; 3. Scheduled emptying jobs assigned to teams managed by sub-contractors; 4. Biocycle, a PS entity, operated the BSF plant; 5. Emptying operations monitored by an independent agency contracted by the municipality. Sources: eThekwini Water and Sanitation Unit. 2015. Contract No. WS6752; FSG interviews.

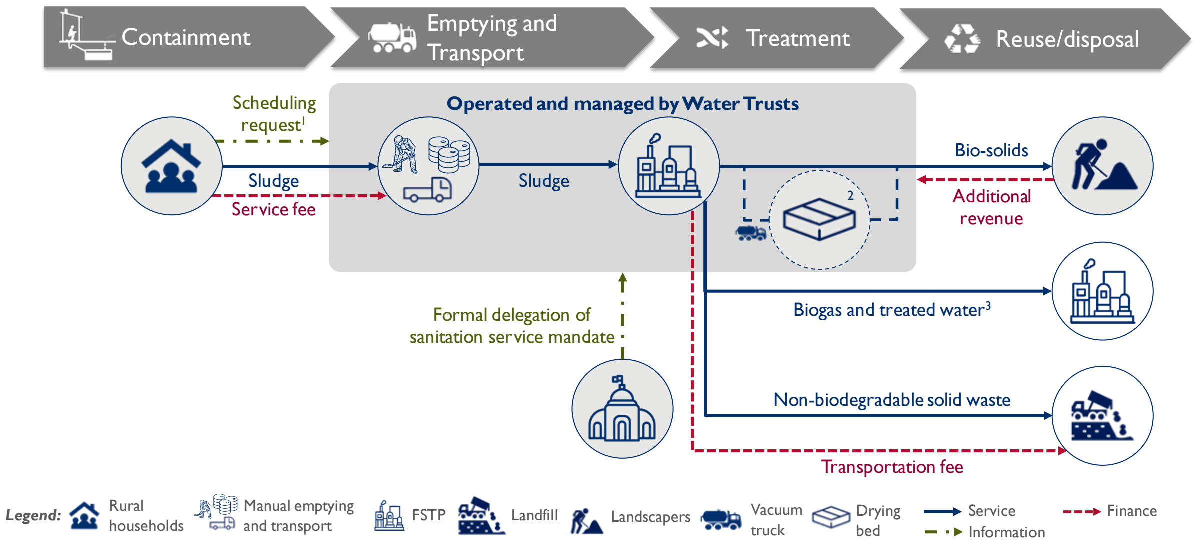
Figure 4: FSM business model in eThekwini, South Africa

2.3 CHAZANGA AND KANYAMA (PERI-URBAN LUSAKA), ZAMBIA

Chazanga and Kanyama are peri-urban settlements in Lusaka with large populations (86,000 and 170,000, respectively) and high population density. Both settlements consist of primarily low-income households and experience frequent disease outbreaks (e.g., cholera). Heavy rains and shallow water tables compound the risks associated with unimproved, unlined pit toilets and the on-site sludge burial practice that dominate these settlements. As per the Water Supply and Sanitation Act of 1997, the national regulator for water and sanitation licensed the Lusaka Water Supply & Sanitation Company (LWSC), a commercial utility formed by the local authority, to provide water and sewerage services in Lusaka city and surrounding peri-urban areas.

Although LWSC delegated water service provision in peri-urban areas to Water Trusts, CBOs formed in 2001, sanitation services were delegated in Kanyama and Chazanga in 2012 and 2014, respectively. The construction of two philanthropy-funded FSTPs using biogas digesters and unplanted drying beds formalized pit-emptying services in Chazanga and Kanyama. The LWSC-licensed CBOs, the Chazanga and Kanyama Water Trusts, which provide water services, to expand their scope to pit-emptying, transporting sludge, and managing the FSTP O&M in their respective areas.

Pit-emptying teams employing existing informal manual emptiers were formed, albeit professionalizing their services and improving safety. Emptying teams were equipped with modified garden tools, cleaning agents and disinfectants, barrels, and a cart (subsequently replaced by a truck) to transport sludge to the FSTP. Staff at the FSTP managed day-to-day treatment operations, including generating biosolids (Chazanga) and biogas (Kanyama) (see Figure 5). A tiered pricing structure—based on 12, 24, or 32 barrels (each of 60 liters)—substantially below prevailing market rates, was intended for households to select an option depending on their pit size and budget. However, partial emptying and the unavailability of a full-emptying service (offered by informal manual emptiers) led to customer dissatisfaction, low service uptake, and losses. The Water Trusts cross-subsidized the sanitation service with revenue from their core water services business line.



Source: FSG Analysis

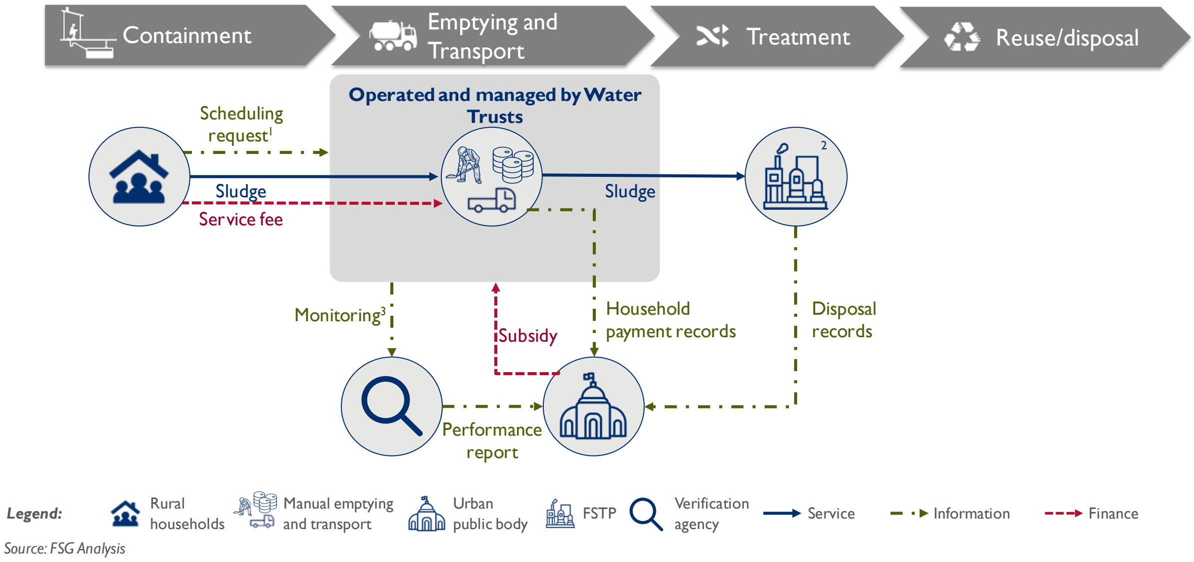
Notes: 1. Households can contact either LWSC or the Water Trusts; 2. The drying beds were located at a different location in Kanyama due to land availability issues; 3. Biogas and treated water are consumed on-site; Sources: ISF-UTS and SNV. 2021. Anaerobic Respiration for Faecal Sludge Treatment and Reuse; FSG interviews.

Figure 5: 2012–2019 – License to empty, transport, and treat fecal sludge in Chazanga and Kanyama, Zambia

As part of a cholera outbreak response in December 2017, authorities shut the two FSTPs temporarily and directed the Water Trusts to transport sludge to Lusaka city's main wastewater treatment plant (WWTP) in Manchinchi. While the Kanyama drying beds were deactivated due to their proximity to boreholes and groundwater contamination risk, both FSTPs' closure extended well past the end of the cholera response in June 2018. Interviews indicate frequent overloading and breakdowns may have also contributed to the FSTPs' closure.

In 2020, the business model changed under the World Bank-funded Lusaka Sanitation Program (LSP), implemented in several zones across Lusaka, including Chazanga and Kanyama. The Water Trusts competed for and won licenses by quoting a per-toilet subsidy requirement. However, their scope is now limited to emptying and transportation only, while an urban-based WWTP at Manchinchi treats sludge (see Figure 6). The Water Trusts' pricing structure has also changed to fixed pricing, and they now provide a full emptying service.

As LWSC licensees, the Water Trusts receive a performance-linked subsidy paid by the LWSC and funded by the World Bank. The LWSC appointed an independent verification agent to periodically evaluate licensees and submit scorecards to process the subsidy payments. The scorecard is based on assessing occupational health and safety, the number of toilets emptied, customer service, and public safety during collection and transport, using metrics from records maintained by the licensees, WWTP, and LWSC, and random inspections by the verification agent. The Water Trusts continue to bear capital investments (e.g., vehicles). Anecdotal evidence suggests that the economics of the service has improved with the change in the pricing structure and the performance-based subsidy.



Notes: 1. Households can contact the LWSC or the Water Trusts; 2. FSG interviews with experts indicate that since 2018, the FSTPs have been shut down, and waste is treated at the Manchinchi WWTP, which does not generate reuse products; 3. Monitoring by an independent agency contracted by the PB. Sources: CWIS. 2022. Performance-based Contracting for Pit Latrine Emptying in Lusaka; FSG interviews.

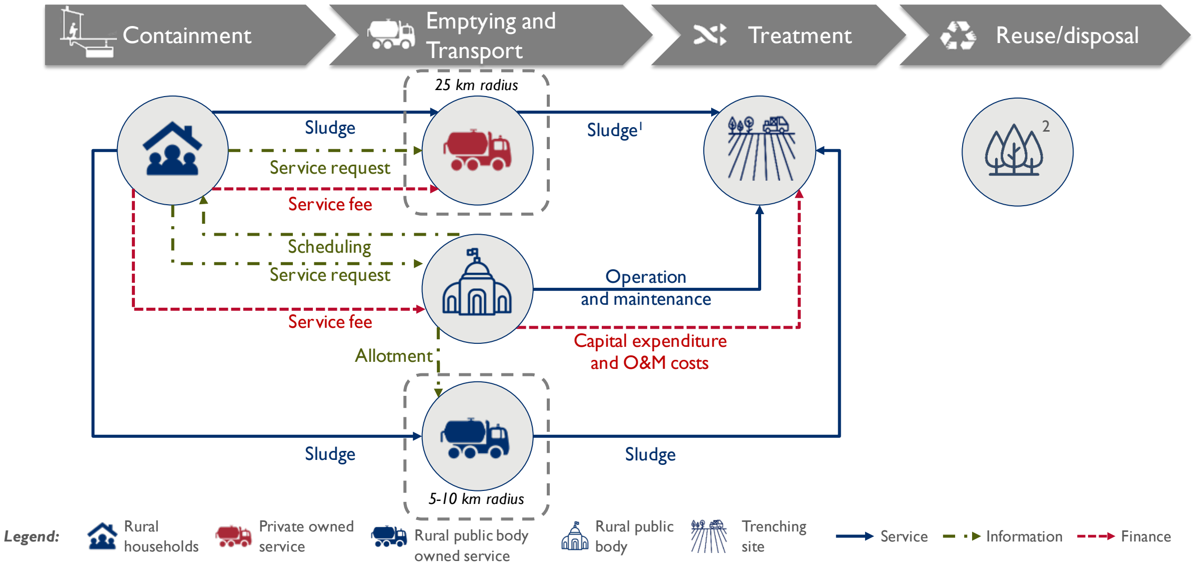
Figure 6: 2020–onwards – License to empty and transport fecal sludge in Chazanga and Kanyama, Zambia

2.4 KHADAK, NEPAL

Khadak is a rural growth center with a relatively new rural municipality formed by the amalgamation of eleven village development committees in the Saptari district of Madhesh state, Nepal. Khadak has deep groundwater levels and a high propensity for flooding during the rainy season owing to a nearby river system.

From 2014 to 2020, SNV's Sustainable Sanitation and Hygiene for All (SSH4A) program aided Khadak municipality in increasing basic sanitation coverage. Toward the end of the program, SSH4A supported the municipality in launching a municipality-operated FSM service—the municipality acquired a vacuum pump mounted on a tractor, leased land from a private landowner to build deep row trenches (current cumulative capacity of 228 m^3 for sludge disposal with the flexibility to add capacity), and passed sanitation bylaws (pending official notification).

The municipality's objective is to provide a safe FSM service to households, most of whom have recently built toilets and have never emptied them, and change disposal practices of several unregulated private desludging providers from the district (not based in Khadak) that service the area. The municipality services a 5–10 km radius of the main municipal area, while private service providers from adjoining markets serve the larger population in the 25 km radius (see Figure 7). Disposal of FS in the deep row trenches is free of charge temporarily to promote disposal by private service providers. However, private service providers' awareness and use of the trench facility are inconsistent.



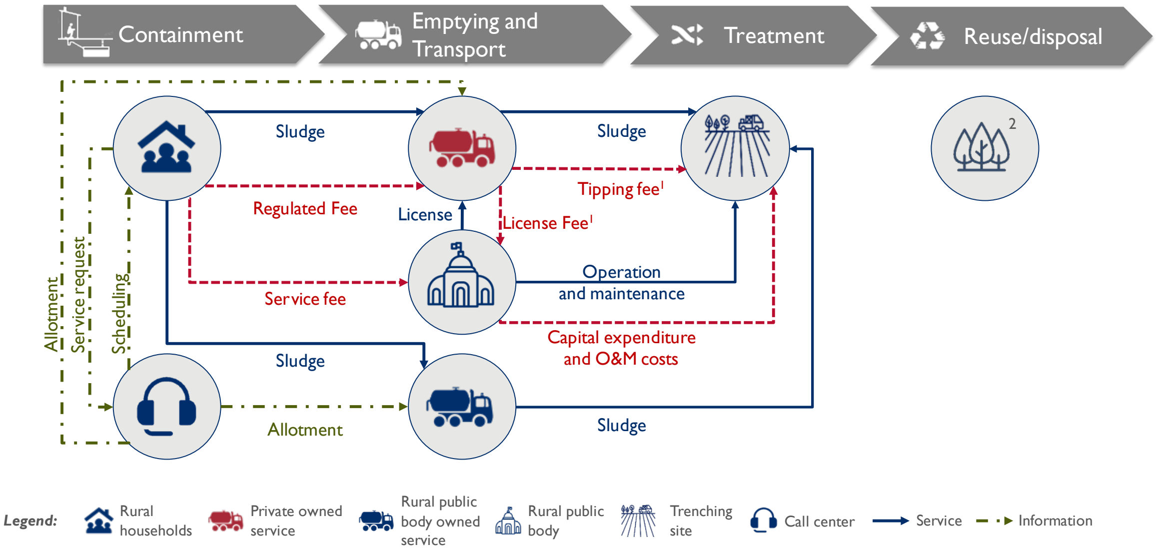
Source: FSG Analysis

Notes: 1. Not all private operators dispose of FS at the trenching site due to lack of enforcement; 2. The landowner will be free to plant trees and use/sell the soil conditioner; Source: FSG interviews.

Figure 7: Current service and institutional arrangement for FSM in Khadak, Nepal

Passage of the sanitation bylaws is a step towards the municipality's plans for an FSM service licensing model. Post notification of the bylaws, the municipality will issue licenses to private desludging operators serving households in its service area. The municipality will finance and operate a call center to assign desludging service requests to licensees or its team based on their availability. Licensing is driven by the motivation to engage and shift the PS toward safe FSM services in the long-term.

The draft license stipulates the service level (e.g., cleanliness) and mandatory disposal at the trench site, among several other conditions, as well as penalties for violations. The municipality is also considering imposing a price cap to ensure affordability for households, although the decision and amount are under consideration. The municipality's service is cheaper than private operators, likely below cost, and subsidized by its consolidated account (i.e., it does not maintain a separate account of revenues and expenses for the FSM service). Figure 8 shows the licensing business model.



Source: FSG Analysis

Notes: 1. Tipping and license fee yet to be finalized by the Khadak municipality; 2. The landowner will be free to plant trees and use soil conditioner; Source: FSG interviews.

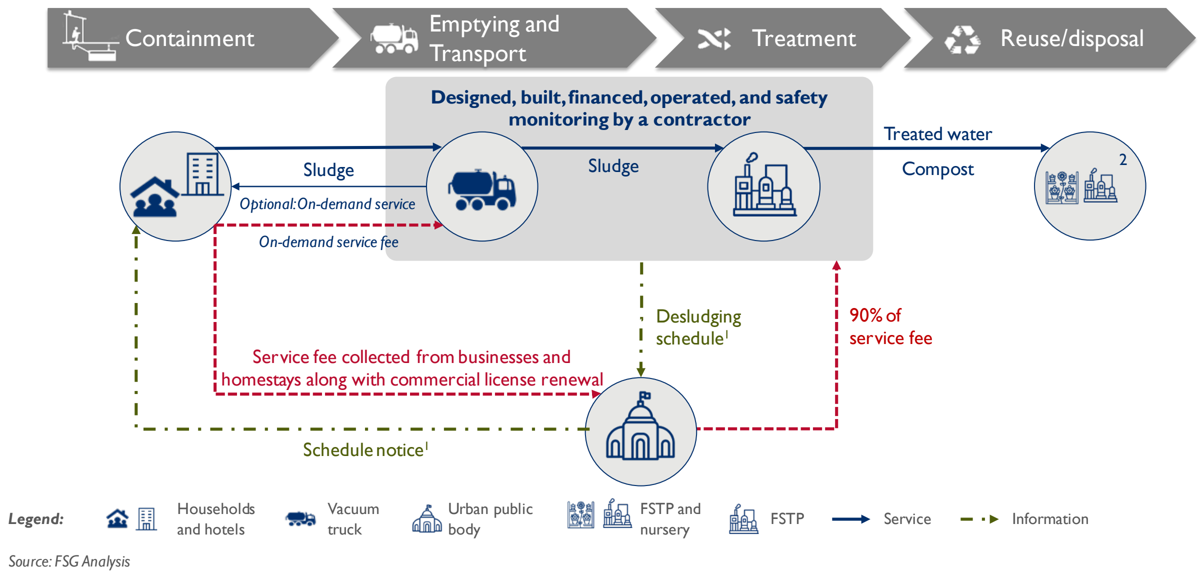
Figure 8: FSM licensing business model planned and under implementation in Khadak, Nepal

2.5 LEH, INDIA

Leh is a small (approximately 45,000 people), densely populated rural growth center in the union territory of Ladakh, India. Leh has a hilly terrain with deep groundwater levels and low flooding propensity. The Municipal Committee has the mandate to provide sanitation services in Leh. A sewerage network serves only 40 percent of households, while many others have EcoSan toilets that do not require desludging. However, many households and small hotels built on-site systems with flush toilets catering to a large and increasing number of tourists visiting in the summer. Sludge began polluting groundwater, the primary drinking and domestic water supply source.

The municipality (local PB) lacked the technical expertise and the human resources required to develop an FSM service. Therefore, it awarded a turnkey integrated contract to Blue Water Company, a PS utility, to design, build, finance, operate, and transfer an FSTP and provide desludging services. The public body contributed an existing vacuum tanker vehicle and mandated scheduled desludging by customers (i.e., households and hotels). The municipality collects desludging fees annually from hotels and households offering homestays when renewing their commercial licenses and other households in advance. Each month, the contractor receives 90 percent of the desludging fee upon submission of service delivery confirmation receipts. The municipality set the service fee through public consultations with business and citizen groups.

The contractor prepares a monthly desludging schedule, and the public body fines customers who refuse services at the scheduled time twice. The contractor also reserves slots for on-demand, urgent desludging requests. Further, poorer households are cross-subsidized by the fees from households providing homestays and commercial establishments. Treated water and compost generated at the FSTP, which uses planted drying beds and DEWATS, are used in an adjacent plant nursery. Under the PPP arrangement, the contractor is responsible for managing capital and operational costs and monitoring and ensuring compliance with effluent standards and its profitability (Figure 9).



Notes: 1. Blue Water Company prepares the desludging schedule, while the municipal corporation of Leh informs the customers about the desludging schedule and levies penalty if a HH is unavailable; Desludging frequency: Low (every two years) for large tanks/pits, high (annually) for smaller tanks/pits; 2. Treated water and compost are used in a nursery on the FSTP premises; Sources: Rath, et al. 2020. Decentralized Wastewater and Fecal Sludge Management: Case Studies from India; Metha and Mehta n.d. Innovative Finance for Sanitation: Case Studies

Figure 9: Licensing business model for FSM in Leh, India

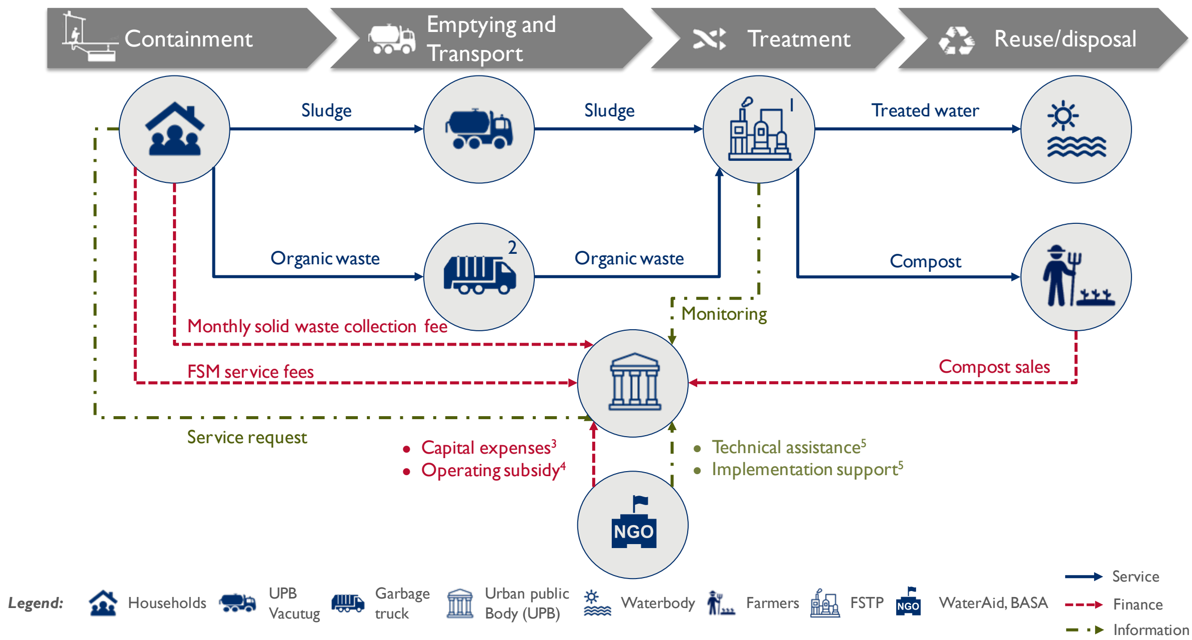
2.6 SAKHIPUR, BANGLADESH

Sakhipur is a small (estimated 34,000 people in 2020), densely populated rural growth center in western Bangladesh. Professional sweepers manually emptied toilets (95 percent are pour-flush pit latrines, and five percent are septic tanks) and disposed of the sludge into nearby open ditches and water bodies.

In 2015, the Sakhipur municipality constructed an FSTP, with assistance from WaterAid Bangladesh and Bangladesh Association for Social Advancement (BASA), to process household FS and solid waste. The municipality financed a Vacutug and the access road and land for the treatment plant. WaterAid provided financial and technical assistance (TA) for constructing the FSTP, which uses unplanted drying beds and constructed wetlands, and setting up the FSM business model with implementation support from BASA.

Households submit and pay for a desludging request at the municipality's office (see Figure 10). Municipality employees empty the pits using a Vacutug based on a daily collection schedule. Additionally, a private operator collects solid waste from households for a monthly fee and delivers it for segregation and co-composting at the FSTP. The compost, marketed under the Sakhi Compost brand, is an additional source of revenue. WaterAid and BASA engaged the Ministry of Agriculture's Department of Agricultural Extension to promote and distribute compost to farmers. A local agriculture school also collaborated to educate farmers on using compost generated from FS.

In the absence of PS partners (except the solid waste collection contractor), the municipality and WaterAid jointly manage the FSTP. The municipality employs and pays staff, who are supported by a WaterAid engineer. The municipality and WaterAid share the equipment replacement costs. BASA provides an operating and maintenance subsidy to bridge the persistent shortfall in revenue (approximately 70 percent of costs). It also assists the municipality with implementation, such as launching the solid-waste management operation before the municipality contracted a private operator, and promotes PS participation.



Source: FSG Analysis

Notes: 1. FSTP; 2. Operated and managed by a PS provider contracted by the municipality; 3. Capital expenses for FSTP construction, desludging vehicles, and replacement costs by WaterAid, garbage truck by BASA; 4. O&M subsidy funded by BASA; 5. Joint management of FSTP by municipality and WaterAid, implementation support by BASA. Sources: WaterAid. 2019a. Faecal Sludge Management Landscape in South Asia; WaterAid. 2021. Strengthening Municipal Finance for Sustainable Sanitation Service Delivery in Small Towns of South Asia

Figure 10: FSM model in Sakhipur, Bangladesh

Table 1 provides a landscape summary of the examples reviewed. Where examples had multiple business models, only one model is depicted for the indicated example (see notes below the table). The analysis includes other aspects of FSM implementation from these examples where relevant.

Table 1: Summary of rural FSM examples reviewed

	Parameters	Bangladesh **Sakhipur**	India **Dhenkanal**	India **Leh**	South Africa **eThekwini** [(a)]	Zambia **Kanyama** [(b)]	Zambia **Chazanga** [(b)]	Nepal **Khadak** [(c)]	India **Ganjam**
Geography	Settlement type	Rural growth center	Rural on-road (clustered[(1)])	Rural growth center	Rural on-road (clustered[(1, 2)])	Peri-urban	Peri-urban	Rural growth center	Rural-mixed (clustered[1])
	Population density (inhabitants per km²)	1,100	268 (rural)	4,918	–	5,636	– (assume similar to Kanyama)	400	352 (rural)
	Toilet technology	WET *Sealed pit/tank: 5%* *Pit latrine: 95%*	WET *Single pit: 86%#* *Septic tank: 8%#* *Twin pit: 7%#*	WET *Septic tank: 5,800* *Soak pits: –*	DRY *UDDT: 94%* *Septic tank: 6%*	DRY *Pit latrine: 90% (unimproved)* *Balance: –*		WET *Pit latrine: 100%*	WET *Septic tank: 73%* *Balance: –*
	Groundwater level	Shallow	Shallow	Deep	Normal-deep	Shallow	Shallow	Deep	Shallow
Scale	Target HHs	8,445[(4)]	Rural: 9,892[(3)] Urban: 16,649[(4)]	5,800[(3, 5)]	~50,000/80,000 UDDTs[(3)]	22,159[(4)]	8,901[(4)]	6,242[(4)]	20,362[(3)]
	Sludge Generated (per annum [p.a.])	Not applicable (n/a)	*Rural: 3,963 m^3 [(4)]* *Urban: 12,300 m^3 [(4)]*	*2,500 m^3 [(3)]*	–	*8,632 m^3 [(4)]*	*4,747 m^3 [(4)]*		
	Sludge Collected (p.a.)	n/a	*Rural: 667 m^3 [(4)]* *Urban: 4,050 m^3 [(4)]*	*2,500 m^3 [(3)]*	–	*389 m^3 [(4)]*	*572 m^3 [(3)]*	–	–
	Share safely managed (p.a.)	58%[(3)]	Rural: 17%[(4)] Urban: 33%[(4)]	100%[(4)]	Nearly 100% of 50,000 targeted UDDTs[(3)]	5%[(4)]	12%[(4)]		
Demand	Awareness/ behavior change communication (BCC) campaigns	PB + CBO	Government + CBO	n/a	PB	Government + CBO	Government + CBO	PB	Government + CBO
	Activation	PB office	Call center	Scheduled desludging	UDDT beneficiary list	CBO or PB office	CBO or PB office	Call center	Call center
	Call center operator	n/a	CBO	n/a	n/a	n/a	n/a	PB	CBO
	Call center cost	–	PB	–	–	–	–	PB	PB

Acronyms: "–" – No data; Notes: 1.a–c. Business model variants depicted in the summary: (a) UDDT emptying with on-site burial, the primary non-experimental disposal method (see Figure 4); (b) Licensing model for emptying and transport with disposal at the municipal treatment plant from 2020 onwards (see Figure 6); (c) Licensing model under implementation (see Figure 8), which refers to several rural settlements formally grouped by PBs for FSM services; (2). Literature and interviews qualitatively describe rural wards as low-population density settlements; (3). Reported figures; (4). FSG estimates; (5). HHs and hotels with septic tanks; (#) Total exceeds 100 percent due to rounding.

(Table continued on the next page)

	Parameters	Bangladesh **Sakhipur**	India **Dhenkanal**	India **Leh**	South Africa **eThekwini**	Zambia **Kanyama**	Zambia **Chazanga**	Nepal **Khadak**	India **Ganjam**
Treatment	Location	New rural FSTP	Existing small town FSTP	New rural FSTP	On-site burial	Co-treatment at existing municipal WWTP (after 2 local FSTPs [4 m^3 capacity each] were shut down)		New rural trench	Existing municipal FSTP
	Capacity (m^3 per day)	8	27	12	n/a	18		288 (total; per unit time: n/a)	40
	Primary users	n/a	Small town	n/a	n/a	City	City	n/a	City
	Operator	PB	CBO	PS	–	PB	PB	PB	CBO
	Capital	Donor	Donor	PS	–	–	–	PB	Provincial Government
	Monitoring	NGO (TA)(6)	NGO (TA)(6)	PS	–	n/a	n/a	–	Provincial Government
	Technology	*For treatment and reuse technologies, see Table 2*							
Emptying & Transport	Method	Vacutug	Vacuum truck	Vacuum truck	Manual	Manual + truck(7)	Manual + truck(7)	Vacuum truck	Vacuum truck
	Service type	On-demand	On-demand	Scheduled	Scheduled	On-demand	On-demand	On-demand	On-demand
	Distance to off-site treatment	~5 km from Sakhipur	Max: 20 km	Max: 10 km	n/a	~30 km	~8 km	3-5 km	Max: 20 km
	Operator	PB	CBO	PS	PS	CBO	CBO	PS (several from other areas)	CBO, PS (two from the municipal area)
	Investor (assets)	PB + Donor (new)	PB (new + existing)	PB (existing)	PS (existing)	Donor (new)	Donor (new)	PS (existing)	PS (existing)
	Monitoring	PB	PB	PB	PB	PB	PB	PB	PB
	PS/CBO customer	**HH**	**PB**	**PB**	**PB**	**HH**	**HH**	**HH**	**HH**
	PS/CBO scope	–	**E+T+T**	**E+T+T**	**E only**	**E+T only**	**E+T only**	**E+T only**	**E+T only**
Revenue source	E&T (O&M)	• HH fees • Reuse sales • Visitor fee(8) • Donor subsidy	• HH fees • PB revenue (9) • Govt. transfers	• Commer-cial customer fees • HH fees	• PB revenue(9) • Govt. transfers	• HH fees • Donor subsidy	• HH fees • Donor Subsidy	HH fees	HH fees
	Treatment (O&M)							• License fee • Tipping fee (to be decided)	• License fee • Tipping fee (–) • Govt. transfers

Acronyms: "–" – No data; E only – Emptying only; E+T – Emptying and transport; E+T+T – Emptying, transport and treatment. Notes: 6. Donor-funded technical assistance NGO partner – WaterAid in Sakhipur; Centre for DEWATS Dissemination Society in Dhenkanal; 7. Sealed barrels transported via small truck; 8. Entry fee for residents visiting the landscape garden at the treatment plant for leisure; 9. PB revenue refers to 'own revenue' (e.g., tax, fee) generated by the PB.

3. KEY FINDINGS: MARKET AND METHODS

Rural contexts generally have smaller populations and lower population densities than urban areas, impacting demand for FSM services. FSM options like self-emptying and in-situ disposal could further dampen the demand for FSM services by public bodies or the PS. Population and housing density also determine the suitability of emptying, transport, and treatment methods typically employed in urban areas. Particularly for FSM, demand and methods determine the types of business models that can be implemented feasibly. This section assesses the demand for FSM in rural areas primarily by examining underlying drivers for FSM as a service and the related methods for safe FSM, starting with the critical stage of treatment, which are appropriate for rural contexts.

3.1 DEMAND FOR RECURRING FSM SERVICES IN RURAL MARKETS EXISTS

Progress toward universal basic sanitation coverage in rural areas remains imperative in many countries. With many rural households acquiring and using improved toilets as first-time customers, knowledge about FSM needs and practices is presumably weak. Consequently, the nature of demand for FSM services and safely managed sanitation, ranging from none to latent to active, is not fully understood. While situational assessments could reveal diverse demand levels across contexts, this section presents insights on rural demand for FSM services and their drivers based on findings from the case study examples and supporting literature.

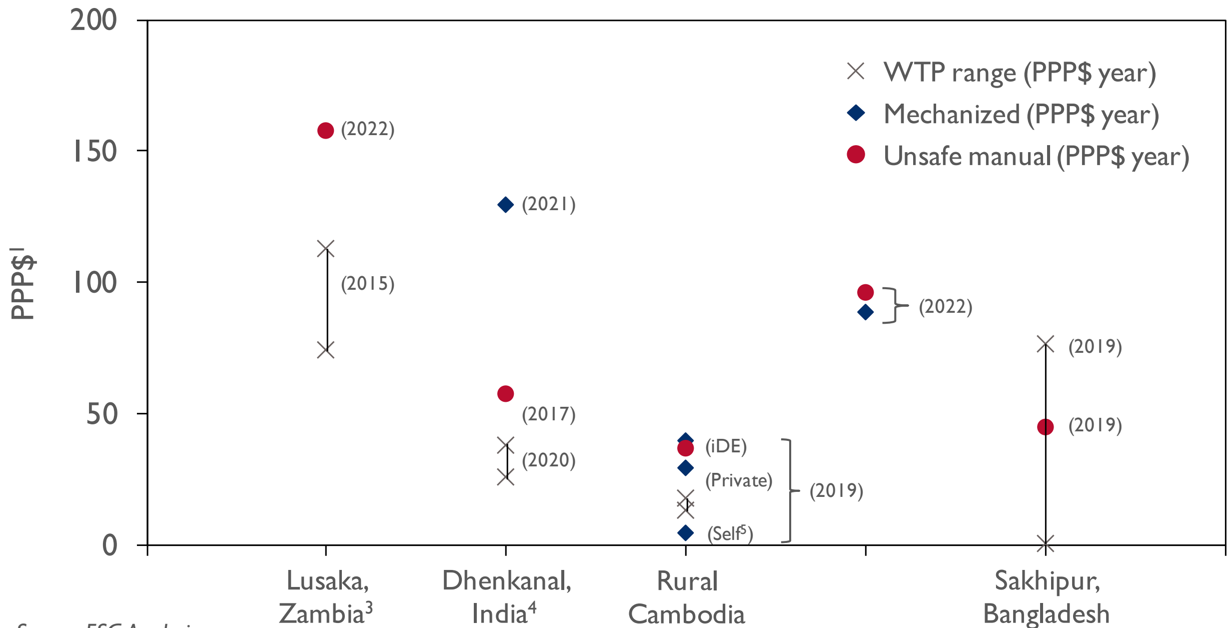
3.1.1 MOST HOUSEHOLDS PREFER HIRING SERVICE PROVIDERS FOR EMPTYING TOILETS AND DEMAND WILL LIKELY INCREASE

In the examples studied, households engaging service providers to empty toilets is an established practice alongside alternatives such as self-emptying. Situational assessments, where available, indicate that most households prefer hiring service providers over self-emptying (Centre for Policy Research 2020, Mow, Al-Muyeed and Nath 2020, Simwambi, et al. 2017). However, preference and actual behavior could vary, as exemplified in rural Cambodia. Here, affordability and availability are primary barriers to hiring service providers, resulting in a sizeable share of self-emptying (Bielefeldt, et al. 2020). Situational assessments also show that many households had never emptied their toilets or emptied just once (Centre for Policy Research 2020, WASH SDG Programme 2018, Al-Muyeed, Nath and Basar 2018). Households had not emptied pits because they either built toilets recently (e.g., Dhenkanal, Khadak) or, worse, practiced unsafe methods, such as draining pits to slow down the fill rate (e.g., Sakhipur, rural Cambodia). Households' unwillingness to self-empty pits, many of which may never have been emptied, indicates that latent demand is higher than the current demand for paid emptying services.

3.1.2 HOUSEHOLDS PAY MORE THAN THEIR STATED WILLINGNESS-TO-PAY

Reported prices for emptying services—unsafe manual and mechanized (vacuum trucks)—are typically higher than what the stated willingness to pay (WTP) studies indicate, where available (see Figure 11). Coupled with the demand for and use of emptying services, this suggests households pay more than their stated WTP. The urgency of desludging pits and the unavailability of alternative service providers are likely reasons. In the examples studied, households seek or plan desludging only when toilets are full—indicated by backflow, difficulty in flushing, or leaks. This practice is consistent with studies in developing countries that found households delay desludging until unavoidable (Robinson and Peal 2020, Jenkins, Cumming and Cairncross 2015). Availability of a service provider then becomes a priority, which explains why the amounts paid are highest when toilets are full (Verhagen and Scott 2019, Chowdhry and Kone 2012).

Alternatively, the WTP data may not reflect actual behavior for several other reasons, such as a respondent's lack of experience hiring mechanized emptying or their anchoring their response to out-of-date prices from a past emptying hire. The literature citing the WTP data does not clarify the methods employed that could indicate the level of accuracy.



Source: FSG Analysis

Notes: 1. Conversion as per EUROSTAT-OECD PPP Programme (PPP$ 1 = United States Dolor [USD] 1) for the year stated in parentheses alongside the value; 2. WTP values as per data available in the literature for the examples studied; 3. Lusaka: Price estimated for an average pit size of 4.5 m^3; 4. Dhenkanal: Mechanical emptying price based on one trip per HH since some HHs may require two or more trips; 5. Price of renting diesel/electric pumps for self-emptying. Source(s): WSUP. 2015. Introducing Safe FSM Services in Low-Income Urban Areas: lessons from Lusaka; CPR. 2020. Solid and Liquid Waste Management in Dhenkanal District: Situation Assessment Report; WaterAid. 2019a. Faecal Sludge Management Landscape in South Asia; World Bank Group. 2019. Household Pit Emptying and Reuse Practices in Rural Cambodia; Shipra Saxena et al. 2022. Bridging the Rural–Urban Divide in Sanitation with a Cluster-Based Approach to Faecal Sludge Management: A Case Study from Dhenkanal District in Odisha, India; Government of Odisha. 2021. Order No: PR-RS-MISC-0009-2020_8667; CWIS. 2022. Performance-Based Contracting for Pit Latrine Emptying in Lusaka; WaterAid. 2020. Small Town Sanitation Learning Series Sakhipur, Bangladesh; FSG interviews

Figure 11: Market prices and WTP values (PPP$ per pit/septic tank)[1, 2]

3.1.3 EMERGING EVIDENCE ON DUAL PIT TOILET PERFORMANCE COULD MEAN AN UNDERESTIMATION OF DEMAND FOR FSM SERVICES IN ASIA AND HAS IMPLICATIONS FOR RURAL FSM POLICIES

In markets where wet containment technologies are predominant, primarily in Asia, governments and development programs have promoted alternating dual pit toilets (ADPs)[10] as a solution that eliminates the need to find, hire, and pay for pit emptying and sludge treatment/disposal services. Guidelines for district-wide FSM in India and rural households in Cambodia recommend ADPs (i.e., building new ones or retrofitting existing single-pit latrines) as the preferred solution to emptying and disposal in rural areas (Department of Drinking Water and Sanitation 2021b, Ministry of Rural Development 2020).

[10] For a description, please see Twin Pits for Pour Flush (sswm.info).

Other examples of such promotions are observed in Bangladesh, Bhutan, Lao PDR, and Nepal (Robinson and Peal 2020, Hussain, et al. 2017, SNV in Lao PDR 2021, SNV in Bhutan 2021)

If well-constructed and correctly operated, ADPs, in theory, allow households to safely remove and handle decomposed dried sludge in the inactive pit after a 2–3-year resting period. However, in practice, ADPs are fraught with challenges because they are rarely operated and fail to perform as intended, resulting in unsafe pit contents when emptied (J. Harper, R. A. Sattar, et al. 2023a, Centre for Policy Research 2020, iDE 2020). Households find switching the flow with the typical junction box unhygienic and cumbersome, often resulting in incorrect operation. Flow junctions are also prone to blockage, leakage, or breakage, compromising functionality as waste flows into both pits (Robinson and Peal 2020; Verhagen and Scott 2019).

Demand for building new ADPs or retrofitting single-pit toilets is likely muted because of the cost involved, household aversion to handling decomposed waste, how fast the shallow individual pits can fill, and operational problems with shallow water tables. For instance, only 10 percent of rural households in Dhenkanal district were willing to pay a fraction of the market rate to retrofit single-pit toilets. The supply-side is also problematic as masons lack knowledge on proper construction (compromising functionality) and are averse to retrofitting in-use toilets (Agarwal, Mukherjee and Dwivedi 2020, Srivastava 2019, Shantz, Lal and Bunleng 2020). Even if technical innovations (e.g., SATO V-trap) resolve quality issues, strict user operational requirements and practical environmental conditions preventing resting pits from drying out properly pose significant barriers to safely managed wet sanitation with ADPs.

The practical challenges have implications for rural FSM planning, particularly underestimating demand for recurring FSM services. For instance, FSM capacity planning in India only accounts for households with single-pit toilets or septic tanks, excluding those with existing or potential to retrofit alternating pit toilets (Department of Drinking Water and Sanitation 2021b). Until innovations to address the above barriers are implemented, FSM planning should consider sustained demand for recurring emptying services from households with existing and those with the potential to upgrade to alternating pit pour flush toilets. As few countries have a rural FSM policy, there is an opportunity to ensure future policies consider the reality that ADPs are unlikely to provide a safely managed solution in wet sanitation contexts.

3.2 RURAL DEMAND PATTERNS AND HUMAN RESOURCES ARE NOT CONDUCIVE TO EMERGING SMALL-SCALE TREATMENT METHODS

The treatment method is among the most critical elements of the sanitation value chain. Several contextual factors, such as hydrogeology, housing density, toilet substructure size and technology, and local norms and practices (e.g., attitudes toward self-emptying), dictate the choice of treatment method, which in turn determines, if not influences, the other sanitation value chain stages and the business model. For instance, an effective in-situ, in-pit treatment method eliminates the need for emptying and transportation services. Distance from and connectivity of an off-site treatment facility with households dictate the transportation method (i.e., trucks, carts, and containers for safe management). These have a bearing on equipment, human resources, and costs, among other aspects of a rural FSM business model.

3.2.1 SMALL-SCALE TREATMENT PLANTS FOR RURAL AREAS ARE RISKY INVESTMENTS

In most examples studied, public bodies had either built a new FSTP or used an existing treatment facility serving urban areas. Policies (e.g., Swachh Bharat Mission – Rural in India), literature, and key informant interviews indicate that public bodies prefer off-site treatment plants, while they view relatively basic methods, such as trenching, as temporary measures.

Most small-scale FSTPs feature drying beds, typically unplanted, as the primary technology and vary in the complementary preceding or subsequent stages (e.g., biodigesters in Chazanga and Kanyama, composting in Dhenkanal and Sakhipur). FSTPs, in the examples studied, treated wastewater using DEWATS modules (e.g., anaerobic baffle reactors, planted gravel filters) and polishing ponds. The FSTPs employed passive designs (e.g., gravity-based systems) to avoid dependence on machinery and electricity, and to lower human resource requirements (see Table 2).

Table 2: Key attributes of treatment facilities employed in select examples

Parameters	Sakhipur	Dhenkanal	Leh	Kanyama[1]	Chazanga[1]	Ganjam
Design capacity (m^3/day)	8	27	12	4	4	40
Location	New rural	Existing small town	New rural	New peri-urban	New peri-urban	Existing municipal
Capex (USD)	118,000	343,000[3]	82,000[4]	125,000	166,500	298,000[3]
Technology (sludge)	Unplanted drying beds	Unplanted drying beds, pasteuriza-tion	Planted drying beds	Biogas digester	Biogas digester, unplanted drying beds	Unplanted drying beds
Technology (wastewater/effluent)	Planted gravel filter, polishing pond	Anaerobic baffled reactor, anaerobic filter, planted gravel filter, sand-carbon filter, and ultraviolet (UV) radiation	Planted gravel filter, polishing pond	Anaerobic baffled reactor, anaerobic filter, gravel filter	Gravel filter, polishing pond	Anaerobic baffle reactor, planted gravel filter, polishing pond
Technology (reuse)	Co-composting for agriculture	Dry biosolids for agriculture	Water and compost	n/a	Dry biosolids for agriculture	Co-composting for agriculture
O&M skills[2]	Medium	Low	Low	High	High	
O&M staffing	• Engineer (WaterAid) • Trained PB workers	• Engineer • Trained workers	• Engineer • Trained workers	Emptying team (part-time)	Emptying team (part-time)	• Engineer • Trained CBO workers
Treatment monitoring	WaterAid	CDD Society	Blue Water Company[5]	–	–	OWSSB
Funding source	Donor	Donor	Private company	Donor	Donor	State Government
Status	Operational	Operational	Operational	Closed	Closed	Operational
Issues reported	1. Repair of compost turner machines 2. Reconstruction of the treatment plant	None reported in literature or interviews	None reported in the literature	1. Frequent blockage 2. Low incoming sludge 3. Overloading drying beds 4. Lack of O&M support	1. Frequent blockage 2. Drying beds not in operation	None reported in the literature

Notes: 1. FSTPs used before closure and switch to co-treatment at an urban WWTP. 2. Subjective assessment based on literature and interviews about technologies adopted and O&M activities (e.g., screening solid waste, distributing the sludge on different beds, replacing sand and grit layers, cleaning biogas digester, cleaning equipment); 3. Conversion rate used: USD 1 = Indian rupee [INR] 83 (2022); 4. Conversion rate used: USD 1 = INR 63.92 (2017). 5. Social enterprise utility established with support from BORDA and CDD Society.

Despite these measures, several challenges identified with FSTPs in urban settings put investment in rural FSTPs at significant risk. Reviews of urban FSTPs and WWTPs find that few function properly, despite supervision by urban public bodies that have arguably better financial, technical, and managerial human resources than rural public bodies (Klinger, et al. 2019, WaterAid 2019b). Several factors cause these issues:

- Variability in sludge quantity due to seasonal fluctuations and the efficacy of sludge collection services impacts FSTP's operation, and local operating staff often lack the knowledge or skills to deal with these fluctuations. Gradual instead of batch loading results in unplanted drying beds clogging and plants in planted drying beds dying;
- Inconsistent sludge quality (i.e., non-organic waste disposed into toilets, causes malfunctioning and temporary closures unless screened adequately). FSTP designs often do not account for such issues; and
- FSTPs and WWTPs require sizeable investments, which urban public bodies are rarely able to provide, resulting in donors stepping in with the initial capital investment. Inadequate financing of O&M results in technical failure unless funded externally, which is available in some instances only.

Treated sludge and effluent require regular monitoring for compliance with safety standards. In the examples studied, while FSTP outputs met safety standards in all cases (except Kanyama and Chazanga, where results were unavailable), public body or PS specialists were responsible for regular self-monitoring safety standards (see Table 2). Details on the treatment monitoring SOPs (e.g., where and how samples are tested regularly) were not available.

Inconsistent sludge quantity and quality, the lack of funds for FSTPs, and the low availability of qualified personnel to operate, maintain, and monitoring are likely exacerbated in rural areas, which raise concerns on the suitability of FSTPs, even small-scale passive designs, for rural settlements.

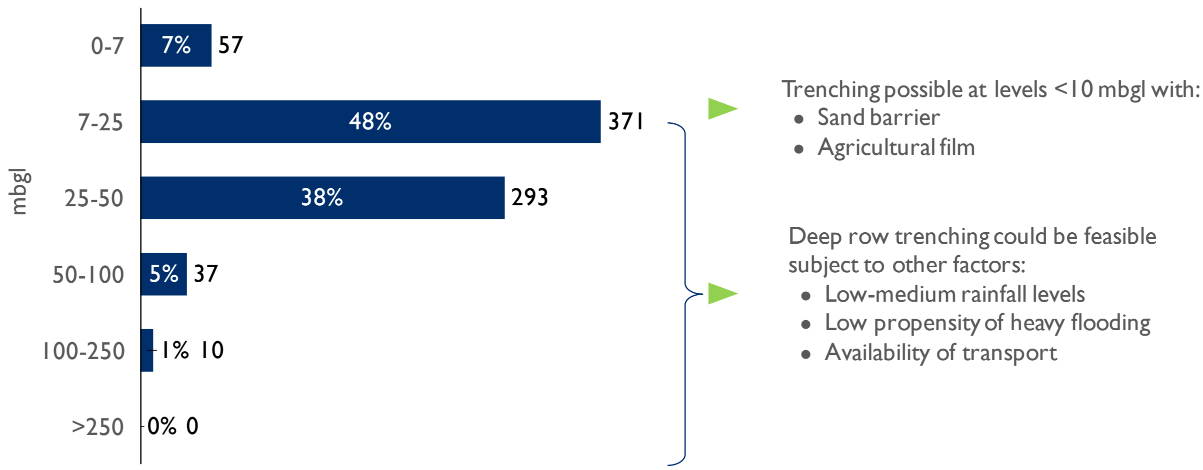
3.2.2 BASIC LOW-TECH METHODS APPEAR BETTER SUITED FOR RURAL AREAS

A few examples studied, such as rural eThekwini and Khadak, employed basic treatment/disposal methods, on-site burial, and off-site trench, respectively. These well-established informal practices across developing countries are being formalized in some policies, such as those in Cambodia and India. Land application, including simple infiltration-evaporation ponds, is another such solution that is both informally practiced in developing countries (i.e., East Asia, sub-Saharan Africa) and institutionalized in several developed countries, e.g., North America, Australia (Jayathilake, et al. 2019, Keraita, et al. 2014).

These basic methods offer several advantages over off-site FSTPs, compatibility with irregular sludge loads being the most significant advantage. Other advantages include low setup (excluding land acquisition if needed) and O&M costs and minimal to no expertise/skill in design or O&M. On-site burial requires labor (hired or self) only for emptying, digging a disposal pit, and transferring sludge—activities suited to unskilled labor. Trenching and land application involve transporting the sludge to a designated site away from human settlements. In both cases, setup costs include fencing to prevent contact with animals or humans, while trenching incurs excavation costs. O&M activities are minimal, such as digging additional trenches to increase treatment capacity and backfilling trenches when full. Reuse applications include planting trenches with trees (e.g., timber) or using the extracted decontaminated soil (after sufficiently safe resting time, assumed two years) on farms as a soil conditioner.

A key tradeoff of basic methods, except on-site burial, is the significant land area required, which is high for trenching but lesser for other land application methods (e.g., infiltration/evaporation ponds). For instance, design guidance suggests trenching requires ten times the area needed for drying beds. Local governments[11] can contribute land plots similar to those granted for FSTPs. They must also secure relevant clearances and permits such as land use, environmental, and food/agriculture (if treated sludge is reused in farming).

To avoid contamination, shallow groundwater levels and proximity to surface water bodies limit the applicability of the basic methods. Design guidelines for burying sludge recommend minimum groundwater depth levels between 7–20 meters below ground level (mbgl). Trenches modified with sand barriers or agricultural film lining in areas with shallower groundwater levels mitigate contamination risks. Nevertheless, there is a significant opportunity for basic treatment methods as most of sub-Saharan Africa's population resides in areas with deep groundwater levels (see Figure 12).



Source: British Geological Survey. 2011. An Initial Estimate of Depth to Groundwater across Africa

Figure 12: Distribution of population by depth to groundwater in sub-Saharan Africa

Land application is better suited to arid or semi-arid regions to accelerate drying and minimize contamination risks. Although application on agricultural land is practiced informally, seasonality (i.e., several months before crop planting, non-rainy season), areas with propensity of flooding, and the risk of food contamination are severe limitations. Developed countries (e.g., United States, Australia) offer regulations and guidelines for untreated sludge application on farms that could be adapted, such as soil injection and lime application to combat insects/rodents and minimum periods between sludge application and farming activities (Jayathilake, et al. 2019). However, ensuring compliance requires the capacity to train farmers and enforce regulations. Shallow trenches in rows alternating with plants/trees on plantations could alleviate these issues, as documented by Keraita et al., (2014, 18) (see Figure 13[12]).

Figure 13: Alternating trenches in a banana plantation[12]

Other considerations, such as rainfall amounts and the propensity for flooding, are also important. Design guidelines, however, indicate that these conditions also apply to FSTPs using drying beds for treatment (see Table 3).

[11] Among the examples studied, land for fecal sludge treatment/disposal is typically provided by governments or local authorities from government-owned land stock; Cases of privately-owned land observed in Khadak (Nepal), several locations documented by Keraita et al. (2014), and prevalent in developed countries under permit/regulation.

[12] Source: Modified image from Keraita, Drechsel, Klutse, and Cofien 2014.

Table 3: Comparison of select passive treatment technologies

	On-site burial	Trenching	Planted drying bed (PDB)	Unplanted drying bed (UPDB)
Typical Capacity	–	<5 m³/day	1.5-6 m³/day	12 m³/day (minimum –)
Site characteristics				
Rainfall (idea)	Low-medium	Low-medium	Low-medium	Low
Flooding propensity (ideal)	Low	Low	Ideally, low (ground formation should be above the recorded flood level)	Ideally, low (ground formation should be above the recorded flood level)
Distance from habitation	–	>500m	>200–500m	>200–500m
Groundwater depth	>7–10 mbgl	>7–10 mbgl	• >10 m from PDB bottom • Not applicable if effluent treatment module added	–
Land (square meters [m²] per m³ of sludge/day)	n/a	~1,000 (very large)	70–100 (large)	80–120 (large)
Setup considerations	Excavation only	• Excavation costs • Fencing costs	• Expert design and construction • Build/repair with local materials • Effluent treatment needed • Shelter for rainy season	• Expert design and construction • Build/repair with local materials • Sludge and effluent treatment needed • Transparent shelter for rainy season
Key O&M aspects	n/a	• Backfilling full trenches • Labor for optional sludge removal and trench reuse (every 2 years) • Well-suited for infrequent or low sludge volumes	• Well-suited for infrequent loading (resting period: ~3–10 days between loads) • Sludge removal (2–3 years) • High efficiency in dry/hot climates • Low skill but training required on maintaining plants and loading sludge	• Needs consistent sludge load and quality to avoid blockage/failure • Labor for regular sludge removal (12–15 days) • High efficiency in dry/hot climates • Low skill but training required on loading sludge

Legend: Advantage, disadvantage; Note: 1. Recommended capacity as per Government of India guidelines, which are provided for comparative purpose in a national context; data supplemented with reported capacities from examples; Sources: National Institute of Urban Affairs 2019; Department of Drinking Water and Sanitation 2021a, ISF-UTS; SNV 2021; Strande, Ronteltap, and Brdjanovic 2014; WaterAid India 2020

3.2.3 RESOURCE RECOVERY IS NOT A RELIABLE REVENUE STREAM FOR THE FINANCIAL VIABILITY OF FSTPS

The abovementioned methods, such as trenching and land application, demonstrate the potential for a circular sanitation economy with minimal effort. Many FSTPs globally, including some among the examples studied, also incorporate a reuse component, typically generating compost or biosolids (i.e., decontaminated dried sludge). Public bodies plan to sell reuse products to farmers, considering their proximity to rural areas, unlike urban treatment plants that are likely to face high distribution costs.

Reuse products, however, are not an assured revenue stream that can improve the economics of FSTPs. On the contrary, generating compost or biosolids increases costs, such as equipment (e.g., co-composting or sludge pasteurization units), regular lab testing, associated labor, other organic waste procurement, marketing, and distribution. Globally, other reuse products such as biogas, briquettes, and treated wastewater are either nascent or unproven compared to compost or biosolids. The desk review examples, corroborated by other studies (Rao, et al. 2020), were unable to monetize reuse products, such as compost/bio-solids (Dhenkanal), biogas (Kanyama), and animal feed (rural eThekwini black fly soldier treatment plant pilot). Sakhipur, with compost sales amounting to 26 percent of revenue, is an exception. A steady waste stream (e.g., sludge, organic waste) from the municipality's sludge and solid waste collection service ensuring volume, promotion, and distribution of compost to farmers by an agricultural extension and positive feedback from farmers who trialed the compost are contributing factors (see section 2.6).

Other challenges include unfavorable community attitudes towards and acceptance of FS reuse products. Regulatory ambiguity in safety standards for FS-derived products (a pre-condition for sale) and regular monitoring costs require active intervention. In Chazanga, Water & Sanitation for the Urban Poor (WSUP) engaged the Zambia Bureau of Standards to resolve the gap in regulatory standards, while in Sakhipur, WaterAid and BASA tested the compost in the government's labs and sought inputs from the Department of Agricultural Extension. Agriculture subsidies, such as those for competing products like chemical fertilizers, could impose a price ceiling on compost as encountered in Sakhipur (WaterAid 2020).

Despite the low monetization potential and several challenges, numerous environmental benefits exist for reusing FS, justifying public investment. Basic treatment methods (e.g., land application, trench) would significantly lower the costs of reusing sludge. However, these products should not be relied upon as a revenue/profit stream for the financial viability of treatment facilities.

3.3 MANUALLY EMPTYING DRY TOILETS CAN BE MADE SAFER, BUT WET TOILETS REQUIRE INNOVATION

3.3.1 MANUAL EMPTYING IS A FEASIBLE METHOD TO FULLY EMPTY DRY TOILETS AND CAN BE MADE SAFER WITH LOW-COST MEASURES

Dry toilets pose several challenges to mechanized and semi-mechanized methods that pump sludge to empty toilets. Pumps cannot extract thick and hardened sludge, characteristic of dry toilets, resulting in only partial emptying of the upper liquid portion. Significant amounts of non-organic solid waste (e.g., sanitary napkins, plastic waste) disposed into toilets with drop holes further complicate mechanized emptying. Preparatory methods such as pre-watering (i.e., reversing the pump flow to inject water and turning dried sludge into a slurry state) have largely proven ineffective and are inappropriate in water-scarce areas. Further, unlined pits and those with low-quality lining can collapse during mechanized emptying.

The examples in sub-Saharan Africa demonstrate manual emptying as a feasible method to overcome these challenges and fully empty dry toilets. In eThekwini, the municipality evaluated several mechanized and semi-mechanized methods and concluded that manual emptying was the only effective option to empty VIP toilets in peri-urban areas and UDDTs in rural eThekwini (Partners in Development 2009). Similar was the case in peri-urban Lusaka, where the high presence of non-organic solid wastes rendered mechanized and manual pumping technologies ineffective for removing sludge from dry sanitation systems (WSUP 2015).

Public bodies tried to improve workers' safety and reduce environmental health risks associated with manual emptying by implementing low-cost measures. These included equipping workers with modified garden tools (e.g., long-handled rakes and spades) and PPE (i.e., suits, boots, masks, and gloves) to prevent contact with FS. While PPE usage was inconsistent, periodic medical check-ups conducted by service providers (e.g., eThekwini, peri-urban Lusaka) did not report major health impacts. Additionally, sanitation workers in both examples were provided a daily ration of milk, which they believed combated the impact of FS exposure (no clinical evidence is available). These measures amounted to one percent of revenue and two percent of labor costs, respectively, compared to the significant benefit of health and environmental risks mitigation. Considering the potential of these low-cost measures, more evidence to ascertain their efficacy in ensuring occupational health and safety of manual emptiers, would be helpful.

3.3.2 MANUAL EMPTYING OF WET TOILETS NEEDS INNOVATION TO IMPROVE SAFETY

Sludge from wet toilets poses significant health and environmental risks at all stages of the sanitation value chain, unlike semi-decomposed sludge from dry toilets. Emptying, in particular, is arguably the most hazardous stage, given the high risk of contact with FS. For this reason, among others, such as social discrimination and stigmatization of sanitation workers, governments in countries such as India and Senegal prohibit manual emptying or prescribe safety practices (e.g., the use of PPE in Cambodia). Nevertheless, unsafe manual emptying practices are prevalent, if not dominant, in many rural areas of developing countries because conventional mechanical desludging (e.g., vacuum tanker trucks) is rare. Interventions are required to improve the safety of manual emptiers, as laws, regulations, and policies alone will be insufficient. Several pit additives are marketed to reduce sludge quantity and prolong pit life, but their claims are questionable (Appiah–Effah, et al. 2020).

An in-pit treatment experiment by iDE in Cambodia points to a potential method to improve the safety of handling sludge in wet toilets before emptying. Several studies globally, but mostly in laboratory settings or at treatment plants, showed that lime can deactivate most pathogens (i.e., E. Coli, Salmonella, total coliforms, and fecal coliforms) within days. Helminth eggs also reduced significantly, but not to levels compliant with the US EPA standards (see Figure 23 in annex A.4.1 for sources). Further, a trial in Cambodia found that mixing lime with a stick (a rudimentary method) could maintain alkalinity at levels intended to deactivate pathogens for up to a week (Chakraborty, et al. n.d.). Lime treatment also received a positive reaction from most households for its odor reduction and perceived sanitizing benefits. Subsequently, iDE introduced lime treatment as part of a dual pit retrofitting service, wherein lime is mixed into the first pit thoroughly with a screw auger to accelerate pathogen deactivation and ensure waste is safe for handling after two years. However, only 60 percent of pits achieved reductions in *E. Coli* and *fecal coliform* concentrations below US and EU standards for land application of fecal sludge (J. Harper, R. A. Sattar, et al. 2023b).[13] Higher-than-permissible pathogen concentrations were attributed to limitations such as households incorrectly operating dual pit toilets during the resting period, inadequate quantities of lime addition, and improper mixing. Although the study could not prove the efficacy of in-pit lime treatment, the authors recommend increasing lime dosage significantly and eliminating storage treatment, which overcome the limitations experienced and potentially enable safe manual emptying of a pit within a few days or weeks. More evidence is required to prove the efficacy of lime treatment and evaluate business models combining lime treatment with manual emptying single-pit toilets. The desk review finds several enabling factors for a professional lime-treatment and manual emptying service—households are unlikely to self-administer lime, lime is widely available in rural areas via agriculture and building materials supply chains, and its costs have a marginal impact on manual emptiers' profitability (see annex A.4.2).

Evaluating potentially safe grassroot practices to generate and disseminate guidance could also improve safety. For instance, using farm pumps and hoses to transfer sludge into an on-site pit or farm is a common practice among rural households in some countries (Robinson and Peal 2020). While

[13] Ascaris ova testing results could not be reported due to problems detected in the tests (refer supplementary material in J. Harper, R. A. Sattar, et al. 2023).

transferring and burying un-treated sludge in an on-site pit could be a potentially safe practice, disposal in nearby farm or water body is not. Identifying and assessing the health and environmental impact of such grassroot practices could inform guidance on manually emptying wet toilets safely.

Having established the demand for FSM services and the suitability of several treatment methods in rural contexts, the next section examines the business models employed in the examples studied.

4. KEY FINDINGS: FSM BUSINESS MODELS

Because FSM impacts public and environmental health, ensuring safe FSM requires public bodies to be involved in some capacity, ranging from regulation to last-mile service delivery. Furthermore, the varied containment and treatment methods determine the activities and resources required to create and deliver value to customers and local communities. This section describes the two business models involving public bodies and the PS identified from the examples studied, primarily in terms of the roles and interactions among the two entities. It also provides insights into the value propositions, practices employed, and potential constraints to improve safety and inclusion, which vary between the two business models. The section concludes by assessing their profitability (to understand viability) to the extent possible, emphasizing critical challenges in cost recognition and reporting.

4.1 BUSINESS MODELS FOR SAFE FSM TEND TO BE IMPLEMENTED BY PUBLIC BODIES

Across developing countries, pit emptying services in peri-urban and rural areas are, by and large, unsafe at one or more stages of the sanitation value chain. Unsafe manual emptying—typically using buckets, shovels, and ropes without protective gear—is prevalent in Asia and sub-Saharan Africa. Low availability or the high cost of mechanized services (due to additional fuel charges for a two-way trip) outside urban settlements drives the dependence on manual emptying (Robinson and Peal 2020, Rao, et al. 2020). Moreover, unsafe disposal is the norm in such cases because formally designated disposal sites are unavailable, or their location is uneconomical for service providers.

The review did not find private-only models among the few examples of business models pursuing safe collection and safe treatment/disposal in rural areas. Models pursuing safe FSM are PB-led, wholly owned and operated by the public body or via PPPs (see annex A.1 for the examples identified). The team focused on the PPPs and one government-owned and operated example in Sakhipur, Bangladesh (where two NGOs practically operated as a PS/CBO, as explained in section 2.6).

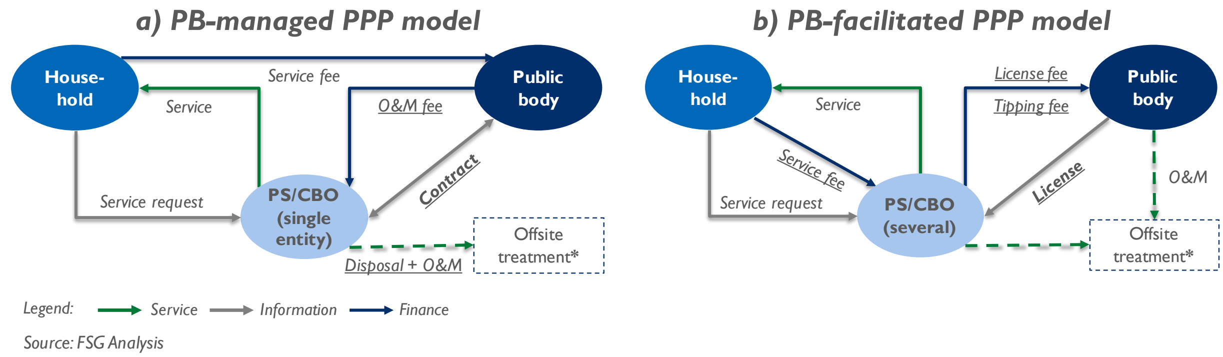
4.2 A PPP INVOLVES EITHER FSM SERVICE MANAGEMENT OR FACILITATION BY A PUBLIC BODY

PPP business models for rural FSM are either **managed** by a public body ("PB-managed") by *contracting* the PS or **facilitated** ("PB-facilitated") by *licensing* the incumbent PS. The main distinction between the two is how the PS entity is paid and who their customer is—the public body under contracting or the household under a licensing arrangement.

In a **PB-managed** business model (Figure 14a), households view the public body as the service provider. The public body contracts and monitors the performance of a PS entity or CBO to deliver services to households in its mandated service area. The public body contract stipulates the scope of services the PS/CBO should provide as well as the fee amount and structure. PS/CBO responsibilities could include emptying and disposal of household sludge, O&M of emptying and transporting equipment and an off-site treatment facility (if applicable), and collecting household charges on behalf of the PB. For instance, the eThekwini municipality contracted a PS entity to empty UDDTs and bury sludge on-site, while public bodies in Dhenkanal and Leh tasked PS/CBOs with emptying, transportation, and treatment, including O&M. In Dhenkanal, the CBO also operated a PB-owned call center[14] for scheduling desludging requests from households. Fees paid by the public body to the PS/CBO are typically linked to the number of

[14] A simple setup involving dedicated space at a PB office or treatment plant, staffed by 1–2 CBO personnel and publicizing the single-point contact. Staff primarily field in-bound desludging requests, schedule appointments, provide information, and register complaints.

toilets serviced. Typically, the public body contracts one entity to deliver the service and manage the infrastructure.



*Notes: * = applicable where on-site treatment/disposal is not feasible or an existing proximate treatment facility is unavailable (i.e., distant, lacks capacity or sludge compatibility).*

Figure 14: Typical PPP business models for FSM observed in rural areas

In a **PB-facilitated** business model that licenses PS/CBOs (Figure 14b), households view the PS/CBO as the service provider. The PS/CBOs are licensed to provide FSM services to and charge households in a defined service area subject to compliance with licensing conditions, typically concerning safety, recordkeeping, and monitoring (e.g., vehicle inspection). PS/CBO licensees either have existing or purchase new equipment for emptying and transportation that they own and maintain. Where on-site disposal is not feasible, licensees must dispose of sludge at a designated site (e.g., trench) or a treatment facility. The treatment facility is owned and managed by the licensing public body or another public body (e.g., an urban municipality with an existing proximate treatment facility); the O&M of the facility also is the responsibility of the PB. Additionally, the public body could regulate licensees' desludging rates as part of licensing terms to ensure the affordability of services. PS/CBO licensees may pay periodic application and annual renewal charges, which tend to be nominal.

Additionally, though not seen in the examples studied, PS/CBO licensees may incur tipping charges at a treatment facility. Ideally, licensees benefit from limited competition implemented by the public body issuing a limited number of licensees. Further, public bodies may direct service requests they receive from households (at their office or a call center) to licensees. The benefits of limited competition for licensed PS/CBOs are subject to a PB's capacity to identify and sanction unlicensed providers. Unlike the typical practice observed of PB-managed business models contracting a single entity, the public body could license several PS/CBO entities in its service area.

PB-managed models can enable new entrants (i.e., PS/CBOs without experience in sanitation). For instance, Dhenkanal municipality contracted women's and transgender self-help groups who underwent training before assuming emptying, transportation, and treatment O&M responsibilities. In rural eThekwini, the public body awarded the emptying and on-site disposal tender to a PS entity with prior experience in solid waste management. By contrast, PB-facilitated models typically license existing sanitation service providers, considering their experience and existing equipment, but not always, as demonstrated in the case of the Water Trusts licensed in peri-urban Lusaka.

The distinctions between the two models are summarized in Table 4.

Table 4: Differences between PB-managed and PB-facilities models for FSM

Parameter	PB-managed	PB-facilitated
PS/CBO's customer	PB	Household
Source of PS/CBO fees	PB (could be collected by the PS/CBO on behalf of the PB)	Household collected and retained by the PS/CBO
Potential scope of PS/CBO activities	• Emptying and on-site disposal • Emptying, transportation, and off-site disposal • Emptying, transportation, and treatment facility O&M	• Emptying and on-site disposal • Emptying, transportation, and off-site disposal
Customer acquisition	PB	PS/CBO (may get PB support)
Emptying & transport O&M costs bearer	PB	PS/CBO
Emptying & transport equipment owner	PB	PS/CBO
Treatment facility O&M and capital costs bearer	PB (including donor funding)	PB (including donor funding)
Examples	Dhenkanal, Leh, rural eThekwini[1]	Chazanga and Kanyama (peri-urban Lusaka)[2], Ganjam, Khadak

Notes: 1. Excludes the pilot black soldier fly treatment facility operated and managed by another private sector entity in partnership with the eThekwini municipality (see section 2.2); 2. Current model of Chazanga and Kanyama Water Trusts, which are licensed to empty, transport, and dispose of sludge at a PB treatment plant situated in Manchinchi (see section 2.3)

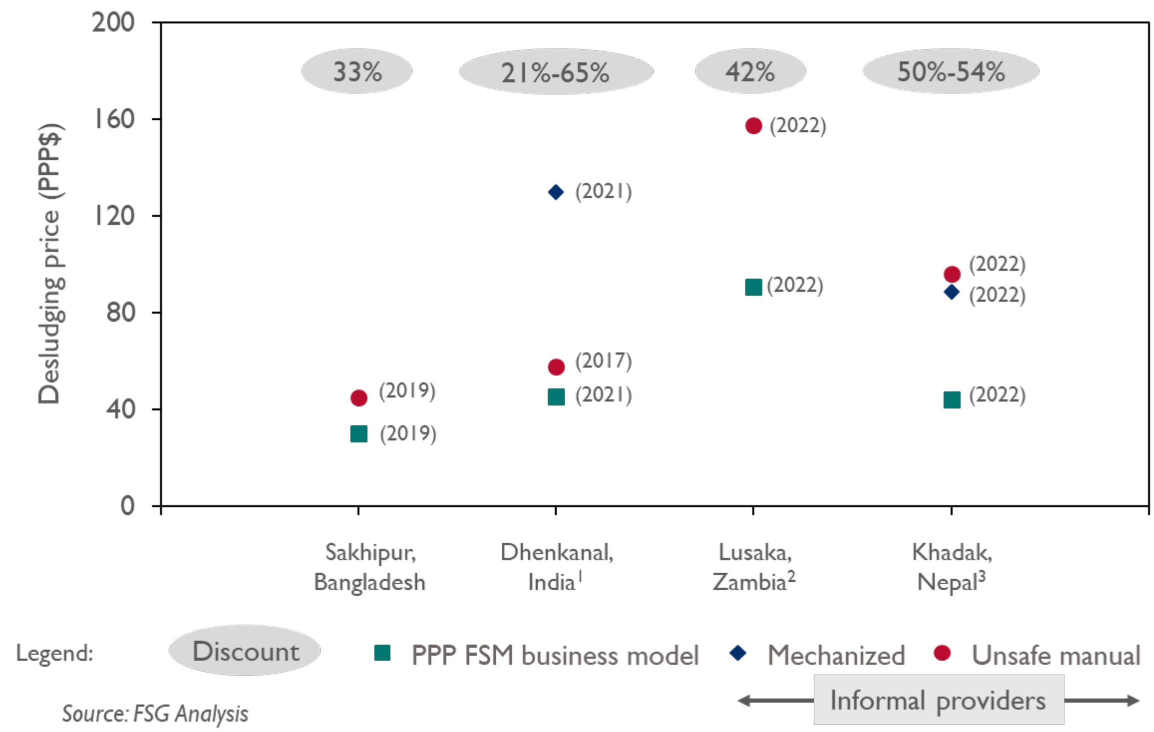
4.3 PPP MODELS AIM TO OFFER AFFORDABLE, SAFE SERVICES WITH VALUE PROPOSITIONS OF BETTER RESPONSE TIME AND CLEANLINESS

Safety is paramount for PB-led FSM business models, but they must often compete with unsafe informal service providers for customer acquisition. Value propositions of affordability and service quality, offered by both PPP models, intend to fulfill these objectives. However, the practices adopted, or their implications (e.g., monitoring), differ between the two PPP models.

PB-LED SERVICES PRICE BELOW THE INFORMAL EMPTYING MARKET TO DRIVE CUSTOMER ACQUISITION AND SHIFT HOUSEHOLDS FROM UNSAFE ALTERNATIVES

Customer affordability is the primary factor in a PB's pricing of desludging services. Ensuring affordability is critical because households tend to seek the lowest cost provider, which could result in selecting informal manual emptiers or self-emptying—neither of which necessarily leads to safe FSM. Among the examples studied, PPP models tend to price their services, on average, 26 percent below informal manual emptiers' rates and 57 percent below informal mechanized emptying providers (see Figure 15). Public bodies charge, regulate, or cross-subsidize low prices to drive initial demand and to compete against informal (unsafe) service providers. Further, public bodies discount or cross-subsidize prices for vulnerable households aiming for equity and maximizing the reach of safe FSM. These range from fixed concessional rates (e.g., Dhenkanal) and transportation fuel costs only (Sakhipur) to volume-based pricing allowing households to opt for a service level, including partial emptying, in line with their budget.

> *"Prices were kept lower than the estimated cost. This was thought necessary to drive initial demand. However, the prices will be increased over the course of time" – Project advisor, Chazanga and Kanyama Water Trusts*



Acronyms: PPP – Public-private partnerships; Notes: 1. Dhenkanal: Per trip to household; 2. Peri-urban Lusaka: Estimated price for an average pit size of 4.5m³; 3. Khadak: Price of the municipality-operated service.

Figure 15: PPP safe FSM prices compared to average market rates (PPP$ per job/trip)

Pricing could have significant implications on the viability of both models (see section 4.5). However, pricing could also affect market participation in PB-facilitated models such that potential licensees could be disinclined to apply for licenses if the profit and/or demand is inadequate. For instance, the team estimated that a proposed price cap for licensees by the Khadak rural municipality in its service area could erode potential licensees' profits compared to operating informally in other settlements that the entrepreneurs served. Since the proposed price cap was still under consideration, the team applied the subsidized price for the municipality's service (a tractor-mounted vacuum pump in the main municipal area). It estimated that PS service providers with 10 percent, 50 percent, and 75 percent of their customers from Khadak vs. other settlements[15] would have overall profit margins of 25 percent, 3 percent, and -18 percent (loss), respectively (see annex A.5). Although the final price cap may differ from the assumption, the example illustrates the potential risk of price caps that undercut the market rate on licensees' incentive to participate unless subsidized by the public body (as seen in the case of Kanyama and Chazanga).

QUICK RESPONSE TIME AND SERVICE GUARANTEES ARE KEY VALUE PROPOSITIONS

Requests for household desludging are typically urgent, as households often wait until toilets are full or overflowing. As a result, they opt for the service provider who can provide service soonest within their budget. Informal manual emptiers residing in the same or neighboring settlements can respond on the same or the next day. Therefore, response time is a significant marketing factor for PPP business models. In the examples of Dhenkanal and Kanyama, PPPs strive to service households within two days while fulfilling more than 75 percent of requests within seven days.[16] A service guarantee of fulfilling all

[15] Assumptions made because entrepreneurs interviewed were unable to estimate the share of total jobs/trips from Khadak compared to other settlements in the same and neighbouring districts.

[16] In Kanyama, 50 percent of requests were fulfilled in two days and 31 percent in 3-7 days. In Dhenkanal, data on the share of households serviced within two days vs. 3-7 days was unavailable .

requests registered with a public body at the regulated price is a secondary value proposition in most examples, subject to monitoring efficacy. This contrasts with private-only models wherein customers far from the service provider could be denied service or quoted high rates.

"Customers can't afford to wait long, especially if the toilet isn't functional. They will call someone else if the municipality can't service them soon. Informal operators, especially manual emptiers will provide same-day service." – Project advisor, Dhenkanal (India)

Response time and service fulfillment are monitored in several examples. In both PPP models, PS/CBOs must report several metrics, such as the number of customers served, sludge quantity collected/disposed, and request and fulfillment dates, backed by customer-attested receipts. However, a PB-managed business appears more likely to monitor response times and service fulfillment because record-keeping is integral to the PS/CBO fees. Contractors' payments are often linked to performance, customer complaints, and redressal actions. PB-managed business models, therefore, ensure that all requests are served, regardless of the customers' location, unless the toilet is unserviceable (e.g., unlined pit, access to emptying equipment) or the customer cancels the request. Among the PB-facilitated models, the Kanyama and Chazanga examples aimed at service levels and reporting practices, similar to those of PB-managed models, driven by a performance-based subsidy.

Cleanliness differentiates a PB's service from informal providers

The examples studied highlight cleanliness as an integral part of service. Both contract and license terms mandate that PS/CBOs develop service protocols, such as sealing slabs (if broken to access the pit), cleaning and disinfecting the service area, and washing equipment. Public bodies aim to ensure compliance by making complaint channels available to redress service deficiency and through penalties prescribed in contracts or licensing documents for varied violations (e.g., spillage). However, the review team could not find evidence of how public bodies detected violations or levied penalties in the two PPP models. While informal providers may adopt some practices, such as cleaning with disinfectants, consistent use is unlikely.

4.4 PB-MANAGED MODELS MAY OFFER ADVANTAGES TO A PUBLIC BODY IN EASE OF MONITORING AND PROGRESS TOWARD GESI GOALS

Delivering the value propositions is clearly dependent on reporting by PS/CBO partners and monitoring by public bodies. In practice, however, reporting compliance is influenced by the PS/CBO's incentive and the PB's capacity to enforce contracting/licensing terms. The differences in the institutional and financial arrangements between the two models determine the extent of a PB's control over a PS/CBO and impact the ease of monitoring. Furthermore, these differences also influence a PB's ability to pursue inclusive goals.

PB-managed models are likely easier to monitor by public bodies than PB-licensed models

PB-managed models that contract a single PS/CBO facilitate monitoring by a public body compared to tracking the activities of one or several PS/CBO licensees (excluding safety of treatment, which is context-dependent and common to both models). More importantly, the fundamental premise of linking PS/CBO contract fees with performance, i.e., a service level agreement, incentivizes the contractor to generate and report monitoring data, thus reducing the public body's burden. Examples of simplified monitoring include customer-attested receipts generated by the PS/CBO to aid performance data and verification in Dhenkanal and Leh.

In PB-facilitated models, licenses also mandate reporting by PS/CBOs, but neither their compliance levels nor methods employed by public bodies to ensure compliance emerged from the research. The desk review team posits that license renewals could be subject to satisfactory reporting but did not find such stipulations in the license forms reviewed in Khadak or Ganjam. Urban FSM literature discusses several technology-based monitoring tools (e.g., mobile apps) deployed for licensees to report data, such as customer and toilet details, sludge quantity collected and delivered to FSTPs, and operator/vehicle details. But data generation by licensees has proven problematic (Rao, et al. 2020, CWIS 2020).

Introducing performance-based subsidies improves reporting compliance by licensees in PB-facilitated models. But ensuring reporting reliability requires verification by the public body or another party on its behalf. For instance, licensees across Lusaka, including the two Water Trusts in Kanyama and Chazanga, receive performance-based subsidies from the public body based on a relatively elaborate monitoring process. Water Trusts submit job cards, household payment receipts, and monthly activity reports, which an independent agency verifies against sludge receipts recorded at the treatment plant. The verification agent also undertakes sample inspections to prepare a scorecard based on which the public body releases donor-funded subsidy payments to the CBOs (ILISO Consulting 2020, Lusaka Water Supply and Sanitation Company 2020). Although subsidies and verification increase costs, the example highlights the importance of performance-linked payments in generating monitoring data.

The relative ease of monitoring is limited to emptying and transport operations. Monitoring the safety of sludge treatment requires technical skills and resources, which are fulfilled largely by externally-funded technical specialists in the examples studied (see section 3.2.1)

PB-MANAGED CONTRACTS INCORPORATE NATIONAL/SUB-NATIONAL POLICIES BENEFITING DISADVANTAGED GROUPS

Public bodies incorporate reference clauses from existing policies or develop guidelines related to social inclusion and rights protection as conditions for a PS/CBO contractor. Take livelihoods, for instance. Most PS/CBOs consisted of or recruited incumbent sanitation workers for last-mile service delivery and O&M, ensuring livelihoods. Public bodies in eThekwini and Dhenkanal went further by reserving employment opportunities for historically disadvantaged groups. In eThekwini, the emptying contract incorporated conditions from the Contract Participation Goals[17] that mandate hiring a certain share of labor and enterprises from "designated and target groups"—black, women, and individuals with a disability (eThekwini Water and Sanitation Unit 2015). In Dhenkanal, the provincial government's sanitation policy encouraged O&M by women and transgender self-help groups (Panchayati Raj and Drinking Water Department 2020). In both cases, compliance targets were met and sustained by investment in the training and capacity building of the policy beneficiaries and, in the case of Dhenkanal, public body officials (Ernst & Young 2019).

Contracts also stipulate mandatory occupational health and safety standards, such as conducting periodic health checks, providing protective equipment, and specifying service protocols. Addressing sanitation workers' labor rights, such as formalized employment, benefits (e.g., insurance), and facilities for cleaning and washing, improve their employment conditions. Other measures that signal a professionalized service and are intended to combat the social stigma associated with sanitation services include work hours restricted to daytime and the use of uniforms.

In PB-facilitated models, license terms address occupational health and safety, and workers' rights to an extent. However, they are not as extensive in scope as the measures in the PB-managed model. Further, ensuring compliance with occupational health and safety standards, particularly using PPE, is challenging.

[17] A standard by the Department of Public Works' Construction Industry Development Board specifying the share of the value of construction projects meeting specific criteria (e.g., duration, value) that must be executed by target enterprises (e.g., local micro-small enterprises) or targeted labor (i.e., populations distinguished by race, gender, youth, disability, etc.)

This is true even for PB-managed models because sanitation workers often resist using protective gear due to discomfort (heat in tropical climes) and impediments to operating equipment.

Overall, a PB-managed model entails several of the good practices identified by a global collaborative formed to address sanitation workers' rights (World Bank; ILO; WaterAid; WHO 2019).

4.5 VIABILITY OF CURRENT FSM MODELS APPEARS UNLIKELY AND REQUIRES ONGOING EXTERNAL FINANCIAL AND TECHNICAL SUPPORT

Assessing the viability of rural FSM business models is key to this research. However, determining the profitability and viability of the business model (see Box 1) and the underlying drivers of profitability for the examples studied has proven challenging. Inconsistencies in the range of costs considered (or reported) and financial data quality (i.e., granularity and completeness) were the primary challenges to establishing the viability of the different models.

Box 1: Profitability and Viability

Profitability refers to the extent to which revenue generated is more than the expenses incurred to deliver safe FSM. Revenue includes all sources explicitly linked to the service, such as HH fees, sales of reuse products, or a PB's sanitation taxes or equivalent (e.g., surcharge on water bill). Expenses include day-to-day costs such as labor, transport, marketing, and regular maintenance among others and longer-term costs, such as equipment replacement. **Viability** is a subjective measure of whether the profitability incentivizes an actor sufficiently to provide a product/service or needs external support.

A PPP model involves two parties with different revenue sources and expenses incurred, and therefore viability differs for a public body and its PS/CBO partners. A PS/CBO may evaluate viability based on their profit (e.g., contract fees in PB-managed or household fees in PB-facilitated models less their expenses) to perform their role. A public body will find a PB-managed model viable if its FSM-specific revenues (e.g., household fees) covers the contractor's fees and its costs (e.g., marketing, supervision). Ideally, a PB-licensed model would be viable for a public body if fees, such as licensing application/renewal, cover its costs (e.g., monitoring). Treatment costs would be common to both models in a given context.

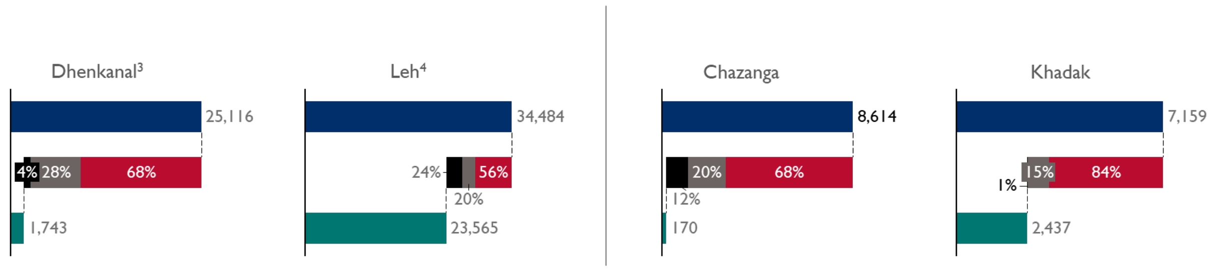
Since FSM is a public health issue, a public body may consider its wider budget, including non-FSM revenues and transfer/grants from higher-level government, to support the FSM service financially. The desk review considers such funding and any donor funding as external funding.

A FEW EXAMPLES REPORT EARLY INDICATIONS OF PROFITABILITY

The examples studied differ in the incorporation of the sanitation value chain stages, particularly on-site versus off-site disposal and treatment. Therefore, the desk review selected comparable examples, isolated the core costs associated with emptying and transportation only (i.e., labor, fuel for vehicles and pumps and their maintenance), and excluded treatment facility costs even if reported.

The select examples in Figure 16 report profits, considering the revenue generated (primarily from household service charges) and the emptying and transportation costs. The finding is consistent with the other examples studied in the desk review. Labor accounts for the most significant share of the core costs considered, followed by fuel. This distribution is consistent with urban service providers in Asia but differs from those in sub-Saharan Africa, where fuel is the major cost driver (Chowdhry and Kone 2012). In the rural examples studied, fuel costs are less than labor, likely because the distances between households and treatment/disposal sites are shorter (maximum of 10–20 km), and smaller-capacity vehicles are used (1–3 m^3) than those in urban FSM.

Notwithstanding the variance in margins (i.e., surplus expressed as a percentage of revenue), the profits in the PB-managed examples are intended to cover the costs of the treatment facility. In the PB-facilitated models, the licensees generate a surplus on the emptying and transportation activities in their scope. However, the need to cover the costs of the treatment facility calls into question the viability of all models where a treatment plant is needed.



Source: FSG Analysis

Notes: 1. Revenues: Service fees collected by the PB in PB-managed models in Dhenkanal and Leh and by the PS/CBO in PB-facilitated models in Chazanga and Khadak; 2. Labor, fuel, and maintenance are expressed as percentages of total costs; costs incurred by PB in Dhenkanal via its contractor, PS in Leh under a Design-Build-Finance-Operate-Transfer PPP arrangement, and by PS/CBOs in Chazanga and Khadak; 3. Quarterly revenue and cost (April–June 2021) annualized; 4. Labor costs for emptying and transport only; costs excluded even if data is available in some cases to enable comparison are consumables (e.g., chemicals), PPE and tools, treatment plant maintenance administration and TA, depreciation, and marketing costs.

Figure 16: Revenue[1] and expenses[2] for emptying and transportation (in USD, expenses in % of total)

SEVERAL INTEGRAL AND ENABLING COSTS ARE GENERALLY UNREPORTED OR UNACCOUNTED RAISING CONCERNS ABOUT LONG-TERM VIABILITY

However, the actual profitability would be lower than computed in Figure 16 and in other examples because treatment and several other costs, such as O&M, administration, and marketing costs, are not considered. These costs are unaccounted for or unreported in most examples, except for Leh (see Figure 17).[18] The contribution of consumables (e.g., cleaning chemicals and disinfectants) and administration (e.g., managerial staff, public body officials' wages) to costs could be relatively low. However, others, such as equipment depreciation, marketing, and external consultants (typically donor-funded), are likely to be significant. Costing for the entire business model, including treatment facilities (where applicable) and depreciation of equipment (e.g., vehicles), would likely lead to deficits in the long term.

Cost items[1]	Sakhipur	Dhenkanal	Leh	eThekwini	Chazanga	Khadak
Labor	✓	✓	✓	✓	✓	✓
Fuel	✓	✓	✓	✓	✓	✓
Consumables (e.g., chemicals)	–	–	–	–	✓	✗
Vehicle maintenance	✓	✓	✓	n/a	✓	✓
Equipment (e.g., PPE, tools)	✓	✗	✓	✓	✓	✗
Treatment plant maintenance	✓	✗	✓	n/a	n/a	✗
Administrative costs and utilities[2]	✓	✗	✓	✓	✓	✗
Consultants[3]	✗	✗	n/a	n/a	✗	✗
Depreciation	✓	✗	✓	✗	✓	✓
Marketing costs	✗	✗	n/a	✓	✓	✗

Legend: ✓ Considered by implementer ✗ Not considered by implementer **n/a**: Not relevant to the implementation – Likely considered but data unavailable

FSG Analysis

Notes: 1. Cost items at O&M level only; finance costs, insurance, taxes, etc. excluded; 2. Include items such as milk, stationery, telecom benefits, and electricity; 3. External consultants involved in design and ongoing improvements to the business model.

Figure 17: Comparison of the consideration of cost items

18 Several key informant interviews confirm the challenges with financial data availability and granularity.

Investments are needed from public bodies and governments to drive behavior change and market safe FSM services across the service area

Public bodies adopt practices such as undercutting market price, offering a quick response time, and cleanliness (discussed in section 4.3) to compete with unsafe informal providers and acquire customers. Public bodies and PS/CBOs also conduct demand-generation and marketing activities to support customer acquisition in the short term and customer retention in the long term by shifting preferences towards safe FSM services.

Increasing customer awareness about proper toilet use and maintenance is critical in several markets where many households have recently built toilets due to sanitation development programs. Situational assessments indicate that many toilets are not yet full, and households have never emptied them. Further, their knowledge about good maintenance practices, such as timely desludging and emptying service options, varies significantly. Several studies show that customers are largely concerned with emptying their toilets only and have low awareness or concern about the impact of unsafe FSM practices (Verhagen and Scott 2019, Tayler 2018). Informal desludging service providers typically advertise their services but rarely educate customers about other aspects of the sanitation value chain.

In some examples, public bodies recognized this challenge and undertook demand-generation campaigns, the intensity of which was higher at the launch of the PPP service. Messaging was context-driven and typically focused on the following:

- Toilet maintenance, such as recommended frequency of desludging and avoiding solid waste disposal, to ensure toilets function properly. These practices also intend to address challenges faced by safe FSM services, such as servicing urgent desludging requests and inefficiencies in emptying and treatment owing to sizeable solid waste content in pits;
- Health and environmental risks associated with unsafe FSM services and unsanctioned disposal; and
- The availability and benefits of the PB's safe FSM service and the process to place desludging requests (e.g., call center/helpline, scheduling).

Campaigns conducted in Dhenkanal and peri-urban Lusaka leveraged various actors, including local leaders, community organizations, and workers. Similarly, implementers utilized several channels, such as door-to-door visits, community meetings, and outdoor and government media. Both examples demonstrate the application of methods and lessons developed for open-defecation-free and toilet promotional activities in recent years. Public bodies or allied actors (e.g., health ministry/department managing community health workers) bear the costs for these activities, underscoring the practice of not accounting for full costs even though a public body or a government affiliate incurs them, and they are integral to customer acquisition for the PPP service providers.

Among several examples, call centers or helplines are emerging as a popular marketing tool that aids operations and monitoring. Records maintained from customer interactions generate several monitoring metrics and are part of processing performance-linked payments by public bodies. This data is also potentially used to analyze and improve performance. From the customer's perspective, call centers reduce search costs (e.g., contacting several service providers) and avoid the inconvenience of booking through offline channels such as visiting a PB's office.

Safe FSM business models rely largely on external funding and TA for design, setup, and initial operations

The design and setup of FSM services require advanced technical capabilities lacking in most public bodies and local PS/CBOs. In most examples, donor-funded consultants provide design and ongoing support to address capability gaps, which implies that such support is a prerequisite for implementing rural FSM business models.

Initially, setting up an FSM business model involves several activities identified by the roles undertaken by consultants in the examples studied. These include situational assessments, capacity planning, determining appropriate methods and technologies for emptying and treatment/disposal, business and financial modeling, and site selection, among others. A decision to use basic treatment methods would also require rigorous technical assessments (e.g., hydrogeology) to ensure health and environmental safety. After setup, ongoing support involves iterating standard operating procedures, maintenance plans, and monitoring systems based on evaluating performance data and emerging issues. Consultants also monitor treatment plants for safety (see Table 2 in section 3.2.1)

Public bodies in the examples studied lack experience in designing, implementing, or managing sanitation services and infrastructure, a situation that manifests in many urban contexts as well. Local PS/CBOs, at best, have demonstrated capabilities in managing profitable emptying and transportation services, with or without state sanction. Donor-funded organizations, whether non-profit program implementers (e.g., WSUP, WaterAid), utilities (e.g., Blue Water Company in India), or specialists (e.g., BORDA, CDD Society), provide technical, operational, and marketing support (Table 5) with donor funding. These consultants also train public bodies and PS/CBOs to transition full responsibility to the local actors.

Table 5: Technical and financial support provided in the examples studied

Examples	***Technical***	***Financial***
Dhenkanal	• PAF • Centre for Policy Research • Consortium for DEWATS Dissemination Society • Blue Water Company	Bill & Melinda Gates Foundation
eThekwini	Consultants hired by the municipality	Bill & Melinda Gates Foundation for the BSF treatment plant pilot
Kanyama and Chazanga	• WSUP • Water and Sanitation Association of Zambia • BORDA • NAKO ILISO (from 2020 onwards)	The Stone Family Foundation Comic Relief World Bank (Lusaka Sanitation Program from 2020 onwards)
Khadak	SNV	SNV
Ganjam	Ernst & Young	Bill & Melinda Gates Foundation
Leh	Fully funded by Blue Water Company under a Design-Build-Finance-Operate-Transfer PPP	
Sakhipur	• WaterAid • BASA	WaterAid

Note: The list is non-exhaustive; omissions are organizations not found in our research.

The example of eThekwini municipality contracting technical consultants to assist with design and implementation using municipal funds suggests the possibility of public bodies replicating this practice. However, the eThekwini municipality is relatively unique among public bodies in developing countries in terms of financial resources. Most public bodies in urban areas depend on government transfers because their own revenues (e.g., local taxes, fees, and service charges) are inadequate and account for a minor share of their budget or expenses (OECD 2022, WaterAid 2021). Rural public bodies are, arguably, more unlikely to have the financial capacity to recruit external consulting and TA.

4.6 GROUPING SEVERAL RURAL SETTLEMENTS COULD POTENTIALLY IMPROVE THE VIABILITY OF RURAL FSM SERVICES

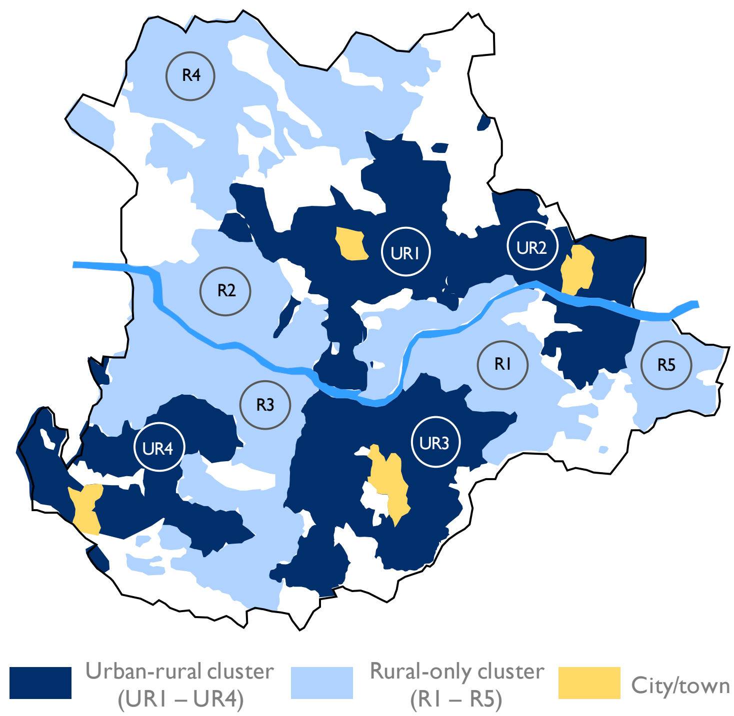
Business model viability for affordable FSM services is predicated on a critical mass of customers within a viable transport distance, which is often relatively low in rural areas. Moreover, desludging is an infrequent service. Several sub-national governments and public bodies in India are experimenting with grouping rural settlements into coherent geographic areas to increase the customer base for PS/CBO contracts and licenses (Department of Drinking Water and Sanitation 2021b, Ernst & Young 2019, TNUSSP 2018).[19] PPP business models also fix their operational capacity (i.e., the number of desludging trips per day) and, by extension, their monthly costs as determined by the number of laborers and vehicles and treatment plant capacity (where applicable). These two tactics combined lower the fixed cost per customer served if capacity utilization is improved by increasing the number of customers served.

Figure 18 illustrates this concept in Dhenkanal, where an urban town's existing emptying, transportation, and treatment infrastructure also serves several rural settlements within a 20 km distance (UR3 cluster in the figure). Whereas before the expansion, the fixed costs were spread over 517 trips to urban households (April–June 2021) (Dhenkanal District Administration 2021a), resulting in unit costs of PPP$ 29 per trip; utilizing the same infrastructure for an additional 110 trips to rural areas, totaling 627 trips, lowers per unit costs by 17 percent. Lower fixed costs per trip improve profitability or the potential to lower prices further for customers. Expanding the service area, however, increases fuel costs. However, in the Dhenkanal example, rural customers pay a fuel surcharge fixed by distance tiers (e.g., 10–15 km, 15–20 km), thus not impacting the PB's or PS/CBO's profitability.

The critical conditions that emerged to implement the urban-rural convergence in Dhenkanal are:

- **Available urban infrastructure capacity**: Service extension is feasible only if the existing infrastructure—emptying and treatment—has the spare capacity to process the additional sludge load from rural areas. Incoming sludge loads from urban households in Dhenkanal were monitored over two years to assess the spare capacity accounting for seasonal fluctuations. The available capacity constrains the number of rural households (and settlements) the treatment plant can serve. Although emptying and transportation capacity are also essential, procuring additional labor and equipment is arguably easier than increasing the capacity of an existing treatment plant.
- **Alignment among the urban and rural public bodies**: An MoU was signed by the UPB and the 17 rural public bodies representing the settlements covered by the urban FSM service extension. The MoU detailed roles, responsibilities, governance, protocols, and pricing. Critical to this inter-governmental cooperation was facilitation by the higher-level district administration and the provincial government to balance the interests of all parties (Saxena, et al. 2022).
- **Similar sludge and toilet characteristics**: The toilet sub-structure technology in the rural settlements was similar to that in the urban areas (i.e., pits and septic tanks), although distribution differed (i.e., a higher share of toilets in the town had septic tanks). The homogeneity in toilet technology enabled utilizing the urban emptying equipment in the rural settlements. Similar sludge characteristics also meant that the existing FSTP could treat sludge generated in rural areas (Centre for Policy Research 2020).

[19] Government guidance/planning documents refer to urban local bodies (e.g., municipalities, towns) with varied populations, including those populations below 50,000 that meet the operational criteria for rural contexts in this desk review (see section 2: Approach and summary of examples reviewed).



Source: Figure recreated from Dhenkanal District Administration. 2021. District-level FSM Plan for Dhenkanal.

Figure 18: Urban-rural and rural-only clusters formalized in Dhenkanal

These characteristics are important because differences in sludge and toilet characteristics can be a major barrier to urban service extension. For instance, in eThekwini, a VIP toilet emptying program in peri-urban areas (preceding the UDDT emptying program studied for this research) employed manual emptying to empty toilets fully. However, co-treatment of the sludge, which had significantly higher total solids and several other differences compared with urban sewage, overwhelmed the urban WWTP and caused severe damage to the systems (Wilson 2011).

- **Maximum transportation distance**: The distance of the rural settlements from the treatment facility determines the feasibility of service extension to them. Lengthier distances increase fuel costs. Beyond an envelope, they become uneconomical for the service provider or prohibitively expensive for the customer, depending upon who bears the transportation cost. The 20-km boundary set in Dhenkanal is corroborated by other experiences in India and globally (Jacob and Bhuyan 2022; Tayler 2018; Chowdhry and Kone 2012).[20]

The provincial government is piloting rural-only clusters for rural settlements that an urban FSTP cannot serve due to distance (more than 20 km) or capacity constraints. The objective is to replicate the clustering concept by strategically locating new FSTPs to service surrounding rural settlements (see rural clusters R1–R5 in Figure 18).

[20] Tayler (2018) estimates a maximum of 15 km, assuming a speed of 20 km/hour accounting for road conditions, for a one-way travel time of 45 minutes, which would allow a truck to conduct three desludging trips a day. Chowdhry and Kone (2012) found desludging vehicles travel approximately 15 km one-way in African capital cities.

5. PRELIMINARY GUIDANCE

The findings indicate that the setup and functioning of PPP FSM business models are dependent on treatment methods suitable for rural contexts, the availability of PS/CBOs with capabilities to deliver safe FSM services, and the PB's capacity to engage in PPPs and operate treatment facilities to ensure safe FSM. This section applies the findings to the different rural contexts and offers preliminary guidance on where PPP business models are relevant and the potential actions that public bodies could take to broaden their applicability.

The factors to consider in assessing the relevance of the two PPP models and the key considerations and prerequisites for their implementation when the context is appropriate are determined through two steps:

- First, examine the suitability of current FS treatment methods (not specific technologies) to three rural settlement classifications—rural on-road, rural growth center, and peri-urban areas—to identify a subset of settlement-treatment contexts where the PPP FSM models could apply.
- Then, demonstrate how the two PPP models could be implemented in suitable 'settlement-treatment' contexts by drawing upon the key conditions and practices from the examples studied.

Additionally, the team identified the following three prerequisites or binding conditions for implementing the two PPP FSM models in rural contexts:

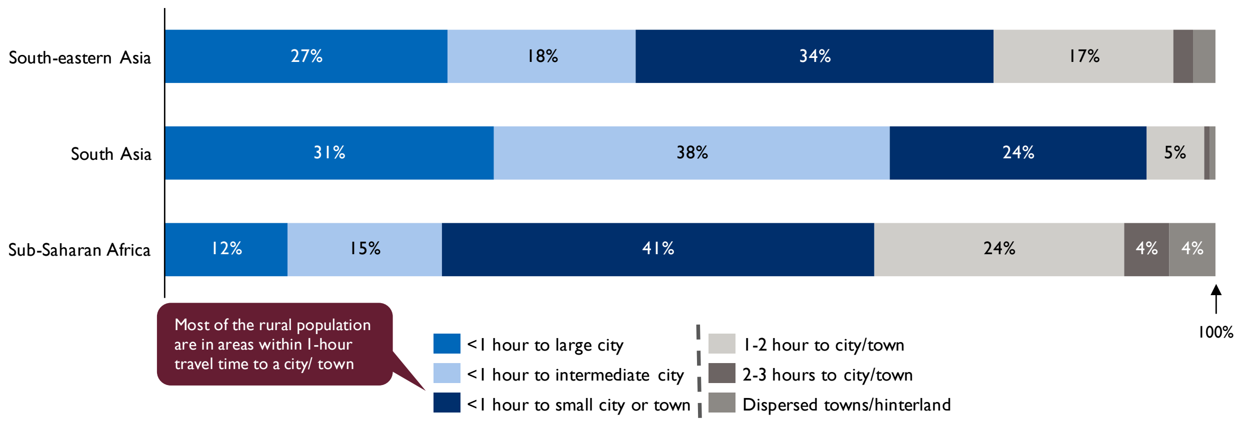
- **High basic sanitation coverage**: Across the desk review examples, the business models benefited from a customer base with toilets requiring frequent desludging (e.g., 3-7 years). A relatively high share of serviceable toilets (i.e., lined or rocky substructures that would not collapse during emptying) is another indicator of potential demand. Rural settlements that do not demonstrate these conditions require alternative business models or solutions;
- A public body must have a **formal mandate for sanitation service provision or regulation** in its service area to implement the PPP models; and
- A public body should have **external financial and technical support,** including funding by higher-level governments and/or donors (see section 4.5), to lead and oversee the PPP implementation.

5.1 PPP FSM BUSINESS MODELS ARE LIKELY APPLICABLE IN A SUBSET OF RURAL CONTEXTS WHERE BASIC TREATMENT METHODS ARE FEASIBLE

Section 3.2 established that treatment method options (e.g., on-site, trenching, FSTPs) act as a binding constraint or influence all other stages of the sanitation value chain and potential FSM business models. Applying an area-wide sanitation lens, the review team mapped the treatment methods emerging from the research against the different rural contexts in which they might be suitable. This served to identify a subset of rural contexts where the team believes the PPP FSM business models could apply, understanding that settlements outside of this subset (e.g., settlements requiring a treatment plant) would need alternative solutions.

To do this, the team focused on two critical characteristics distinguishing rural contexts—population and population density (a proxy for housing density, i.e., dispersed or congested housing)—as described in WaterAid et al. (2019). Population and population density have a bearing on the suitability of the treatment method, as does housing density, indicative of space on-site and land availability, which would be expected to be lower, on average, in rural on-road contexts compared to rural-mixed contexts (consisting of peri-urban and rural growth centers as explained in section 2[21]).

Second, the team made a broad assumption that establishing and operating treatment plants is rarely feasible in rural areas, including peri-urban areas, because of the financial and human resource constraints discussed in section 3.2.1. Proximity to an existing treatment plant (FSTP or co-treatment at WWTP) serving cities or towns offers the possibility of utilizing existing infrastructure, subject to capacity availability and sludge compatibility (see section 4.6). Although most of the rural population is in areas within one-hour travel time[22] from a city/town—from 69 percent in sub-Saharan Africa to 93 percent in South Asia (see blue-shaded bars in Figure 19)—less than a third live close to large cities (more than 1 million population) where treatment plants with capacity are likely to be concentrated (Klinger, et al. 2019). Few smaller cities/towns (20,000–1 million population) are likely to have FSTPs or WWTPs (for co-treatment), let alone those with excess treatment capacity. The probability of utilizing an existing treatment plant could increase significantly if more infrastructure and human resource capacity-building investments flow into urban settlements.



Note: Large city (>1 million population); Intermediate city (0.25–1 million population); Small cities and towns (0.02–0.25 million)
Source: Cattaneo et al. 2021; based on population data along the urban-rural continuum in 2015.

Figure 19: Rural population distribution by travel time to urban areas (2015, by regional groups)

Accordingly, the review team identified a range of potentially feasible rural context–treatment method combinations where the PPP FSM business models could be applied (see Figure 20). The identification is based on generalizing the different rural context types, although several exceptions will exist (e.g., hydrogeological factors, housing density, land availability).

- Rural on-road settlements are more likely to have space for on-site burial and/or land plots in surrounding areas for local, basic off-site treatment methods.
- Rural growth centers and peri-urban areas are less likely to have such space available and may require a combination of on-site and off-site basic treatment options.
- Rural on-road and rural growth centers will likely be farther from an existing, urban off-site treatment facility. The likelihood may be low even for peri-urban settlements, unless they are adjacent to large cities with available treatment capacity (e.g., Kanyama and Chazanga) or in countries, such as India and Senegal, with actual or planned investments to build septage or fecal

[21] The desk review differentiates between peri-urban areas and rural growth centers based on their proximity to urban settlements.
[22] The travel time corresponds roughly with the distances and number of emptying jobs/trips noted in Tayler (2018), Rao et al. (2020), and Chowdhry and Doulaye (2012).

sludge treatment plants in many smaller cities and towns (NITI Aayog-NFSSM Alliance 2021, ONAS 2017).[23]

	Treatment methods	Rural on-road	Rural growth center	Peri-urban
	Settlement size *(inhabitants range)*	Small-medium *(500-5,000)*	Medium-large (5,000-50,000)	Medium-large (5,000-50,000)
	Population density *(inhabitants per km² range)*	Low-medium *(50-300)*	Medium-high *(300-1,500)*	Medium-high *(300-1,500)*
On-site	Burial	Scattered housing with space available on-site	Possible congestion but space largely available on-site	Congestion likely; inconsistent availability of space on-site
Off-site	Land application	Several large land parcels, away from human habitations, are likely available		Large land parcels likely a challenge
	Trench			
	New FSTP	Low feasibility		
	Existing treatment plant(1) with capacity, within 20 km(2)	Very low probability	Very low probability	Low probability, but exceptions exist(3)

Legend: Feasible — Feasible opportunities may exist — Low feasibility

Acronyms: FSTP – Fecal sludge treatment plant; Notes: 1. FSTP or co-treatment at WWTP; 2. Based on Taylor, 2018; 3. Exceptions include countries such as India and Senegal, representative of trends likely in countries with predominantly wet sanitation.[23]

Figure 20: Rural context–treatment method combinations potentially feasible for PPP FSM business models

Rural contexts outside those in Figure 20, for which the current treatment options are not feasible, would need other solutions, typically household-managed. Closing a full pit (i.e., in-situ treatment/disposal) and constructing a new toilet is a simple, feasible solution, particularly where unlined deep pits become full after 8–10 years or more. Other possible on-site household-managed treatment solutions are composting toilets and biodigesters. However, these are uncommon in rural contexts and face several barriers (e.g., an inadequate base of suppliers, improper O&M by households) and produce a final waste stream for disposal/reuse in the local environment that is typically unsafe.

5.2 PUBLIC BODIES CAN TAKE SEVERAL MEASURES TO BROADEN THE APPLICABILITY OF PPP FSM BUSINESS MODELS

In those combinations of rural contexts and treatment methods where the two PPP models are potentially feasible (Figure 20), conditions related to the availability of PS/CBOs with the required skills and capacity and sufficiently capacitated public bodies to engage with and monitor PS/CBOs, affect successful implementation (see also Box 2).

a) PB-facilitated models are suitable where enterprises with existing resources already operate or are willing to invest, incentivized by a critical mass of customers. Licensing allows enterprises to continue operating and generating revenue, subject to enhanced conditions (e.g., safety), the violations of which attract penalties and risk their income. Public bodies must possess regulatory and monitoring capabilities to ensure a shift toward safe FSM.

b) PB-managed models address contexts where enterprises lack the financial capacity to invest in safe FSM. Contracting enables a public body to appoint an enterprise to deliver services per its

[23] Examples are not comprehensive as we did not have the resources to review plans for treatment facilities in every country of interest.

specifications, thereby assuring income for the enterprise and insulating it from low demand. The public body must have financial resources to assure contractor income and monitor contract performance.

For both PPP models, the public body must also have technical knowledge and financial resources to set up and operate a local, off-site treatment facility if neither on-site burial nor utilizing a proximate existing facility is feasible.

These **requirements will likely limit the contexts where the two PPP models could apply** if one or more conditions are unmet. For instance, an inadequate customer base in less populated rural on-road and even small rural growth centers would be unattractive for PS participation and lower the likelihood that local FSM enterprises exist.

Box 2: What qualifies as an existing FSM enterprise in dry and wet technology contexts?

The presence (or not) of FSM enterprises and the types and capabilities of entities varies between dry and wet technology contexts.

- In dry technology contexts, an existing enterprise would consist of an individual or self-organized group of manual emptiers, not unions or associations formed to protect members' interests (Philippe et al. 2022; Zaqout et al. 2021). Manual emptier enterprises tend to be informal and highly localized, i.e., their operations are confined to a few villages.
- In wet technology contexts, enterprises would consist of entrepreneurs employing a team of workers or private cooperatives that own or operate (via rental) mechanized or semi-mechanized desludging and transport equipment (e.g., vacuum tanker truck, pump, or Gulper plus cart/small vehicle) enabling, or with potential for, safe emptying practices. Mechanized desludging enterprises are known to serve a larger area (e.g., 20–25 km) beyond their base of operations. The review excluded manual emptier groups as enterprises because the practice is unsafe for wet toilets and prohibited in some countries.

In both technology contexts, enterprises do not exist where only informal manual emptiers operate individually or at best form a team for an emptying job. They typically lack the financial capacity to invest in appropriate tools and equipment (Philippe et al. 2022).

However, public bodies can take several steps to address the contextual and capacity limitations and broaden the applicability of the PPP models. These measures pertain to the setup and operations, both of which require critical support from higher-level governments to augment the capacity of public bodies and sustain safe FSM in rural areas.

ENGAGE WITH HIGHER GOVERNMENTS TO PLAN AND FINANCE INFRASTRUCTURE

a) Seek TA in planning treatment facilities and structuring PPPs

Environmental and hydrogeological conditions will vary across and even with settlements, thus warranting technical evaluation to determine appropriate treatment methods. Public bodies should leverage technical assistance from higher-level governments (e.g., environmental agencies, contracted consultants) to conduct site assessments, identify suitable methods (on-site and/or off-site), and, where required, an off-site facility is required, draft specifications (e.g., technology, capacity, location). Support to fill any regulatory gaps (e.g., reuse in agriculture applications) may also be required. Published guidance by national or provincial governments could accelerate assessments and planning. *Example: The Government of India's manual on FSM contains details on technologies, estimated costs, and O&M requirements for rural public bodies* (Department of Drinking Water and Sanitation 2021a).

Prior experience in contracting public services or licensing local businesses would benefit rural public bodies in structuring PPPs with PS/CBOs. Despite such experience, inadequate knowledge of safe FSM practices may limit a PB's ability to engage PS/CBOs. Model bylaws, sample PPP FSM engagement templates, and similar resources by higher-level governments will help public bodies ensure a comprehensive range of aspects are addressed. These include roles and responsibilities, compliance (e.g., environment, occupational health and safety), and progress towards GESI goals, among others. *Example: Sample procedure, terms, and conditions for licensing FSM service providers, laid down for district-level officials by the Government of India* (Department of Drinking Water and Sanitation 2021b, 30-34).

b) Minimize investments and costs for public bodies and PS/CBOs

In contexts where on-site treatment/disposal is not feasible, public bodies must invest in setting up the treatment/disposal facility and in O&M. Despite the low cost of basic treatment methods, public bodies may encounter investment constraints (e.g., planning assessment, land acquisition). Public bodies could partner with external actors, such as higher-level governments to leverage infrastructure grants or available public works programs, and private landowners.

(i) *Apply for infrastructure grants or public works funding mechanisms*: Non-land acquisition setup costs for land application and trenching involve fencing. Additionally, trenching requires internal access paths and periodic excavation and backfilling. Public bodies could cover setup costs with public works infrastructure grants and leverage public employment or livelihood programs by provincial or national governments for short-term labor (e.g., dig trenches). *Examples: In South Africa, the Ministry of Cooperative Government and Traditional Affairs' municipal infrastructure grants for building FSTPs* (Department of Water & Sanitation 2023)*; In Odisha state (India), construction of treatment facilities are eligible for funding by an employment guarantee program, among other financial sources* (Panchayati Raj and Drinking Water Department 2020).

(ii) *Lease land from private landowners*: Local sites suitable for basic treatment methods may not be available in the government's land stock but could exist in private hands. While renting land is an option, a public body could also enter into a nominal lease with private landowners to lower costs. In exchange, the private landowner gets the right to sell/use the treated sludge (e.g., soil conditioner or plant crops/trees in compliance with agricultural or other standards). *Examples: A landowner leasing the trench site to Khadak municipality can reuse the sludge after five years*[24]*; private landowners treat sludge in their farms in Southern India (see section 3.2.2)*.

Investments in equipment, such as vehicles and vacuum pumps, could also be sourced from higher-level governments or infrastructure grants, lowering the financial outlay by public bodies or local PS/CBOs. Alternatively, national or provincial governments could facilitate bulk procurement, lowering acquisition costs for several public bodies toward equipment operated by their contractors or leased to licensees. Public bodies may also transfer or nominally lease existing assets (e.g., equipment, office space) to PS/CBOs, lowering their upfront costs. In several examples studied, such assets are transferred from a PB's existing service or acquired using grants from higher-level government or donors. *Examples: The PARC*[25] *Program in Senegal facilitated the procurement of new desludging vehicles for lease by PS service providers* (USAID 2022)*; the Government of Odisha purchased desludging trucks for all urban local bodies across the province* (Ernst & Young 2019).

[24] Interview with SNV Nepal.
[25] *Programme d'appui au renouvellement des camions de vidange* or Exhauster Truck Rapid Acquisition Program

Increase the addressable market and drive demand to attract PS/CBO

The significantly lower population and dispersion of rural settlements in an area (e.g., county, district) could lead to demand levels inadequate for service viability or unattractive for enterprises, particularly for new entrants. Public bodies can take several measures to grow the customer base for PPP business models.

a) Collaborate with higher government authorities to formalize clusters

A public body could expand the service area by clustering several settlements, thus increasing the number of customers. Beyond technical planning (e.g., viable distance, assessing sludge characteristics), clustering entails inter-governmental cooperation and coordination, as *exemplified in the urban-rural convergence PB-managed business model in Dhenkanal (section 4.6).* A rural public body typically would need the institutional leadership of a higher government authority and technical support to design and facilitate cluster formation.

b) Incentivize enterprise participation with demand-driving measures

(i) <u>Limit licensees in PB-facilitated PPP models</u>: A public body controls the number of licenses it issues, directly impacting market share. Market intelligence (e.g., number of toilets, emptying frequency, prices, wages) would aid a public body in estimating the number of licenses that balance service availability with licensee profitability. License issuance needs to be complemented by the deterrence of unlicensed service provision. Passing sanitation bylaws is a step, but public bodies also need monitoring capacity to detect and penalize such providers. While the desk review did not uncover specific deterrence systems or practices, the team posits that licensees have an economic motivation to report unlicensed operators proactively and gradually lower unlicensed service provision.

(ii) <u>Channel demand to PS/CBOs</u>: A public body can complement a contractor's and licensees' marketing efforts, thus providing a competitive advantage. The examples reviewed show measures such as public bodies conducting campaigns and passing on service queries received at their offices or through call centers and helplines to the PS/CBOs. Public bodies could also reserve FSM services to public institutions (e.g., government offices, schools, health facilities) for contractors and licensees.

(iii) <u>Explore the feasibility of implementing scheduled emptying:</u> Urban experiences with scheduled emptying have established several benefits, such as demand assurance (i.e., desludging by authorized instead of informal providers), demand consistency (i.e., daily or weekly desludging jobs throughout the year), and efficiency (e.g., route planning and pooling desludging requests to lower transport costs). The examples of Leh and rural eThekwini demonstrate the implementation of scheduled emptying in small-scale settings.

Target local non-sanitation or external FSM PS/CBOs as enterprises.

A PS/CBO enterprise needs to provide sanitation workers tools and equipment (e.g., PPE, modified garden tools, containers), implement SOPs, service customers (e.g., scheduling, resolving complaints), and engage with the public body (e.g., reporting), among other activities. In contexts where local FSM enterprises are absent and local informal sanitation workers lack the capabilities to transition into licensees or contractors, the following alternatives could enable the PPP FSM business models:

a) Engage local non-sanitation PS/CBOs

Invite entities with an existing business or service to diversify into FSM services. Those operating in adjacent or related services (e.g., solid waste management, water provision) might be better positioned to leverage existing assets (e.g., customer relationships, equipment, logistics expertise). Such entities will likely require TA to learn safe FSM practices. *Examples: Licensing Water Trusts in Chazanga and Kanyama with TA from WSUP; Contracting women and transgender CBOs in Dhenkanal and Odisha state in India with financial and TA from a funder.*

b) Invite FSM PS/CBOs from other neighboring settlements

Advertise license or contract opportunities to existing FSM businesses in other geographical areas. FSM businesses could recruit, train, and support local informal sanitation workers as franchisees or sub-contractors. Several critical management, technical, and financial support services that the franchisor/prime contractor provides directly address local capacity gaps. *Examples: The city-based main PS contractor for the rural eThekwini UDDT emptying program employed local micro-businesses and informal sanitation workers; A water services provider in the Eastern Cape Province in South Africa franchised 22 micro-entrepreneurs to provide emptying services to schools and households* (Drechsel et al. 2016, 32).

LEVERAGE EXISTING SYSTEMS AND RESOURCES TO MONITOR AND IMPROVE SAFETY ACROSS THE VALUE CHAIN

Ensuring safe FSM requires public bodies to monitor all aspects of the sanitation value chain, from service delivery by PS/CBOs to treatment and disposal/reuse. Monitoring compliance, especially workers' safety and on-site service quality, requires significant resources—full-time internal staff or subcontractors (see section 4.4 about verification agents). Similarly, ensuring safe treatment and reuse, if applicable, requires establishing regulations for methods appropriate for rural areas and technical resources for monitoring compliance. Assuming most rural public bodies lack such resources, the review draws upon practices from the examples studied that could simplify monitoring PS/CBOs and safety of treatment/reuse.

a) Adopt established record generation and customer feedback methods

Record-keeping is a requisite to monitor and improve service delivery quality. To encourage PS/CBOs to generate the required data, public bodies can leverage their roles in the institutional arrangement, i.e., issuing/renewing contracts or licenses and payments. Contractors have incentives to maintain records if their payments are linked with performance. Compliance with self-reporting and providing appropriate equipment are typical licensing conditions that a public body can assess when renewing licenses. Public helplines for service inquiries provide an avenue for customer feedback. Recording inbound complaints (e.g., service not provided, deficiency), complemented by feedback calls to a sample of HHs placing service requests through the PB, could be used to assess performance levels, including violations. While these reports may be neither comprehensive nor accurate, public bodies could use these as a starting point to solicit customer feedback and conduct periodic, randomized post-service inspections.

Public bodies can adopt tried-and-tested reporting methods (i.e., templates, channels, frequency) existing in urban areas or developed by higher-level governments. More importantly, adopting existing methods enables data standardization and area-wide FSM monitoring, making a case for and justifying technical and financial assistance by higher-level governments. An area-wide monitoring imperative creates opportunities for efficiency and lowers the burden on public bodies, such as call centers/public helplines serving several clusters and GPS monitoring of vehicle routes. *Examples: the standardized reporting and verification system of licensees across Lusaka, including the two Water Trusts in* *the peri-urban areas (see section 4.4); province-wide record-keeping and monitoring desludging vehicles' routes in the state of Odisha (India), which includes the Dhenkanal example studied for this desk review* (Ernst & Young 2019).

b) Engage higher-level governments for treatment/reuse regulations and compliance

Any treatment method(s) chosen in a service area requires periodic monitoring for safety. Monitoring activities involve trained personnel to assess regulatory compliance, such as the distance of disposal sites from water bodies and houses, the farm type (e.g., food crops, nursery, tree farms) used for land application of sludge, and measures to minimize vector attraction (e.g., insects, rodents), among others. Facilities and skills to test soil, groundwater, and fecal sludge reuse products for contamination are likely concentrated in urban areas. Provincial governments' support is crucial in deputing technical personnel and sample collection and testing in laboratories. The desk review did not uncover specific treatment/reuse monitoring practices from the examples studied. However, tasking a provincial government's technical personnel to support PS/CBOs with regular testing at FSTPs across the Odisha state (India), including Dhenkanal, demonstrates the potential for inter-governmental collaboration in alleviating public bodies' monitoring capacity challenges.

Public bodies can pursue several measures in tandem, depending on their context and capacity to improve the conditions for PS/CBO participation and safety along the sanitation value chain. However, with rural FSM in its nascency, proactive support from higher-level governments is necessary for public bodies to blueprint, validate, and scale PPP business models for safe FSM in rural areas.

6. AREAS FOR FURTHER RESEARCH

The desk review helped understand the demand for FSM services, the potential suitability of various methods for treatment and emptying based on conditions in rural areas, and the functioning of the two PPP business models for rural FSM. The preliminary guidance identified different potentially feasible rural contexts to implement PPP business models and measures to broaden their applicability. At the same time, several significant gaps emerged in the comparative analyses of the two PPP business models for rural FSM. This section highlights the areas where research and evidence would further inform the development of viable FSM business models in rural areas. The list is non-exhaustive and intends to support evidence and knowledge generation.

The full costs to set up and operate safe rural FSM services through the two PPP business models

Several rural FSM services examples report early indications of profitability for the public body or the PS/CBO depending on the PPP model; however, this is based on analysis of a narrow range of costs, primarily labor, transportation, and maintenance. The desk review identified several integral and enabling costs across the examples studied that are unreported or unaccounted for. Public bodies may consider some of these costs as subsidies or their contribution towards safe FSM as an environmental and health public good. Nevertheless, understanding the cost types and amounts borne by both parties (public body and PS/CBO) in small-scale settings and for the varied on-site and off-site treatment methods is crucial for the viability of safe FSM services. Moreover, identifying the costs the PS cannot or is unwilling to bear would inform the areas and scale of public investment required.

The comparative benefit in maximizing safely managed sludge under the two PPP business models

Prima facie, to maximize safely managed sludge levels, PB-managed business models offer two advantage over PB-facilitated business models—first, the potential for integrating emptying and transport with treatment, and second, accountability and monitoring of a single contractor operating the integrated model (as explained in section 4.2). However, the data or estimates on the share of safely managed sludge from the examples studied do not offer a discernible pattern. This is partly because two PB-managed examples implemented scheduled emptying, which is relatively rare even in urban areas. It is important to understand what conditions around the sanitation mix, regulatory context, the PPP arrangements, and monitoring method help to maximize the share of safely managed sludge in a given service area.

On-demand affordable service to customers

The studied examples offered varied value propositions—affordability, response time, clean/safe services—to acquire customers and to compete with unsafe service providers. However, these value propositions are from a supplier's perspective. The desk review could not establish why customers chose (or not) a safely managed desludging service. Understanding the customers' perspectives on the factors they consider important in selecting a service provider, other than affordability, would help design better PPP business models and value propositions to maximize safely managed sludge.

Approaches for area-wide FSM

The desk review proposed several contexts where PPP business models could be applicable based on the feasibility of current treatment methods. Moreover, the reach of current safe FSM business models is limited by the population, population density, dispersion of settlements, and sanitation mix, among other factors. Applying an area-wide lens to FSM services early on is imperative. Therefore, there is a need to identify the range of solutions that would apply to different contexts and allow for simultaneous alternative standardized services/processes for FSM in a given geography. This would involve identifying the conditions suitable for, or warranting, solutions ranging from self-management by households to PB-served provision (i.e., including last-mile service delivery by a PB's employees and equipment).

Improving sanitation workers' safety

The PPP business models, particularly PB-managed, demonstrate several levers to improve sanitation workers' safety, combining worker provision requirements (e.g., modified equipment, health checks) and penalties on service providers. However, the wider evidence base shows that sanitation workers face health risks despite such measures, emphasizing the inconsistent use of PPE due to discomfort and functional impediments. In-pit pre-treatment with lime before emptying, examined in this desk review (see section 3.3.2), is one of several measures that could be incorporated in PPP business models employing manual emptying and lower the exposure risk for sanitation workers. More research of testing in-pit lime pre-treatment methods in practical conditions (i.e., typical household behavior and usage, environmental conditions) would benefit workers' safety at all value chain stages.

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8. ANNEXES

A.1 LIST OF FSM EXAMPLES IDENTIFIED

Region	Country	Location	Geographic coverage		Safe FSM		Model
			Urban	Peri-Urban/ Rural	Collection	Disposal	
Southeast Asia	Malaysia	National	Yes	Yes	Yes	Yes	PPP
	Vietnam	Hai Phong	Yes	Yes	Yes	Yes	PPP
South Asia	Bangladesh	Bhaluka	No	Yes	No	No	Private
	Bangladesh	Sakhipur	No	Yes	Yes	Yes	Government
	India	Devanahalli	No	Yes	Yes	Yes	Government
	India	Dhenkanal	Yes	Yes	Yes	Yes	PPP
	India	Rural Ganjam	Yes	Yes	Yes	Yes	PPP
	India	Kalibilod	No	Yes	Yes	Yes	Government
	India	Kumhari	No	Yes	Yes	Yes	Government
	India	Leh	No	Yes	Yes	Yes	PPP
	India	Muzzafarpur	Yes	No	Yes	No	Government
	India	Musiri	No	Yes	Yes	No	Private
	India	Pathar Pratima	No	Yes	No	No	Private
	India	Patora	No	Yes	Yes	Yes	Government
	Nepal	Khadak	No	Yes	Yes	Yes	PPP
North Africa	Egypt	Beheira Governorate	No	Yes	Yes	No	Private
Sub-Saharan Africa	South Africa	eThekwini	Yes	Yes	Yes	Yes	PPP
	Botswana	Mogoditshane and Broadhurst	Yes	Yes	Yes	Yes	PPP
	Zambia	Kanyama and Chazanga	Yes	Yes	Yes	Yes	PPP

A.2 SAFELY MANAGED SLUDGE AS A SHARE OF TOTAL SLUDGE GENERATED (SOURCES AND ESTIMATES)

The review examined the share of safely managed sludge out of the total sludge generated as a metric to understand and compare the efficacy of the business models in increasing safe FSM (see Scale in Table 1). For each example, if data from literature or key informants is unavailable, the review estimates the metric based on several parameters. Below are the details for each example studied.

1. **Sakhipur, Bangladesh**
   As per the SFD[26] prepared in December 2020, 58 percent of fecal waste generated in the town is safely managed. According to the Census of Bangladesh Bureau of Statistics in 2011, the number of households in Sakhipur municipality is 7,473. With a national population growth rate of 1.37, the estimated number of households in 2020 is about 8,445.

2. **Dhenkanal, India**

Sludge generation	**Rural**		**Urban**	
Description	Calculation	Value	Calculation	Value
Households		9,892		16,649
Source: Rural – Dhenkanal District Administration. 2021. District-level FSM Plan for Dhenkanal, Odisha Urban – Government of India. 2012. Census India 2011. Extrapolated using the 2011 census value and population growth rate of 11%				
Number of HHs with septic tanks		1,385	51% of HHs = 16,649 x .51	8,491
Number of HHs with pit latrines		8,507	13% of HHs = 16,649 x .13	2,164
Source: For rural area – Dhenkanal District Administration. 2021. District-level FSM Plan for Dhenkanal, Odisha For urban area – Shipra Saxena et al. (2022).				
Number of septic tanks requiring desludging per year	Once every 10 years	139	Once every 10 years	849
Number of single pits requiring desludging per year	Once every 2.5 years	3,403	Once every 2.5 years	866
Source: Dhenkanal District Administration. 2021. District-level FSM Plan for Dhenkanal, Odisha				
Volume of septic tanks (m^3)		13.875		13.875
Volume of single pit (m^3)		0.6		0.6
Source: Dhenkanal District Administration. 2021. District-level FSM Plan for Dhenkanal, Odisha				
Total sludge generated per year (m^3)	= (139 x 13,875) + (3,403 x 600)	3,963	= (849 x 13,875) + (866 x 600)	12,300

Sludge collected				
Sludge collected (m^3)	In first five months of operation	278	50% of FSTP capacity per day	13.5
Explanation: 278 kiloliters (KL) of sludge from rural areas was treated in the FSTP from February–June 2021; the urban sludge treated consistently accounted for 50% of the total FSTP capacity (i.e., 27 KL/day), according to Shipra Saxena et al. (2022).				
Sludge collected and treated in the year (m^3)	= (278/5) x 12	667	= 13.5 x 25 x 12	4,050
Explanation: The team annualized the amount of sludge collected. The FSTP is operational for 25 days a month.				
Share of sludge safely managed	Sludge collected/sludge generated	17%	Sludge collected/sludge generated	33%

3. **Leh, India**: A total of 5,800 households in Leh, of which approximately 5,000 are a part of the annual scheduled desludging plan. The remaining 800 households presumably use EcoSan[27] toilets, which are dry "Ladakhi" toilets that produce compost. Therefore, the review assumes that 100 percent of sludge generated in Leh is safely managed.

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26 WaterAid Bangladesh. 2020. "SFD Lite Report Sakhipur Municipality, Tangail District, Bangladesh."

27 BORDA. n.d. FSM for Leh.

4. **Rural eThekwini, South Africa**: The urban public body installed 80,000 UDDTs, out of which an estimated 50,000 UDDTs were contracted for emptying over two years (i.e., assumed as 25,000 per annum). A total of 49,825[28] UDDTs were emptied by the end of the contract. The difference with the pre-tender estimate largely includes households upgrading or replacing the toilets or those the contractor could not identify.

5. Kanyama and Chazanga, Zambia

Sludge generation and collection	Rural		Urban	
Description	Calculation	Value	Calculation	Value
Sludge generation rate (m^3/cap/year)		0.06		0.06
Source: Ruth Kennedy-Walker. 2015. Planning for Faecal Sludge Management in informal urban settlements of low-income countries: A study of Lusaka, Republic of Zambia				
Population		169,253		86,000
Source: For Kanyama – Central Statistical Office. 2012. 2010 Census of population and housing For Chazanga – Water and Sanitation for the Urban Poor. 2019. Can participatory behaviour change methods help limit the spread of cholera?				
Open defecation rate		15%		8%
Source: GFA Consulting Group GmbH. 2018. SFD Report Lusaka, Zambia, 2018.				
Population dependent on On-Site Sanitation Systems (OSS) systems	= 169,253 x (100%-15%)	143,865	= 86,000 x (100%-8%)	79,120
Explanation: The remaining households are dependent on OSS systems				
Sludge generated per year (m^3)	= 143,865 x 0.06	8,632	= 79,120 x 0.06	4,747
Explanation: Population dependent on OSS systems multiplied by sludge generation rate per capita				
Sludge treated (m^3)		389		572
Source: Water and Sanitation for the Urban Poor. 2018. Full Project Financial Analysis; Strengthened Sanitation Services Lusaka, Zambia At Kanyama, 292 m^3 was collected from November 2016 to July 2017; the figure has been annualized. In Chazanga, the figure is for 2017				
Percentage of population served	Sludge collected/sludge generated	5%	Sludge collected/sludge generated	12%

Total addressable market	Rural		Urban	
Description	Calculation	Value	Calculation	Value
Total population				86,000
Source: For Chazanga – Water and Sanitation for the Urban Poor. 2019. Can participatory behaviour change methods help limit the spread of cholera?				
Average HH size				6
Source: For Chazanga – Ruth Kennedy-Walker. 2015. Planning for Faecal Sludge Management in informal urban settlements of low-income countries: A study of Lusaka, Republic of Zambia				
Number of HHs		35,682	= 86,000/6	14,333
Source: For Kanyama – Central Statistical Office. 2012. 2010 Census of population and housing				
Basic sanitation		9%		9%
Unimproved sanitation		90%		90%
Explanation: In Lusaka, 90% of peri-urban households use pit latrines, and 9% are connected to the sewerage network or use septic tanks, according to Aubrey Simwambi et al. 2017. Approaches to Faecal Sludge Management in Peri-Urban Areas: A Case Study in the City of Lusaka. These values have been applied to both Chazanga and Kanyama.				
Percentage of households that empty pits		59%		59%
Explanation: In peri-urban Lusaka, 41% of residents using pit latrines report having the potential to replace them with new ones, according to Aubrey Simwambi et al. 2017. Approaches to Faecal Sludge Management in Peri-Urban Areas: A Case Study in the City of Lusaka. This value has been applied to both Chazanga and Kanyama.				
Total addressable market	= 35,682 x [9% + (90% x 59%)]	22,159	= 14,333 x [9% + (90% x 59%)]	8,901

[28] 2019. Final Review of Urine Diversion (UD) Emptying Operations.

6. **Khadak**: With a population of 38,700[29] and an average household size of 6.2, Khadak has 6,242 households. The review assumed that 100 percent of the households depend on pit latrines. The data on sludge collected by the municipal truck is unavailable, and the licensing mechanism is currently under implementation.

7. **Ganjam district (rural areas proximate to Behrampur city)**: Data on the specific rural areas covered by the urban FSTP are unavailable. The FSTP at Behrampur services a population of 97,200 (20,362 households)[30] annually. The projected population in 2017 is 360,077, [31] and the average household size is 4.7,[32] resulting in 76,612 urban households. Based on a desludging frequency of 5 years, the annual number of urban households is 15,322. Therefore, the review assumes the remaining 5,040 households are from surrounding areas served by the FSTP. The review did not find data on sludge collected from rural areas or other metrics (e.g., vacuum tanker size and trips) to prepare estimates.

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29 SNV. WASH SDG programme – Inception Report Nepal

30 OWSSB. "Berhampur Septage Project Summary." (http://www.owssb.nic.in/Home/BerhampurSeTP)

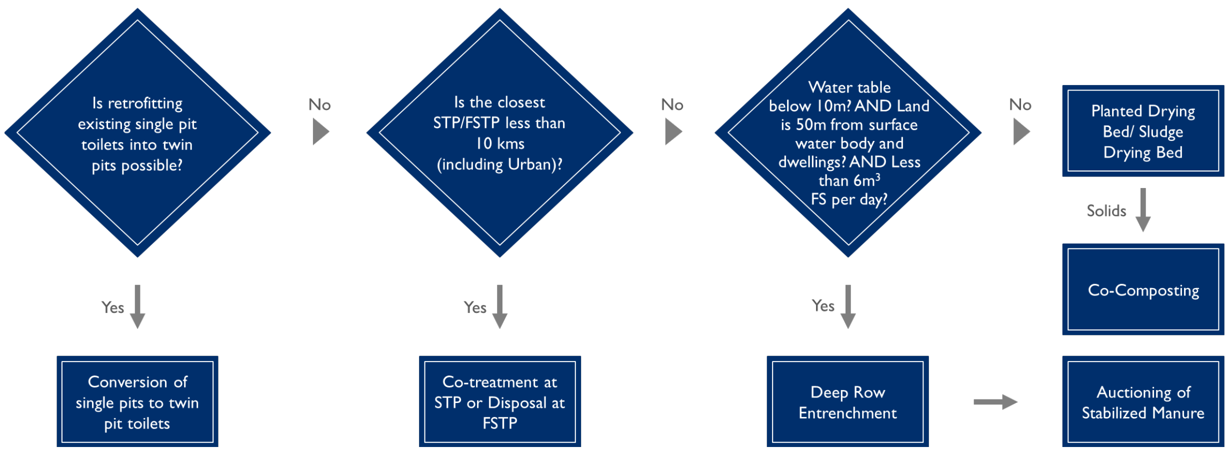
31 AMRUT Mission Guidelines and SAAP – 2015–16. 2016. Detailed project report on design, construction, operation and maintenance of septage treatment system

32 Government of India. 2012. *Census India 2011*.

A.3 ROLE OF ALTERNATING DUAL PIT LATRINES IN FSM POLICIES FOR RURAL AREAS

In countries such as India and Cambodia, where FSM policies are formally documented, the most preferred solution for rural FSM for single pit latrines is their conversion to alternating dual pit latrines (ADPs) wherever feasible.

As per the Swachh Bharat Mission (Grameen) Phase-II Guidelines, the Indian government actively advocates retrofitting single-pit toilets with a second pit in rural areas, wherever feasible, before considering recurring FSM services. The flowchart in Figure 21 provides further details on the order of priority guidance for rural FSM in India:



Source: Recreated based on guidance and schematics in Department of Drinking Water and Sanitation, 2021. Toolkit for District Level Officials on Faecal Sludge Management, New Delhi: Ministry of Jal Shakti, Government of India.

Figure 21: Decision matrix for FSM (Swachh Bharat Mission)

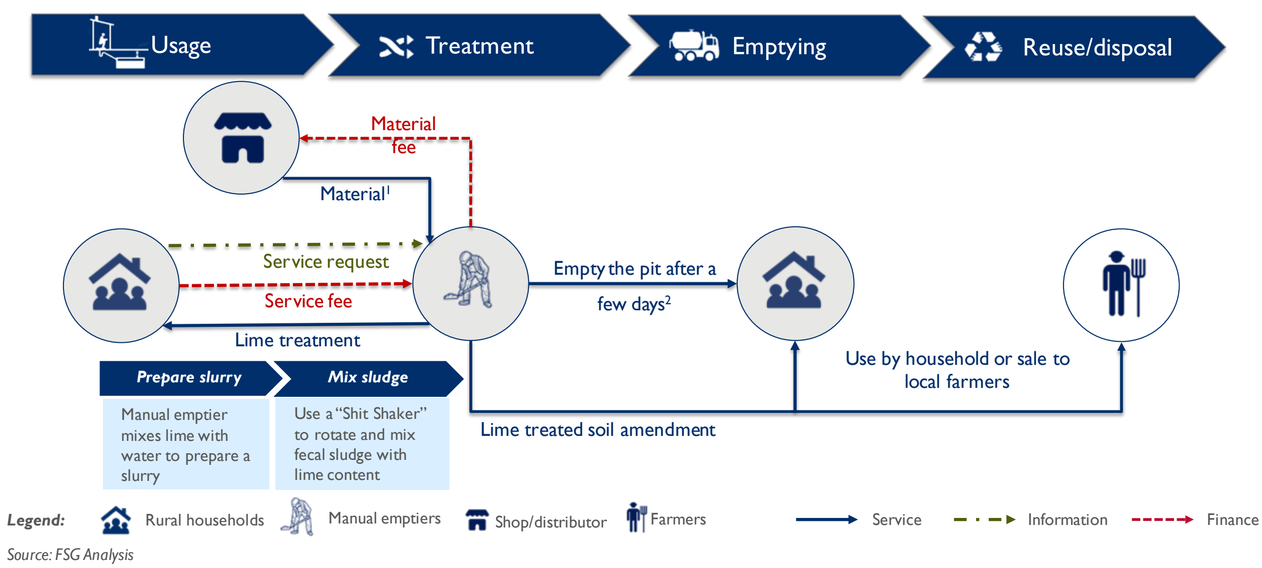
In Cambodia, the national FSM guidelines for rural areas recommend on-site over off-site treatment. Specifically, the guidelines recommend alternating dual pits as the preferred method as they avoid the need to construct new pits when existing pits are full and problems related to on-site burial. Burial in trenches on the household's property is recommended as the next best on-site option. In situations where on-site FSM is unfeasible due to factors like shallow water tables and wetlands, bio-digesters are proposed as viable alternative solutions (Ministry of Rural Development 2020).

A.4 LIME TREATMENT OF FECAL SLUDGE AND POTENTIAL INTEGRATION INTO MANUAL EMPTYING OF SINGLE PIT LATRINES

A.4.1 SUMMARY OF LITERATURE AND HYPOTHETICAL MODEL TO INTEGRATE LIME TREATMENT INTO MANUAL EMPTYING OF SINGLE PIT LATRINES

iDE introduced lime treatment as part of a retrofitting upgrade by its partner enterprises. iDE's sales agents identify households with single pits nearing capacity. Partner enterprises dose the single pit with lime and install an alternating second pit enabling the household to continue using the toilet without emptying the first pit. Lime treatment aims to accelerate pathogen deactivation and ensure that the decomposed waste is completely safe to handle after two years when the second pit could get full.

Trials in laboratories and the use of lime at sludge treatment facilities demonstrate its potential to render sludge safe for handling within a few days. A short timeframe offers an opportunity to integrate lime treatment into a manual emptying business model for single-pit toilets and improve safety. The review team conceptualized a hypothetical model (Figure 22) wherein a manual emptier would dose a pit with lime and use a "shit shaker" (a repurposed auger or cement mixer) to mix the lime throughout the pit and raise pH levels to appropriate levels for deactivating pathogens. The service provider (or household) would empty the treated waste after days for use (or sale) as a soil amendment in farms. Households would make alternate arrangements (e.g., use a neighbor's toilet if socially acceptable) in the interim period.



Notes: 1. Material includes screw auger, PPE kit, and emptying tools; 2. The time after which the pit is safe for emptying is inconclusive as per existing research; Source: Conceptualized based on iDE Cambodia Alternating Dual Pit upgrade model.

Figure 22: Hypothetical model: Professional in-pit lime treatment service for single-pit toilets

The team examined several factors to assess the potential for such a business model:

1. **Need for professional services**: In theory, households could administer lime treatment themselves. However, the execution requires know-how (e.g., maintaining pH levels for a certain duration) and avoiding health risks such as skin or eye inflammation from contact with lime. Moreover, households are unlikely to invest in equipment like augers for an infrequent activity like pit emptying. Treatment and emptying are, therefore, more conducive to professional service by manual emptiers.

2. **Ease of procuring material and equipment**: In-pit treatment requires hydrated lime (calcium hydroxide) and mixing equipment. Hydrated lime is widely available in rural areas, typically at construction material retailers since it has several applications in agriculture and construction. However, lime is typically available as a mix of hydrated lime and quicklime (calcium oxide) in varying ratios, thus impacting the treatment efficacy. Auger or cement mixers to mix sludge are also available, but with an average price of USD 288 among several sample countries, it could be an expensive investment for manual emptiers.

Treatment duration for timely service delivery: Treatment duration (i.e., contact time in the pit for the lime to kill sufficient pathogens in FS) is critical for service feasibility, assuming households can make alternate arrangements to use a neighbor's toilet while theirs is temporarily out-of-service for a few days. Current evidence from laboratory trials and treatment facilities indicates lime could potentially deactivate most pathogens within 1–10 days. The review examined results from seven studies (Figure 23), which showed reduced pathogens such as *E. coli*, Salmonella, total coliforms, and fecal coliforms. Helminth eggs were also reported to have reduced significantly, but the levels did not meet the United States Environmental Protection Agency standards.

Pathogen	2 Hours[1]	1 Day[1]	10 Days[1]
E. Coli	☒ (2/7) ☑ (3/7)	☒ (1/7) ☑ (4/7)	☑ (5/7)
Salmonella	☑ (5/7)	☑ (5/7)	☑ (5/7)
Helminth eggs[2]	☒ (2/7)	☒ (2/7)	☒ (2/7)
Total coliforms	☑ (4/7)	☑ (4/7)	☑ (4/7)
Fecal coliforms	☑ (4/7)	☑ (4/7)	☑ (4/7)

☒ (x/y) – x out of y studies indicate treated sludge is not safe to handle
☑ (x/y) – x out of y studies indicate treated sludge is safe to handle

Note: 1. Time to inactivate the said pathogens at pH 12 established from studies' results in laboratory conditions. 2. Helminth eggs were reported to have reduced significantly, but levels did not meet US EPA standards. Sources: (Anderson et al., 2015; Bina and Movahedian Attar, 2004; Chakraborty et al. 2014; Greya et al. 2016; Ngwanamoseka Nobela 2014; Noland et al. 1978; Strande et al., 2009) ; Additional sources of interest - Bina, Bijan & Attar, Hossein & Kord, I. (2004). The Effect of Lime Stabilization on the Microbiological Quality of Sewage Sludge. Iranian Journal of Environmental Health Science & Engineering; Farzadkia, M. & Bazrafshan, E. 2014 Lime stabilization of waste activated sludge. Health Scope 3 (1), e16035; Zewde, A. A., Li, Z. & Xiaoqin, Z. 2021 Improved and promising fecal sludge sanitizing methods: treatment of fecal sludge using resource recovery technologies. J. Water Sanit. Hyg. Dev. 11 (3), 335–349. Available from: https://iwaponline.com/washdev/article/11/3/335/81332/Improved-and-promising-fecal-sludge-sanitizing.

Figure 23: Pathogen reduction results in seven studies

An initial study on in-pit lime treatment tests in Cambodia revealed that pH levels required for pathogen inactivation could be maintained for up to a week after rudimentary methods, such as mixing lime with sludge using a stick. Households reacted positively to lime treatment, with the majority citing odor reduction (and the perceived ability of lime to kill germs [Chakraborty et al. n.d.]). Building on the results, iDE piloted lime treatment in ADP pits in Cambodia using a screw auger to improve the consistency of mixing lime with FS. The results showed active *E. Coli* in one third of toilets after two years of treatment and resting (per World Health Organization [WHO] guidelines). These results were attributed, in part, to improper mixing of lime and incorrect operation of ADP toilets by households. The results further emphasize the need for professional services and the inability of households to operate alternating pit toilets properly.

While the above studies show promise despite the challenges, more research into the efficacy of in-pit treatment is warranted to study the effects of diverse conditions inside pits (e.g., water content, solid waste presence), variance in the mixing process, and the quality of lime (e.g., moisture content, quicklime to hydrated lime ratio in the available supplies). Supply-side assessments will also be needed to understand the perceptions of manual emptiers regarding the value of potential benefits such as reduced odor, lower health risk, and reuse potential compared to the need for two trips (one to administer lime and another to extract treated sludge), and additional costs for materials and equipment.

3. **Impact on profitability:** Integrating lime treatment into a manual emptying service entails additional costs and affects the profitability of pit emptiers, which is elaborated further in the following section.

A.4.2 ESTIMATED IMPACT OF LIME TREATMENT ON MANUAL EMPTIERS' PROFITABILITY

To study potential integration into the manual emptying business model, the review team analyzed the impact on profitability for pit emptiers across three sample countries: Cambodia, Senegal, and India. Integrating pit lime treatment into a manual emptying service entails additional costs, which include the following:

- **Operating expenses:** A pit emptier must visit a household twice—first, to mix the sludge with lime and second, to empty the pit—resulting in additional traveling costs. The typical distances traveled by pit emptiers from their operating base to households and the fuel costs for a two-way trip were considered to calculate the transportation costs.
- **Cost of goods sold:** A mixture of lime and water is added to a pit for treatment. The quantity of lime required for treatment depends on the volume of the pit. Further, to produce an even mix of lime and FS, a "shit shaker" (a repurposed auger or cement mixer) is used, which adds to the overall cost of goods sold.

The team estimated the change in profits by incorporating the above lime treatment costs into manual emptiers' current cost structure. The results of the analysis are summarized in the table below:

Geography	Emptying frequency	Net profit per year for unsafe manual emptying (USD)	Cost of goods sold per year for lime treatment (USD)	Additional annual operating expenses for lime treatment (USD)	% decrease in profit due to additional lime treatment costs
Cambodia	Thrice a week	2,797	304	75	14%
	Once a week	932	142	25	18%
	Once a month	215	80	6	40%
Senegal	Thrice a week	7,208	471	54	7%
	Once a week	2,403	195	18	9%
	Once a month	554	90	4	17%
India	Thrice a week	1,982	143	104	12%
	Once a week	661	86	35	18%
	Once a month	152	64	8	47%

Source: FSG Analysis

Assuming that emptiers undertook approximately three trips per week, profits were reduced marginally by 7 to 14 percent across the three geographies. The reduction excludes the potential benefit of offsetting the cost of common practices, such as pouring kerosene in pits and alcohol consumption to combat odor (Zaqout et al. 2021). Profits were reduced by 9 to 18 percent if the frequency of emptying trips was lowered to once per week. Higher frequency of trips results in lower costs due to economies of scale. Moreover, the analysis indicates that profitability would reduce significantly, by 17 to 47 percent, for pit emptiers with one emptying trip per month. Thus, lime treatment is more likely feasible for pit emptiers who make several weekly emptying trips.

A.5 KHADAK MUNICIPALITY – POTENTIAL IMPACT OF REGULATORY PRICE CAP ON PRIVATE DESLUDGING OPERATORS' PROFITABILITY

The review team examined the potential impact of implementing a price cap for licensees in Khadak municipality on the willingness of licensees to participate.

- The team calculated the unit economics (i.e., price, cost [labor, fuel, maintenance and repairs, insurance, and deprecation]), and the resulting profit per trip. The figures were based on data provided by two desludging operators serving households in Khadak municipality and other Saptari district areas. Private service providers were making an average profit of USD 8 per trip (see Saptari district, including Khadak [before price cap]) in Figure 24)
- Since a proposed price cap was unavailable, the team assumed that the price cap would be the same as the municipality's desludging price of Nepalese rupee (NPR) 1,500 (USD 11). This price cap leads to a loss of USD 6 per trip for private service providers offering services in Khadak (see Khadak municipality (after price cap) in Figure 24)

Figure 24: Private service providers' revenue and profit from other markets and Khadak municipality before/after licensing (USD)

- The total revenue and the profit of the businesses will depend on the share of the trips conducted in Khadak municipality versus other areas because of the difference in revenue and profit due to the price cap. However, operators could not estimate the share of households from Khadak municipality out of the total households they serve. Therefore, the team estimated the financial impact in three scenarios— 10 percent, 50 percent, and 75 percent of the trips are from Khadak, respectively. The profitability drops as the share of trips from Khadak increases (see Figure 25).

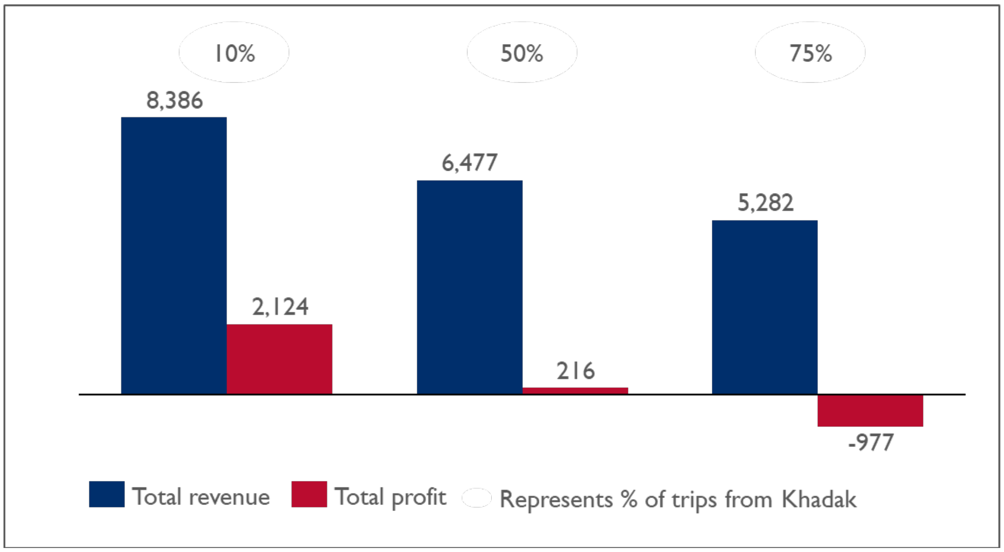


Figure 25: Potential financial impact after licensing based on the share of trips in Khadak versus other municipalities (share expressed in percentage, revenue, and profit in USD)

A.6 SANITATION WORKER RIGHTS ADDRESSED BY PPP BUSINESS MODELS

A joint report by World Bank, ILO, WaterAid, and WHO in 2019 introduced an initiative that identified several critical challenges faced by sanitation workers and corresponding remedial levers or good practices, such as:

- Providing acknowledgment and formalization to the sanitation workforce (including legal protections);
- Mitigating occupational health risks for sanitation workers;
- Delivering health services to sanitation workers;
- Establishing SOPs and guidelines; and
- Promoting workers' empowerment through unions and associations.

In the examples reviewed, several practices align with the above and include:

Acknowledgment and formalization

Workers, many of whom were informally engaged in desludging, are formally employed on the payroll of the public body or its PS/CBO partners. Women and non-sanitation workers are also encouraged to undertake pit-emptying jobs. In Chazanga and Kanyama (peri-urban Lusaka), uniforms and identification (ID) cards are issued to workers to signal a professionalized workforce. In all examples studied, daytime operating hours signal desludging as a legitimate state-sanctioned service. Together, these practices aim at reducing the stigma associated with sanitation services.

Mitigating occupational health risks

In addition to incorporating national labor, health, and safety policies, service contracts/licenses also assign responsibility for providing safety equipment and health services. These agreements ensure the necessary measures are taken to maintain a safe and healthy working environment. In Khadak, licensing laws mandate occupational safety standards for licensed operators. Water Trusts in Chazanga and Kanyama (peri-urban Lusaka) include mandatory budgeting for and provision of PPE for all workers. In eThekwini, the tender document includes health and safety benefits for workers. Cleaning facilities and equipment are available at the FSTPs in Dhenkanal, rural eThekwini, and Chazanga and Kanyama (peri-urban Lusaka before 2020).

SOPs and guidelines

PS/CBOs developed detailed SOPs for the health and safety of employees. In Dhenkanal, these include regular quarterly health check-ups of the members. Orientation on routine management and periodic maintenance activities are undertaken to facilitate the identified emptiers to carry out routine tasks relating to emptying, transport, and treatment operations.

A.7 SERVICE MONITORING IN RURAL FSM EXAMPLES REVIEWED

A.7.1 METRICS REPORTED AS PART OF MONITORING

In the rural FSM examples reviewed, monitoring appears among several activities that a public body should record or its contractor/licensee should report, with certain instances of specified metrics:

- Rural eThekwini: The public body mandated the contractor to submit the desludging schedule, a global positioning system (GPS) and date-referenced photograph of each emptied UDDT, and completion certificates signed by the customers and the local community liaison officer.
- Dhenkanal: The Urban Local Body maintains records of the household request and service delivery dates; a record of the invoice; customer details (e.g., personal identifiers); customer type (i.e., residential, institutional, or commercial); the type of on-site sanitation system; and the fees charged.
- Leh: The contractor submits a periodic desludging schedule to the public body and collects and shares customer feedback with the public body after service delivery to receive payment.
- Kanyama and Chazanga: A performance scorecard is maintained to calculate monthly subsidy payments, detailed in the following section.

A.7.2 PERFORMANCE SCORECARD TO DETERMINE SUBSIDY PAYMENTS IN LUSAKA

The Lusaka Water Supply and Sanitation Company Ltd (LWSC), the public body that is mandated to provide potable water supply and sanitation services to the city of Lusaka, instituted a monitoring and verification system by engaging an independent agent to assist with the payment of performance-based subsidies to the sanitation service provider. The public body developed a performance scorecard comprising 14 key performance indicators (KPIs), with some KPIs reported by the service provider and others by the independent agent. The KPIs are reported monthly, compared with pre-determined targets, and scores are assigned based on compliance with the targets. The final score is a weighted aggregate of the KPI scores, upon which the subsidy amount is paid.

Of the 14 KPIs, the service provider reports the following parameters:

- Percentage of emptying and transport fleet trips with a waste transport license and an LWSC permit;
- Percentage of service providers' staff who completed the occupational health and safety refresher training and medical tests;
- Number of households served;
- Volume of FS emptied;
- Percentage of customers whose information is provided in a template provided by the LWSC;
- Volume of FS delivered at the designated FSTP; and
- Percentage of FS collected from the customer delivered at the designated FSTP.

The independent verification agent reports the following parameters based on field visits:

- Number of safety incidents reported to the LWSC;
- Number of households who reported complaints to the LWSC regarding service response time and quality of service delivery;
- Whether the worksite cleared of all household items and plastic sheeting placed on the ground in the workspace in key risk areas;
- Whether only authorized personnel were in the workspace and contaminated objects were kept within the worksite unless transported to the vehicle;

- Whether personnel had worn PPE;
- Whether the collected FS was transported safely; and
- Whether the collected FS was disposed of only at the designated FSTP.

A.8 KEY INFORMANTS

Collation of potential examples

- Andy Peal, Independent Consultant
- Andy Robinson, Independent Consultant
- Avinash Kumar, SACI Water
- Aubrey Siwambi, BORDA Zambia
- James Harper, Independent Consultant
- Mohammad Asaduzzaman, iDE Bangladesh
- Peter Hawkins, Independent Consultant
- Sandhya Haribal, Consortium for DEWATS Dissemination Society (CDD), India

Dhenkanal, India

- Anju Dwivedi, Center of Policy Research
- Dr. Hrudanand Mohanty, Center of Policy Research (formerly of PAF)
- Krishna Swaroop Konidena, Consortium for DEWATS Dissemination Society (CDD), India
- Pragyal Singh, Ernst & Young LLP
- Shipra Saxena, UNICEF Odisha
- Swastik Pandey, Blue Water Company

Rural eThekwini

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- Lucky Hlongwa, Gabisha Services
- Lungi Zama, eThekwini Water and Sanitation Unit
- Nick Alcock, Khanyisa Projects
- Teddy Gounden, Consultant (formerly of eThekwini Water and Sanitation Unit)

Chazanga and Kanyama, Zambia

- Kun Zhang, Athena Infonomics
- Reuben Sipuma, Water and Sanitation for the Urban Poor
- Rosie Renouf, Athena Infonomics
- Sam Drabble, Water and Sanitation for the Urban Poor

Khadak, Nepal

- GC Krishna, SNV Nepal
- Parshuram, private truck operator, Khadak municipality
- Ratan Budhathoki, SNV Nepal
- Rajeev Munankami, SNV
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