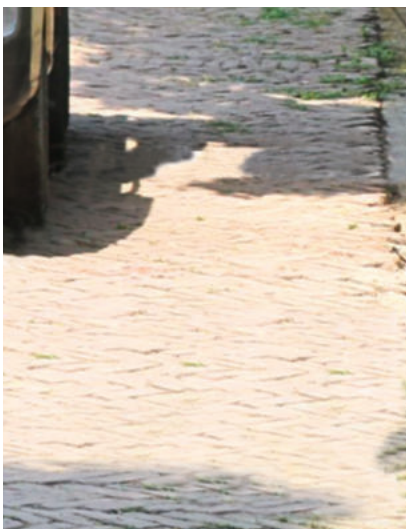
BUSINESS MODEL
For
INCLUSIVE SANITATION
Investigating FSM for Integrated Waste Management in Bangladesh









DEPARTMENT OF PUBLIC HEALTH ENGINEERING
14, SHAHEED CAPTAIN MANSUR ALI SARANI,
KAKRAIL, DHAKA-1000

CWIS-FSM Support Cell

Contributor

Monzur Morshed
Business Expert

Design & Printing

ADFAIR DESIGN & SUPPLY
48/AB, Baitul Khair (4th floor), Suite-401
Purana Paltan, Dhaka-1000, Bangladesh
Mob: 01713014933

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Foreword

Amidst rapid urbanization and environmental challenges, the demand for sustainable and inclusive sanitation solutions has become imperative. Bangladesh, grappling with a burgeoning population and escalating waste generation, confronts intricate issues in effectively managing Integrated waste systems. Fecal sludge management (FSM) emerges as a pivotal aspect of urban sanitation, particularly for the multitude relying on onsite sanitation systems like septic tanks and pit latrines. Unfortunately, FSM often suffers from neglect or inadequate implementation, leading to environmental degradation, health hazards, and social disparities. To tackle these hurdles, there is a pressing need for a comprehensive landscape study that consolidates analyses and key findings of existing fecal sludge service delivery business models, addressing the solid waste mechanism and incorporating case studies pertinent to financial aspects across the sanitation value chain encompassing emptying, transportation, and treatment. Such an endeavor aims to propel the scaling up of sustainable Integrated Waste Management practices in Bangladesh. In response, the CWIS-FSM Support Cell, DPHE, has crafted a landscape study titled **"Business Model For Inclusive Sanitation: Investigating FSM for Integrated Waste Management in Bangladesh."**

This landscape study meticulously evaluates prevailing FSM business models in Bangladesh, offering a comprehensive snapshot of FSM service delivery status, identifying pivotal stakeholders. It delves into diverse business models promoting inclusive sanitation, scrutinizing their efficacy, areas for enhancement, and scalability potential. Additionally, it probes into the requisite arrangements essential for successful FSM towards Integrated Waste Management (IWM) endeavors while assessing the feasibility of replicating such initiatives.

Targeting a diverse audience comprising policymakers, regulators, service providers, donors, researchers, and practitioners engaged in FSM and Solid Waste Management endeavors in Bangladesh or analogous contexts, this study aims to furnish valuable insights and guidance for enhancing and expanding Integrated Waste Management service delivery. Furthermore, it endeavors to ignite fresh ideas and innovations for FSM as well as Integrated Waste Management business models. I believe this document will significantly bolster stakeholders' efforts in advancing City-wide Inclusive Sanitation (CWIS) in Bangladesh.

Tushar Mohon Sadhu Khan
Chief Engineer
Department of Public Health Engineering

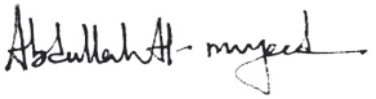
Acknowledgement

With rapid urbanization and environmental challenges, sustainable and inclusive sanitation solutions are crucial. Bangladesh, with its growing population and increasing waste, faces significant challenges in effective waste management. Fecal sludge management (FSM) is essential for urban sanitation, especially for those relying on septic tanks and pit latrines. However, FSM often suffers from poor implementation, leading to environmental degradation and health issues.

To address these challenges, the CWIS-FSM Support Cell, DPHE, has developed a landscape study titled **"Business Model for Inclusive Sanitation: Investigating FSM for Integrated Waste Management in Bangladesh."** This study reviews current FSM business models, offering insights into FSM service delivery and key stakeholders. It examines effective and scalable business models, necessary arrangements for FSM success, and the feasibility of replicating these models.

Targeting policymakers, service providers, and researchers, this study provides valuable guidance for improving Integrated Waste Management in Bangladesh. It aims to inspire new ideas and innovations, supporting efforts to advance City-wide Inclusive Sanitation (CWIS).

To finalize this document, I would first like to express my deepest gratitude to Mr. Tushar Mohan Sadhu Khan, Chief Engineer of the Department of Public Health Engineering, for his precise guidance. My sincere thanks also go to Mr. Md. Shafiqul Hassan, Co-chair of the CWIS-FSM Support Cell, along with the respected Project Directors and officials of DPHE who provided invaluable feedback and insightful advice throughout the finalization process. Sincere thanks to the partners of the CWIS-FSM Support Cell (ITN-BUET, WaterAid, Practical Action, SNV, Athena Infonomics, Global Water and Sanitation Center-GWSC, AIT, FANSA and Others) for bringing knowledge which are immensely valuable while deliver this document. Lastly, I extend my heartfelt appreciation to all the officials of the CWIS-FSM Support Cell, whose commitment and hard work from the beginning to the end were crucial in bringing this document to completion.



Dr. Abdullah Al-Muyeed
Chief Operating Officer
CWIS-FSM Support Cell
Department of Public Health Engineering

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Acronyms and Abbreviations

ADB	-	Asian Development Bank
BMGF	-	Bill & Melinda Gates Foundation
CBO	-	Community Based Organization
CFSC	-	CWIS-FSM Support Cell
DPHE	-	Department of Public Health Engineering
E&T	-	Emptying and transport
FS	-	Fecal Sludge
FSM	-	Fecal Sludge management
FSTP	-	Fecal Sludge Treatment Plant
GOB	-	Government of Bangladesh
GWSC	-	Global Water & Sanitation Center
IRF	-	Institutional and Regulatory Framework
IWM	-	Integrated Waste Management
JMP	-	Joint Monitoring Programme
KLD	-	kiloliters per day (= m^3 per day)
LGD	-	Local Government Division
LGED	-	Local Government and Engineering Department
m^3	-	cubic meters (1 m^3 = 1 KL)
MOLGRD&C	-	Ministry of Local Government, Rural Development and Cooperatives
NGO	-	Non-governmental Organization
NAP	-	National Action Plan
OSS	-	On-site Sanitation Systems
PAB	-	Practical Action Bangladesh
PPP	-	Public-private Partnership
SDG	-	Sustainable Development Goals
SLA	-	Service Level Agreement
SNV	-	Netherlands Development Organization
SMOSS	-	Safely Managed On-Site Sanitation
WB	-	World Bank
WHO	-	World Health Organization
WAB	-	WaterAid Bangladesh
WSUP	-	Water and Sanitation for the Urban Poor

Summary

Fecal sludge management (FSM) solutions are required because 50% of the world's population depends on OSS (On Site sanitation), such as pit latrines and septic tanks. Fecal matter from OSS must be safely emptied, transported, treated, and disposed of. The fast advancement of IRF (Institutional and Regulatory Framework) and the NAP (National Action Plan) for FSM demonstration in Bangladesh have shown that capacity upstreaming and information sharing can significantly alter the behavior of open defecation. It is now essential for continuous toilet use to implement the FSM actions needed when septic tanks or toilet pits fill up. This study offers suggestions for growing and thriving to investigating FSM towards IWM (Integrated Waste Management) in addition to information on current business model implementation strategies across Bangladesh.

The study is divided into two parts:

- Part A presents findings on Emptying and transport (E&T) and treatment components of the sanitation value chain. The analysis is based on case studies (Part B) and Data collection, field visit and KII conducted with 16 emptying and transport operators of 16 cities across in Bangladesh where the FSTP's are fully operationalizing, 16 municipalities that own emptying vehicles along with 16 Fecal Sludge Treatment Plant (FSTP) operators and more than 30 officials across 16 cities; Relevant FSM Network and Stakeholders who involved in implementing FSM were also keep in desk research.
- Part B documents 04 FSM business models based on the findings and analysis of 16 FSM business case studies implemented in Bangladesh. The 16 business case studies are classified into Four typologies whose features and value propositions are discussed in Part B.

  This study draws upon an existing FSM practice in different cities of Bangladesh, as well as secondary documents from the Sector Lead Partners, CWIS-FSM Support Cell, DPHE, ITN-BUET, World Bank statistical report, JMP (2021), and SMOSS Study (2022) for its approach to business models and the analysis undertaken. The following is a summary of Part A's main conclusions:
- **Analysis of Emptying and transport:** This analysis validates most of the anecdotal information that is currently available concerning Emptying and transport operators. A vast majority (67%) of the operators are providing service delivery businesses under the Service level agreement (SLA) Contract with LGI's. Business is essentially demand driven with operators traveling long distances, 44% of the operators travel more than 6-10 kilometers [km] to serve their customers. While the SLA Contract earn a reasonable income, recovering capital deployed seems to be a challenge. Entrepreneurs who manage between 300 and 700 trips annually and charge more than (BDT) 1,000 remain profitable.

  Businesses which can only manage under 300 trips have a high probability of failure, despite the fees charged, and those businesses that carry out many more trips but charge less than BDT 700.0 usually make a loss.

- **Analysis of FSTPs and IWM Plants:** Bangladesh does not have sufficient sewage treatment plants and much number of functioning FSTPs to treat the quantum of fecal sludge (FS) generated and collected. At the end of 2022, Bangladesh has about 18 FSTPs where 16 nos. are in full operation and about 39 number had already constructed and 74 number is under pipeline. Out of 16 functional FSTP's 07 nos. has co-composting facilities by which a handsome portion of O&M cost is incurred from the selling of bio-fertilizer at local as well as national level. Table 2 represents the scenarios at a glance. The per capita cost of an FSTP to serve 100,000 people is about 77.00 to 120.00, and the annual operating cost per capita is BDT 38.00 to 110.00. This calculation will be helpful for the comparison between Sewage and N-Sewage service.

  Therefore, FSM demonstrates that it can be scaled up to achieve Target 6.2 of the United Nations Sustainable Development Goals (SDGs) - by 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, with special attention paid to the needs of women and girls, as well as those in vulnerable situations. According to NAP, the suggested mission could provide safe sanitation for all Bangladeshis by 2030.

Financial transfers for sustainable fund flow of FSM: Households and institutions requiring desludging services pay for emptying and transport services. However, the prices charged by emptying and transport operators/service providers are not paying the disposal fees to the FSTPs or receiving any tipping fees for safe disposal to FSTP's. Reuse of treated solids is an additional revenue source for the FSTP, but its contribution to a stand-alone FSTP will only be a fraction of the FSTP Operation and Maintenance (O&M) costs. Therefore, the operational costs of an FSTP have to be largely borne by the public sector. Alternatives (and the associated challenges), such as local governments regulating FSM markets by setting tariffs (user acceptance of tariffs) or by providing services against a sanitation tax (political will, collection efficiency), are briefly discussed. The primary challenge in FSM remains its acceptance as a viable option in sanitation. While the LGI's has taken policy and program measures through LGD on this front, globally, significant work has to be done in mainstreaming FSM. Specifically, in reporting data on FSM services (e.g., WB, ADB), allocating significant and dedicated funds, Including FSM as a part of the sanitation solution, and citizens demanding such services from their local authorities.

Chapter 1: Introduction

1.1 Introduction

Fecal Sludge Management (FSM) for On-site Sanitation Systems (OSS) such as septic tanks and pit latrines is one of the key solutions to achieving Target 6.2 of the United Nations Sustainable Development Goals (SDGs) - by 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations (United Nations 2021). FSM in this context refers to the collection, transport, treatment, and disposal/reuse of fecal sludge (FS). as shown in Figure 1.

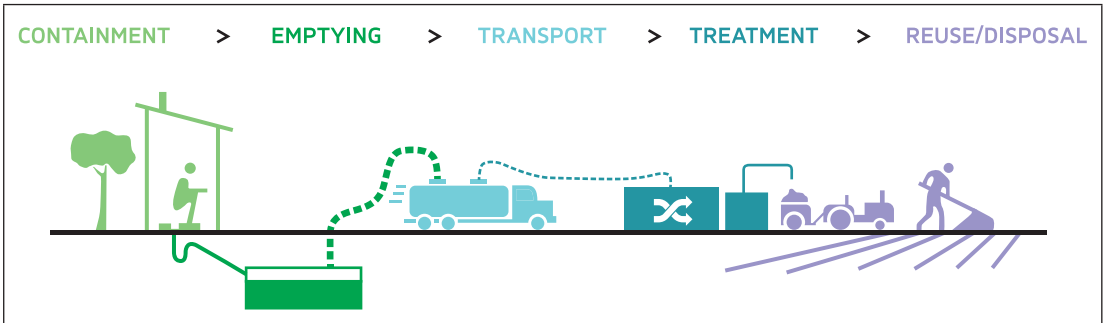


Figure 1: FSM Sanitation value Chain

Source: Bil & Melinda Gates Foundation 2015

Globally, in 2020, 54% of the global population used safely managed sanitation services, 44% in rural and 62% in urban. 3.6 billion people lacked safely managed services, including 1.9 billion people with basic services, 580 million with limited services, 616 million using unimproved facilities, and 494 million practicing open defecation. Estimates for safely managed services were available for 120 countries and seven out of eight SDG regions, representing 81% of the global population. (WHO/UNICEF JMP 2021). Figure 2 provides a breakdown of the percentage of people using OSS in different regions.

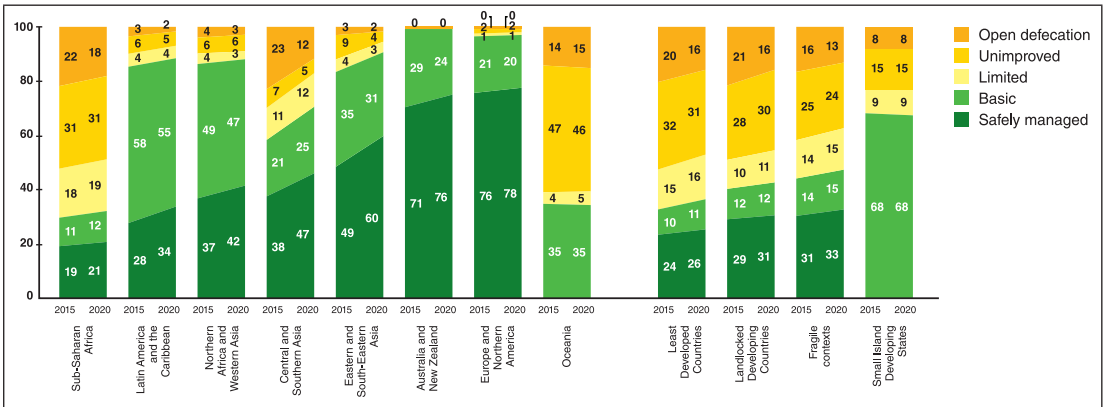


Figure 2: Regional Sanitation Coverage 2015- 2020(%), Data from WHO/UNICEF JMP 2021.

1.2 FSM In Bangladesh

Unsafe practices are currently filling a gap in the Fecal Sludge Management (FSM) value chain. This includes situations where toilets overflow or require manual emptying, leading to untreated sludge being transported and discharged into nearby drains and water bodies. This poses significant health risks to residents, reminiscent of the challenges associated with open defecation. In numerous areas, septic tanks and pits are directly connected to the storm drainage system, which in turn links to open water bodies both within and outside urban areas. This problem is exacerbated by frequent flooding. Access to improved toilets and safe FSM services varies widely based on income level and geographical location. Low-income households, particularly those in informal settlements, primarily rely on various types of pit latrines and septic tanks and are less likely to be connected to the storm drain network. They depend on desludging services, often involving collection and transportation by carts and vans. It is estimated that approximately 20 percent of residents in low-income areas occasionally resort to open defecation due to the absence of proper containment infrastructure or difficulties in accessing emptying services. In some towns, open defecation rates ranged from 1 percent (Sakhipur) to 6 percent (Faridpur) before interventions. In Faridpur, manual emptying of a tank or pit costs between USD 15.00 and USD 50.00. In lower-income areas of Bangladesh, the typical cost is between USD 20.00 and USD 50.00, the latter applying to larger tanks serving multiple households. In Sakhipur, the fee for fecal sludge collection and transportation is USD 6.50 per trip within the municipality, while clients outside the municipality incur higher costs due to additional fuel expenses. Mechanized systems for emptying pit latrines with direct storage in concrete rings or latrines connected to septic tanks by pipes are not utilized in Sakhipur. Instead, it is customary to seal a full pit and dig a new one to replace it. When a pit or tank needs to be reused, manual emptiers are hired to empty it and transport the waste to disposal points. Ultimately, the cost of FSM services is often determined by factors such as the volume of sludge, the type of emptying (manual or mechanical), distance to a disposal site, ease of access, condition of the containment facility and the sludge, and the socioeconomic status of the customer. A major challenge that Bangladesh is facing is the gap between access and quality of WASH services. The access to improved water is 98.5% (not including arsenic contamination) while safely managed drinking water service coverage is only 42.6%. The progression from open defecation free (almost 1.5%) to universal access to safely managed sanitation, which is currently 36.4% in rural areas (Estimated MICS 2019). Other challenges are inadequately designed low-cost and low-tech solutions for specific environments such as flood and storm-prone coastal areas or water-scarce hilly environments; fecal sludge management and safely managed sanitation options for densely populated areas such as urban slums. Shared toilet commonly uses in densely populated urban slum, which is not counted as improved toilet by the JMP. Additional solutions are needed to extend and affordable resilient services to people living in hard to reach (HtR) areas, coastal and arsenic prone areas.

The absence of treatment facilities in most towns and cities also leaves a gap in the sanitation chain. In Faridpur, the sludge treatment plant started is currently operating at 40 percent capacity. In Bangladesh, the significant amount of solid waste and fecal sludge generated offers the possibility of combined composting. Co-composting is also a core part of the FSM business model already developed by the Municipality of Faridpur Sakhipur, Kushtia, Jashore and Saidpur with support & technical guidance from the Development Partners in Bangladesh.

BOX 1. SANITATION LADDER.

The World Health Organization and United Nations Children's Fund (WHO/UNICEF) Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) uses a benchmark to compare service levels across countries through a sanitation service ladder. The new ladder builds on the established improved/unimproved facility type classification with additional criteria related to service levels as mentioned below:

- Safely managed – use of improved facilities that are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site
- Basic – use of improved facilities that are not shared with other households
- Limited – use of improved facilities shared between two or more households
- Unimproved – use of pit latrines without a slab or platform, hanging latrines or bucket latrines
- Open defecation – disposal of human feces in fields, forests, bushes, open bodies of water, beaches, and other open spaces or with solid waste

Source: WHO/UNICEF JMP 2021

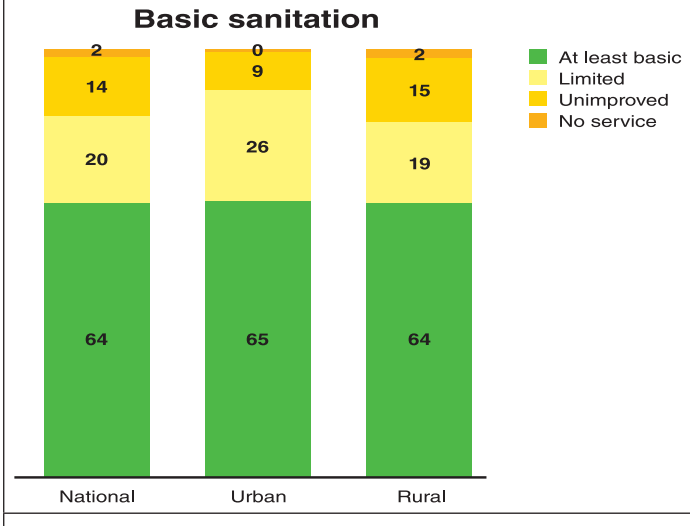


Figure 3: Percent of Population by Sanitation Coverage. UNICEF, Bangladesh MICS 2019

In line with the global sanitation commitment, Bangladesh realized new sanitation challenges regarding sanitation governance to bring changes in policy guidelines. The milestone of sanitation policy reform aligning SDG 6.2 journey is the formulation of Institutional and Regulatory Framework (IRF) 2017 for Fecal Sludge Management (FSM) followed by National Action Plan (NAP) 2020 for both urban and rural setup of the country. The FSM sector in Bangladesh is nascent but rapidly emerging. Several projects have been implemented across the country and serve to demonstrate technical as well as business model aspects of FSM. Some of the noteworthy projects aim to demonstrate Public-private Partnerships (PPPs) and regulatory aspects such as licensing (Co-Composting), implementation of sanitation tax, and so forth. The sector needs to

rapidly learn from these projects, as well as the technology pilots, in order to develop solutions for scaling up FSM. These solutions have to connect all components of the sanitation value chain, along with institutions (stakeholders and regulations), technical solutions and appropriate financing models to sustain FSM implementation. A strategy for scaling up FSM, as part of a larger sanitation plan, can then emerge.

1.3 About the Study- Business Models for FSM In Bangladesh

This study documents successful FSM lessons in Bangladesh, with a particular emphasis on questions such as "Who is paying for FSM?" and "Is that the best arrangement?" Although a shortage of data over a long period limits extensive research, emerging a propensity in FSM organization are explored. With a new focus and comprehensive study, this report supplements the study's attempt to answer the major question: "What is the best way to ensure that FSM is paid for in the long term?" "What arrangements should the key stakeholders make for a successful FSM project?" as well as "Are such projects replicable?" These conversations should help to improve FSM implementation in Bangladesh and other relevant geographic areas. Data used to this study as of July 2023.

The study is divided into two parts:

- **Part A** summarizes the analyses and key findings from 16 business case studies and 04 business models in relation to financial data collected on the emptying, transportation, and treatment components of the value chain, along with practices and recommendations to scale up FSM in Bangladesh.
- **Part B** presents service delivery mechanisms and operational FSM towards Integrated Waste management good practices through the co-composting as case studies of IWM (Integrated Waste Management) in Bangladesh.

PART A

Analysis of Business Models for Fecal Sludge Management

Chapter 2: Business Models for FSM

2.1 What is the Meaning of 'Business Model' in FSM?

The term 'business model' can be a misnomer in the sanitation sector, as a 'business' is typically associated with income generation and profits. In this report, the term business model follows the definition by Osterwalder and Pigneur (2010) as previously applied to waste management and sanitation (Otoo and Drechsel 2018):

"A business model is defined by who your customers are, which markets you operate in, who your partners are, what costs you have, where your revenues come from, which activities you engage in, and how is value created and delivered to your customers."

In this report, the term 'business model' is used as a tool to articulate FSM solutions – their costs, potential for revenue generation for cost recovery, and partnerships and engagement between diverse stakeholders (government, donors, entrepreneurs, technology providers, community-based organizations [CBOs], and non-governmental organizations [NGOs]). The provision of sanitation is like waste management, traditionally a public service to maintain public health and budgeted as such by municipalities.

Trémolet (2012) argues that sanitation services should not be viewed solely as a public good, but rather as a market-oriented endeavor involving various stakeholders in what is commonly referred to as the 'sanitation value chain'. However, this value chain has experienced market failures due to factors like external effects, imperfect information, local monopolies, and competition in service delivery. These issues result in inadequate quantity and quality of sanitation goods and services on both the demand and supply sides. To address these market failures, solutions typically involve improved investment decisions, better regulations and standards enforcement, and support for market-based solutions through financing and business support. This study assesses business models in both public and private sectors, examining service delivery arrangements between them. The models cover all aspects of the sanitation value chain and showcase mechanisms to address challenges faced by FSM stakeholders, while also identifying opportunities for increased private sector involvement in sanitation services. The study utilized a combination of desk research and field visits, including interviews with various stakeholders such as government officials, private operators, sector experts, investors, and funders.

2.2 Generic FSM Business Model for Bangladesh

A business model canvas is a framework developed by Osterwalder and Pigneur (2010) to present a business model, as shown in Figure 4. The core of a business model is the 'value' (Value Proposition) a 'customer' (Customer Segment) is deriving from FSM services. Then follows 'how' (Customer Relationships) and through 'whom' (Channel) the service is delivered to the customer. Once the mechanism of service delivery is established, its viability is analyzed through the Revenue Streams and Cost Structures. According to Otoo and Drechsel (2018), the business model canvas has been adapted by integrating the social and environmental costs and benefits.

Broadly, the FSM business models in Bangladesh provide the following value propositions:

- Value Proposition 1 (VP1) – Timely and safe emptying of OSS in households, businesses, and institutions.
    - o Value Proposition 1A (VP1A) – Safe transportation of FS to designated disposal sites.

- Value Proposition 2 (VP2) – Treatment of FS for a healthy community and environment.
- Value Proposition 3 (VP3) – Recovery of nutrients from FS to produce high quality compost by co-composting with solid waste.

The business model canvas presents the abovementioned value propositions (color coded) and their corresponding customer segments and other elements categorized with specific color codes. Depending on each value proposition offered by the business, its customer segment will vary – e.g., for a business providing emptying and transport services (VP1), the customer segments are individual households, businesses, and institutions. For FS treatment (VP2), it is the municipality as well as the private enterprises. The customer segments for reuse value propositions depend on the type of resource recovered; for a business providing treatment of FS for recovery of nutrients and the sale of fertilizer (VP3), the primary customer segments are farmers, farmer producer organizations, and fertilizer distributors. The other elements of the business canvas are self-explanatory.

Figure 4: GENERIC BUSINESS MODEL CANVAS FOR FSM In BANGLADESH.

<table>
<tr><th>Key partners</th><th>Key Activities</th><th>Value Propositions</th><th>Customer Relationship</th><th>Customer segment's</th></tr>
<tr><td rowspan="5">Municipalities, City Corporations and other LGI's, Technology suppliers, Financial Institutions/ Development Partners, CBO's/ Cooperatives/ Sanitation Enterprises, Research& Development Institutions (Local Universities, Govt. Agricultural Research Institute etc.)</td><td>*Containment- Septic tank/Pit latrines</td><td></td><td></td><td>-Community (HH, LIC)
-Commercial
-Institution</td></tr>
<tr><td>FS E&T</td><td>VP1: Timely & safe emptying of OSS
VP1A: Safe Transportation of FS to designated disposal site</td><td>LGI directly operated service, SLA and PPP provision for FSM service delivery in Municipalities.</td><td>-Households
-Commercial
-Institution</td></tr>
<tr><td>*FS Treatment</td><td>VP2: FS Treatment for a healthy and safe community and environment.</td><td>Contract with Municipality</td><td>-Municipalities
-Private Enterprises
-CBO's</td></tr>
<tr><td>-Organic waste collection,
-Compost production,
-Compost sales & marketing</td><td rowspan="2">VP3: Production of high-quality compost</td><td>-Direct compost sales
-Compost sales through distributers.</td><td rowspan="2">-Farmers
-Fertilizer Industry
-Agricultural Extension Department
-Agroforestry
-Nurseries
-landscapers
-LGI's recreational place</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Customer Relationship Management</td><td>Channels</td></tr>
<tr><td>Direct, Municipality, Word to mouth, TLCC, Community engagement, public awareness, advertisement.</td></tr>
</table>

	Key resources Land, Finance, Technology, Labors, Approvals & Contracts for service provision across the chain.		SLA, PPP by CBO's, Cooperatives, PS, NGOs through agreement with LGI's.	
			Distributers	
Cost Structures			**Revenue Streams**	
Fixed Investment Cost (Infrastructure, FS equipment's & materials procurement cost, FSTP operating materials cost O&M Cost- Staffing, Fuel, raw materials, Utilities, advertisement, sales, etc.) Depreciation and Contingency Cost			Desludging/ emptying fees -Service operator Licensing fees -O&M budget support -Sanitation tax Compost sales	
Social and Environmental Cost			**Social and Environmental benefits**	
-Potential health risk for emptiers, FSTP operator's negligence on OHS. -Improper FS Treatment & Disposal causing environmental and health risk			-Reduced pollution of soils and water bodies -Reduced Human direct exposure to Fs -Job creation and mainstreaming of social status for manual emptiers. Improved soil health, resulting in affordable agricultural cost-effective productivity as well as food security.	

Note: Colors indicate relevance to the corresponding value proposition. Dark green is applicable to all VPs.

2.3 Typology of FSM Business Models in Bangladesh

Figure 5 provides an overview and typology of the 'business model' areas of focus across the sanitation value chain. These business models are presented here based on the analysis of existing practices of 16 FSM business case studies from Bangladesh, as shown in Figure 6. In total, 04 business models emerge from 16 case studies across all components of the sanitation value chain. Part B of the report cover the FSM service delivery mechanism with case studies. The business models have been grouped into Four (4) main categories:

A) Public Sector-led Model: LGI Owned and Operate

Under this model, the government takes the lead in providing fecal sludge management services. This can involve the establishment of treatment plants, collection services, and operation and maintenance of the entire system. The government may allocate funds for the construction and ongoing operation of the facilities and employ trained personnel to manage the operations.

B) Public-Private Partnership (PPP) Model

PPP models involve collaboration between the government and private sector entities. The government provides the policy and regulatory framework, while private companies or entrepreneurs are responsible for implementing and operating fecal sludge management services. This model can bring together the strengths of both sectors, including public oversight and private sector efficiency.

C) Private sector/ Community led Service Level Agreement Model

In this model, marginalized group of communities take an active role in fecal sludge management. It involves organizing local community groups or cooperatives that are responsible for fecal sludge collection, transportation, and treatment under the service level agreement with LGI's. This model promotes community ownership, social empowerment, and engagement in decision-making processes.

D) Hybrid Model: LGI Owned and Operated by Private Sectors

A hybrid model combines elements of the public and private sectors, as well as community participation. It may involve a mix of public and private service providers working together to deliver fecal sludge management services. For example, the government might establish & operate the treatment plants, while private companies/ NGO's/sanitation enterprises handle the collection and transportation of fecal sludge.

Each of the business models presented is an attempt to solve a problem. In studying these models, it should be kept in mind that enabling policies (NAP, 2020) and empowering regulations are key for making them effective. For example, when a demand based desludging contract with service level agreement is in effect, the city should have strong regulation and communications campaigns to raise awareness in households regarding cooperation with the

Operator to enable desludging. If such cooperation is not forthcoming, the contract becomes unviable. Each model thus requires different sets of regulations to make it effective. Another key requirement is appropriate risk-sharing between the municipality (contracting authority) and the service provider (Operator). For example, an integrated tender with Service level Agreements (Model C) may seem ideal for FSM. However, if the service provider is burdened with the customer willingness to pay (user fees) for desludging, the tender may not attract bidders due to high perceived risk. The municipality should shoulder its share of the burden in a nascent sector such as FSM. However, business models such as franchise emptying and transport, non-profit emptying and transport, incentivized disposal, and are not yet observed in Bangladesh.

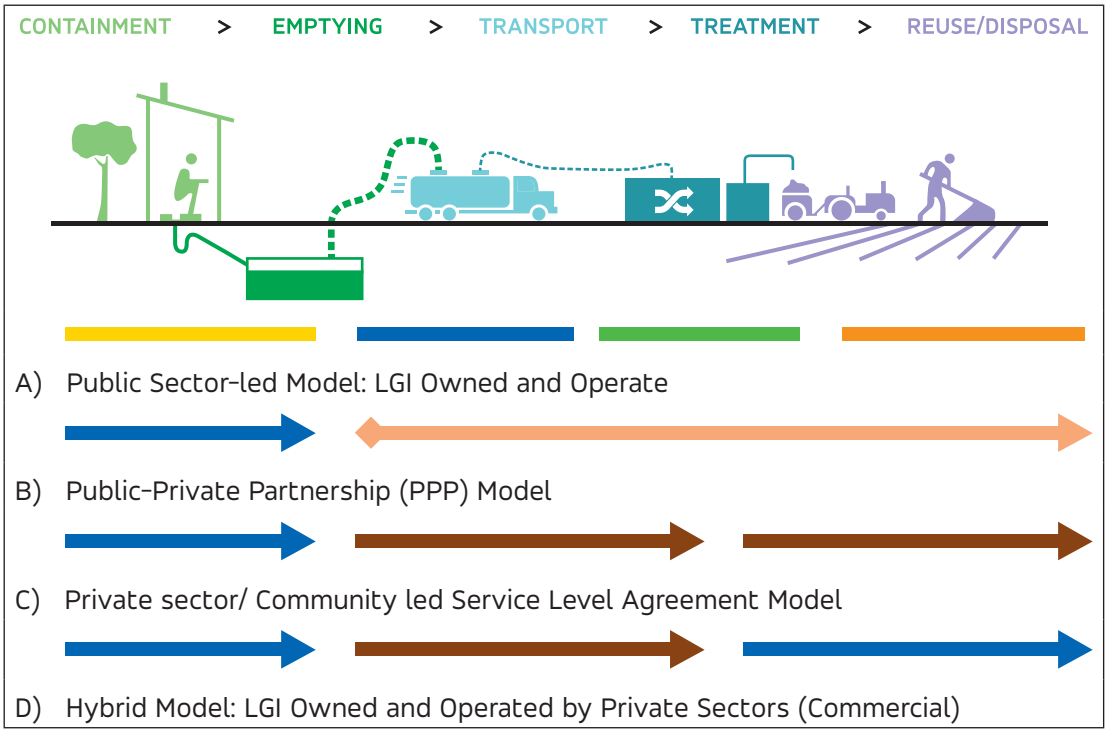


FIGURE 5. BUSINESS MODEL TYPOLOGY ALONG THE SANITATION VALUE CHAIN.

Model -A	Model-B	Model-C	Model-D
Lakhsmipur, Teknaf, Mymensingh.	Kushtia, Jhenaidah, Jashore, Gazipur, Benapole, Khulna	Faridpur, Meherpur, Jamalpur	Sakhipur, Saidpur, Rangpur, Chattogram

Figure 6: Typology of FSM Models in Bangladesh

2.4 CO-Composting through Integrated Waste Management in Bangladesh

Co-composting plays a pivotal role in the sustainable management of organic waste in Bangladesh's Fecal Sludge Treatment Plants (FSTPs). As earlier mentioned, that out of 16 operating FSTP's, 07 FSTP's are performing the Co-composting functions which we can address as the Integrated Waste Management. This innovative approach involves the controlled decomposition of organic matter from various sources, including fecal sludge, alongside agricultural residues, and solid/green/kitchen waste. By combining these elements, FSTPs in Bangladesh can create a nutrient-rich compost that serves as a valuable soil conditioner and fertilizer. Already the Soil Research Development Institute has affiliated these bio-fertilizer for some fruits and traditional crops & flowers under Urban-Agriculture farming. This practice not only diverts organic waste from landfills but also contributes to enhancing soil fertility and agricultural productivity. Moreover, co-composting aligns with Bangladesh's broader environmental and agricultural

sustainability goals, providing an eco-friendly solution to the country's waste management challenges. As a result, the adoption of co-composting practices in FSTP operations stands as a notable example of how integrated waste management approaches can positively impact both urban sanitation and agricultural sectors in this region.

2.5 Synopsis of Existing Co-Composting that addressing the IWM In FSTP's, Bangladesh

Sl.	Location	Collection	Transport	Treatment	Resource Recovery	Model Type
1	Khulna City Corporation	3rd Party Entity & Municipality -Both	3rd Party Entity & Municipality –Both	3rd party. In major case consolidated amount of repairing and maintaining cost provided by the KCC	Initially Briquette, Bio-fertilizer	Model- B
2	Faridpur	Private Company through Co-operative Society Kuthibari & Bandhob Palli.		Private Company SDC -CRTC	Vermi compost, Bio-Fertilizer	Model- C
3	Sakhipur	BASA in cooperation and technical support with WaterAid and overall City service oversees by Municipality		BASA with the Technical support by WAB	Sakhi Compost	Model- D
4	Saidpur	Operated and supported by NGO		Municipality through NGO	IWM demonstration & produced Fertilizer commercially marketing	Model- D
5	Kushtia	3rd Party Under PPP		Private Company (CSFC) under lease agreement with Municipality	Bio- fertilizer produced through Co-composting (IWM)	Model- B
6	Jashore	Private Service Provider (ESCAP) under PPP agreement with Municipality			Bio-Gas, Fertilizer through IWM demonstration	Model- B
7	Chattogram	Private Service Operators (CSS & M. Forak Ahmed & Sons) under lease agreement		Chattogram City Corporation	City compost by co-composting	Model-D

2.6 Third Urban Governance and Infrastructure Improvement (Sector) Project: UGIIP-III

Third Urban Governance and Infrastructure Improvement (sector) Project (UGIIP-3) is a prolong approach based on integrated and holistic ways for human development, economic growth and poverty alleviation by enhancing municipal waste management and strengthening capacity to deliver municipal services and improve physical infrastructure and urban services (specially to the poor) in 31 secondary towns of Bangladesh.

The UGIIP-3 project, or the Urban Governance and Infrastructure Improvement Project Phase 3, is a significant initiative aimed at enhancing waste management services in Bangladesh. This project focuses on developing and improving systems for the effective management of solid and fecal waste in urban areas of the selected cities. It employs a multifaceted approach, encompassing the establishment of modern waste treatment facilities, the implementation of sustainable waste collection and transportation systems, and the promotion of community engagement and awareness regarding waste management practices. Through targeted interventions, UGIIP-3 strives to address the pressing challenges posed by rapid urbanization and population growth in Bangladesh, with the ultimate goal of creating cleaner, healthier, and more livable urban environments. By prioritizing waste management service development, this project plays a pivotal role in advancing urban sustainability and public health in Bangladesh.

2.6.1 Economic Value Propositions of UGIIP-3 regarding city wide Integrated Waste Management in Bangladesh

The UGIIP-3 Project in Bangladesh offers several economic value propositions in the context of city-wide collective waste management services:

Job Creation and Skills Development: The project creates employment opportunities in various aspects of waste management, including collection, transportation, sorting, and treatment. This not only reduces unemployment rates but also contributes to the development of a skilled labor force in the waste management sector.

Revenue Generation and Cost Savings: Proper waste management can lead to revenue generation through recycling and sale of valuable materials. Additionally, efficient waste handling practices can lead to cost savings by reducing the need for clean-up operations due to pollution and environmental degradation.

Boost to Local Economy: Well-managed waste services contribute to a cleaner and more attractive urban environment. This can lead to an increase in property values, which benefits property owners and can potentially lead to higher local tax revenues.

Reduction in Healthcare Costs: Effective waste management practices lead to a reduction in environmental pollution and associated health risks. This, in turn, can lower healthcare costs by decreasing the incidence of diseases related to poor waste handling practices.

Compliance with Regulatory Standards: Adhering to modern waste management practices ensures compliance with environmental regulations and standards. This helps avoid potential fines or penalties associated with improper waste disposal, safeguarding financial resources that would otherwise be allocated for legal and regulatory compliance.

Resource Conservation and Circular Economy: Proper waste management promotes recycling and reuse of materials, conserving natural resources and reducing the need for raw material extraction. This contributes to a more sustainable and environmental-friendly economy.

Business and Investment Opportunities: Clean and organized urban areas are more appealing to investors and entrepreneurs. A well-functioning waste management system creates an environment conducive to business activities, potentially leading to increased economic activity and business growth.

2.7 Financial Assessment of Operation and Maintenance considering Revenue generation for Integrated Waste Management under UGIIP-3

Solid Waste- REVENUE				**Solid Waste- O&M**	
Category	Number	Service Fee /month in	Annual Revenue in BDT	Category	Annual Cost in BTD
Household	8000	100	9600,000	Human Resource staffing	6456000
Rest./Hotel/ Hostel	50	500	300,000	Fuel	2372500
Commercial	300	100	360,000	Maintenance	1046000
Sub-total Revenue			1,02,60,000	Total O&M	9874500
FSM- REVENUE				**FSM- O&M**	
Category	Number	Service Fee /month in	Annual Revenue in BDT	Category	Annual Cost in BTD
Household	4000	83.33	40,00,320	Human Resource staffing	1692000
Rest./Hotel/ Hostel	50			Fuel	1779375
Commercial	300			Maintenance	650000
Sub-total Revenue				Total O&M	4121375
Cash Flow				**Conservancy- O&M**	
Annual Revenue in BDT		**Annual O&M in BDT**		Category	Annual Cost in BTD
Solid Waste	1,02,60,000	9874500	**Annually, more 54.29% from the total revenue will be used for operation and maintenance**	Human Resource staffing	5976000
FSM	40,00,320	4121375		Fuel	1336250
Conservancy		7992250		Maintenance	680000
Total	**14260320**	**21988125**		Total Conservancy Cost	7992250

ESCALATION OF CASH FLOW

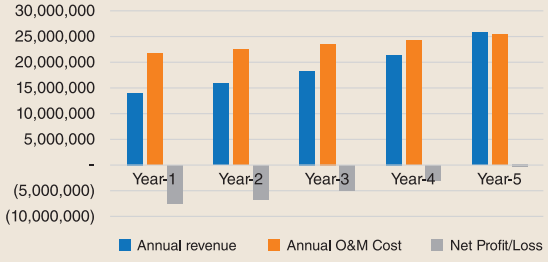
Item	CAPEX
SLF	83315037.9
FSTP	11541156.69
Total	**94856194.59**

	Item	Year-1	Year-2	Year-3	Year-4	Year-5
	Annual revenue	14,260,320	16,021,859	18,388,129	21,563,042	25,846,906
	Annual O&M Cost	21,988,125	22,744,538	23,639,591	24,591,150	25,637,865
	Net Profit/Loss	(7,727,805)	(6,752,678)	(5,251,462)	(3,028,109)	209,041
10%	**NPV**	(99,654,553.49)	(99,049,076.63)	(98,116,939.43)	(1,880,217.23)	(94,726,396.77)
15%		(98,698,279.45)	(98,213,469.22)	(97,467,099.41)	(96,361,699.77)	(94,752,264.42)
20%		(97,961,826.10)	(97,569,944.61)	(96,966,639.46)	(96,073,123.54)	(94,772,185.83)
	IRR	**(1.82)**				

Concessionaire

	Item	Year-1	Year-2	Year-3	Year-4	Year-5
	Annual revenue	14260320	16021859.04	18388129.07	21563041.72	25846906.1
	Annual O&M Cost	21988125	22774537.5	23639591.25	24591150.38	25637865.41
	Net Profit/Loss	-7727805	-6752678.46	-5251462.177	-3028108.655	209040.6845
0.1	**NPV**	-4798358.905	-4192882.044	-3260744.843	-1880217.232	129797.8184
0.15		-3842084.861	-3357274.631	-2610904.821	-1505505.175	103930.1651
0.2		-3105631.51	-2713750.024	-2110444.869	-1216928.954	84008.76274
	IRR	**0.102633801**				

Financial Cashflow



NPV= Rt/(1+i)^t - iO

Rt+ Net Cash Flow
i= Discount Rate
t= Time of Cash Flow
iO= Initial Investment

IRR+R1+(NPV1*(R2-R1)/(NPV1-NPV2)

R1= Lower Discount Rate
R2= Higher Discount Rate
NPV1= Higher NPV
NPV2= Lower NPV

Cost Inflation/year	10%
Depreciation (IAS 16)	10%
Popl. Growth rate/Year	2%
Infrast./ Commercial growth/ yr	5%

Figure 7: Escalation of Cash Flow for IWM, UGIIP-III.

Figure 8: List of Operationalize FSTP's In Bangladesh

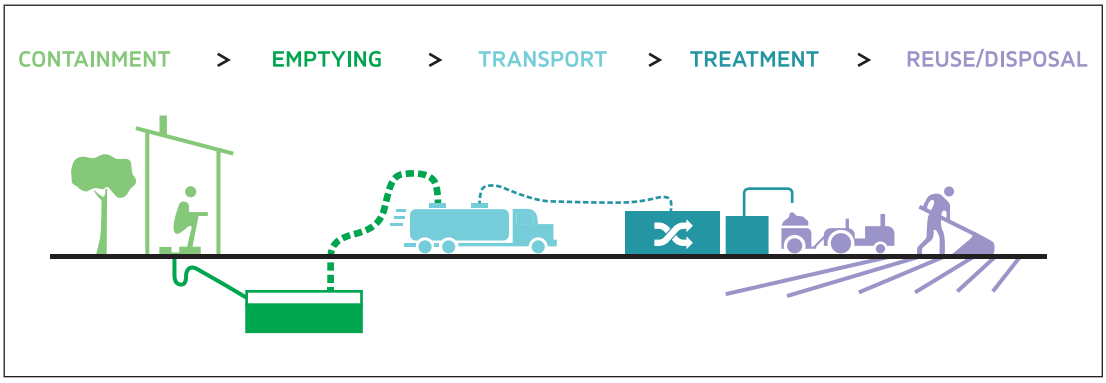


Figure 9: Economic Value Propositions of Business Models in Categories

A Public Sector-led Model: LGI Owned and Operate

- ✧ Improved Sanitation and Public Health
- ✧ Regulatory Compliance
- ✧ Job Creation and Local Economic Development
- ✧ Separate Sanitation budget formation
- ✧ Reduced Dependency on Informal Service Providers
- ✧ Integration with Urban Planning
- ✧ Access to Financing and Technical Support from Development Partners.

B Public-Private Partnership (PPP) Model

- ✧ Leveraging efficiency in Service Delivery often leads to cost-effective and well-managed operations.
- ✧ Invest in infrastructure and technology upgrades, leading to improved service quality and coverage.
- ✧ Cost Sharing reducing the strain on government budgets.
- ✧ Revenue sharing mechanism and Cost Recovery.
- ✧ Risks associated with operations, such as fluctuations in demand or technical challenges, can be shared between the public and private partners, reducing the overall risk for both parties.
- ✧ Technology Transfer and Innovation, which can lead to better waste treatment and management practices.
- ✧ Improved Asset Management
- ✧ PPP models can facilitate the scalability and expansion of FSM services to underserved areas, improving sanitation coverage in urban and peri-urban regions.
- ✧ Compliance and Accountability ensuring that private partners adhere to quality standards and regulatory requirements.

C Private sector/ Community led Service Level Agreement Model

- ✧ Cost-Effective Service Delivery can help to manage operational costs and reduce waste, making services more economically viable.
- ✧ Performance-Based Payments incentivizes efficient and effective service delivery.
- ✧ Risk Mitigation outline responsibilities for managing unforeseen issues like equipment breakdowns or changes in demand, reducing financial risks.
- ✧ Investment in Infrastructure such as treatment plants and transportation fleets which reduces the burden on the government to fund capital-intensive projects.
- ✧ Revenue Generation can help offset operational costs and potentially lead to profits.
- ✧ Transparent Cost Structures help to understand the pricing structure and make informed decisions about service contracts.
- ✧ Efficient Resource Allocation ensures that resources like trucks and treatment facilities are optimally utilized to minimize operational costs.
- ✧ SLAs promote the long-term sustainability of fecal sludge management services, reducing the need for frequent renegotiations or disruptions in service provision.
- ✧ Accountability and monitoring collectively ensures the treatment of FS for a healthy community and environment.
- ✧ Reduction of Informal Service Providers

D LGI Owned and Operated by Private Sectors

- ✧ Accountability and Reporting
- ✧ Incentives or penalties for Performance
- ✧ Flexible Contractual Arrangements
- ✧ Expertise and Professionalism
- ✧ Private operators may efficiently allocate resources like collection vehicles and treatment facilities, reducing waste and operational costs.
- ✧ Private sector participation can reduce the reliance on public funds for the provision of FSM services, freeing up government resources for other essential services.
- ✧ Risk Transfer
- ✧ Competition and Quality Improvement
- ✧ Private operators can generate revenue through user fees and charges for their services, which can help cover operational costs and potentially yield profits.
- ✧ Private sector involvement creates job opportunities within the FSM sector, contributing to local economic development and poverty reduction.
- ✧ Private sector operators often bring efficiency and cost-effective practices to FSM services.
- ✧ Timely and safe emptying of containment units specially LIC focused as per municipalities priorities.

2.8 Recommended Business Modalities towards Integrated Waste Management

Business models, especially in neglected sectors such as sanitation, are ultimately only effective when there is a source of sustained funds for running the system effectively. The basic principle touted in such circumstances is that of Polluter Pays (UNEP 2001). In FSM, the household is willing to pay for collection and transport services when directly affected (toilet blockage, odor, etc.). A preventive approach such as scheduled desludging may not elicit a willingness to pay and requires tax-based financing. The challenge is how to cover the costs of FS treatment, which has much higher operating expenses than the operating margins of a typical emptying and transport service providers. Therefore, FS treatment continues to require public funds. presented FSM business models only cater to sections of the entire value chain. Therefore, LGI's need to seek combinations of the models outlined above and perhaps minimize the need for public subsidies. Possible combinations of business models that could be sustainable are:

1. Model A provides a complete solution. However, if the household does not take responsibility for maintaining the containment, business models for O&M of the service may need to be encouraged.
2. Model B and Model D should be implemented in tandem, through appropriate contracts, regulations, and community awareness.
3. Alternatively, Model B interventions may be enhanced to Model C to enable performance linked payment models aligned with outcomes. Supporting regulations and community awareness programs will be important in this regard.

While planning for these combinations, it is critical that the primary objective should be to provide entire FSM service coverage. Care should be taken to assure service is accessible to the poor and vulnerable communities of the society through differential/ subsidized tariffs/taxes, as appropriate. Stakeholder consultation in a gender inclusive and participatory manner is vital in designing the business model.

Chapter 3: Financials of Fecal Sludge Emptying and transport

The inconspicuous phrase "Treasure Hunt (গুপ্তধনের সন্ধানে)" accompanied by an 11-digit cell phone number, prominently painted on the metal vacuum-tanks scattered throughout Faridpur Municipality's urban, town, and rural areas, signifies the challenge of addressing a crucial yet sensitive topic - the desludging of septic tanks and pits. The infrequent need for OSS desludging, spanning years between each operation, presents an additional hurdle in marketing this service. Business promotion is arduous, with an unsettled client base, and actual operations pose even greater difficulties - encompassing physical risks during emptying, harassment during informal disposal, irregular working hours, and narrow profit margins. Assisting individuals with their overflowing toilets is undeniably a demanding endeavor. Emptying and transportation (E&T) stand as pivotal services in FSM, often overlooked in a sector that has only recently gained increased public attention. The imperative to disseminate information about emptying is growing more pressing by the day, especially considering the anticipated surge in the demand for mechanical pit emptying across both urban and rural areas of Bangladesh. Evidence suggests that the affordability and accessibility of OSS (On Site Sanitation) emptying are primary concerns for households, significantly influencing their desludging behavior. Figure 10 shows the population wise emptying and transport operators in Bangladesh. This section offers an overview of the emptying and transport sector within the FSM framework of Bangladesh. Presently, there are a total of 26 FSM private operators (combining seasonal and professional) operating in 16 municipalities across eight divisions in Bangladesh, with detailed discussions regarding their business operations covered in the subsequent section of this report. In Bangladesh, it was found Mechanical emptying has a number of theoretical advantages over Manual emptying. But in a concise form this report reveals that,

- Cost effective: BDT 1000 to 1200 per septic tank for mechanical emptying compared to BDT 5000 to 6000 per septic tank for manual emptying. Traditionally, the cost of Mechanical emptying was much higher there, approx. BDT 12000 to 15000 but due to the initiation of Mechanical emptying services by some NGOs, Private Sector and Paurashavas, cost for mechanical emptying has drastically decreased. Figure 11 shows the Structure of Entities providing Emptying and Transport Services in Bangladesh.
- Collection fleet: emptying and transport service providers are small businesses with most entrepreneurs are operating the desludging services by a contractual agreement with the LGI's.
- Desludging duration: 1-1.5 hour per septic tank for mechanical emptying compared to 1-3days per septic tank for manual emptying.
- Service fee: FSM service delivery mechanism is overseen by the designated section from Municipalities specially for emptying, transport and safe disposal. Service fee or tariff rate is mainly based on trip or fleet/vacutug volume basis by the LGI's to provide the mechanical emptying service to the city dwellers at affordable rate where the marginalized community or LIC's are always considered under special tariff. The tariff is also varying on length of a trip (for commercial customers).

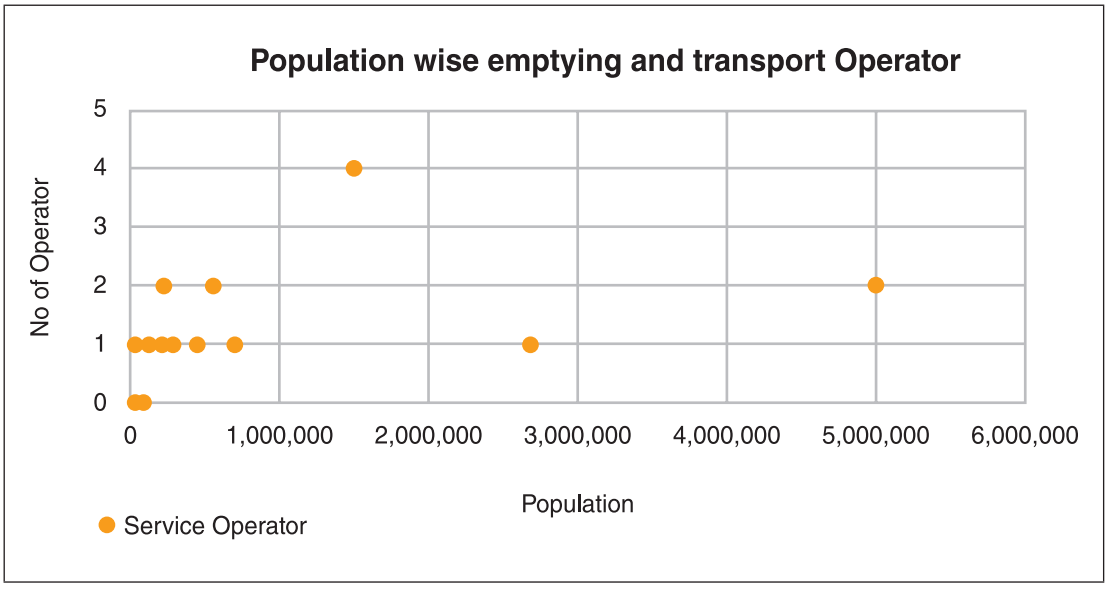


Figure 10: Structure of population wise Emptying and transport operators in Bangladesh.

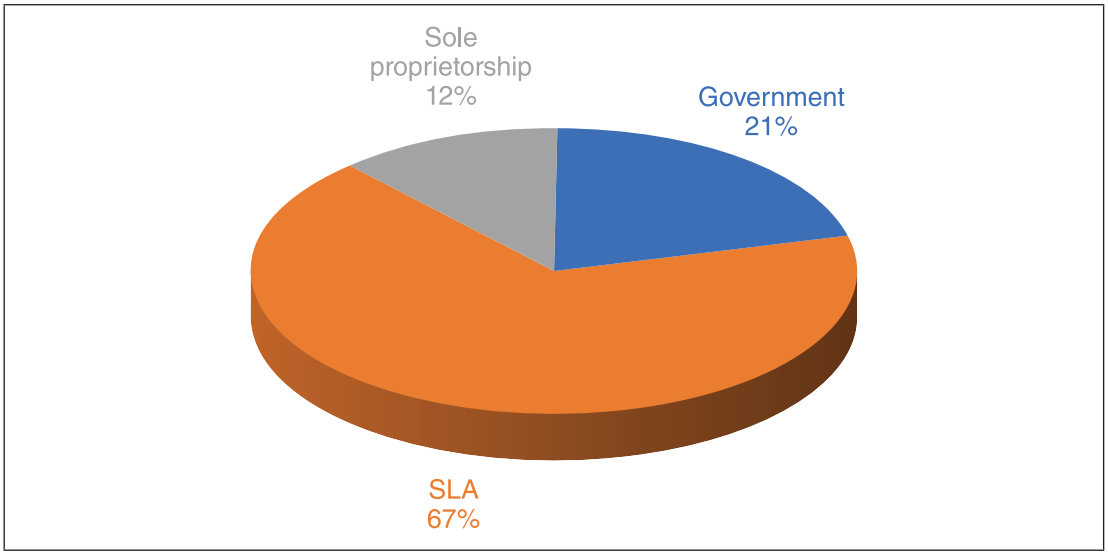


Figure 11: Legal Structure of Entities providing Emptying and Transport Services in Bangladesh.

The study found that the private sector gained knowledge and awareness on fecal sludge emptying & transport and was exposed to technologies for FS E&T. However, it also discovered some challenges of the private sector: (i) inadequate knowledge on financial transactions and viability of emptying business; (ii) lack of start-up capital; and (iii) uncertainty of the number of trips of emptying, which is directly related to profit.

FS emptying (e.g., scheduled desludging) could be one of the key interventions in addressing the above challenges, which would assure a certain number of emptying trips, resulting in increased cash flow, i.e., profit. This would ultimately mean a financially viable business plan, supported by borrowing start-up capital from a local market/financial institution.

3.1 Marketing and Pricing of Desludging Services

As previously said, developing an effective marketing plan for an emptying and transport operator is difficult. Because the emptying service occurs at irregular times, consumer recall and loyalty cannot be counted on. Because the need for the service develops at different times and in different areas, focused marketing is unsuccessful. These factors explain the widespread walls, trees, and electric poles with painted phone numbers, as well as miking in cities, a marketing tactic used by 60% of Bangladesh's service operators right now.

Entrepreneurs based in larger metropolitan areas, however, find this method ineffective and resort to newspaper advertisements, door to door campaign, digital texting, social media advertisement etc. As a result of these challenges, emptying and transport operator services remain essentially demand driven. Shown in figure 12. Most operators are bound to travel extra distances and very narrow road than usual to serve customers within the city. The operators' willingness to travel long distances to desludge OSS raises questions about their ability to set prices for full cost recovery and profit. There is no collection or a plan to charge any discharging/tipping fees at FSTP, and licensing fees; Sometimes the length of a trip depends on the location of the house/containment. It is surprising that fuel expenses are less than the maintenance expenses, which is because most of the vacutugs are getting old, which required higher maintenance costs. High maintenance requirements can consequently interrupt trips, which might affect the quality of emptying and transport services.

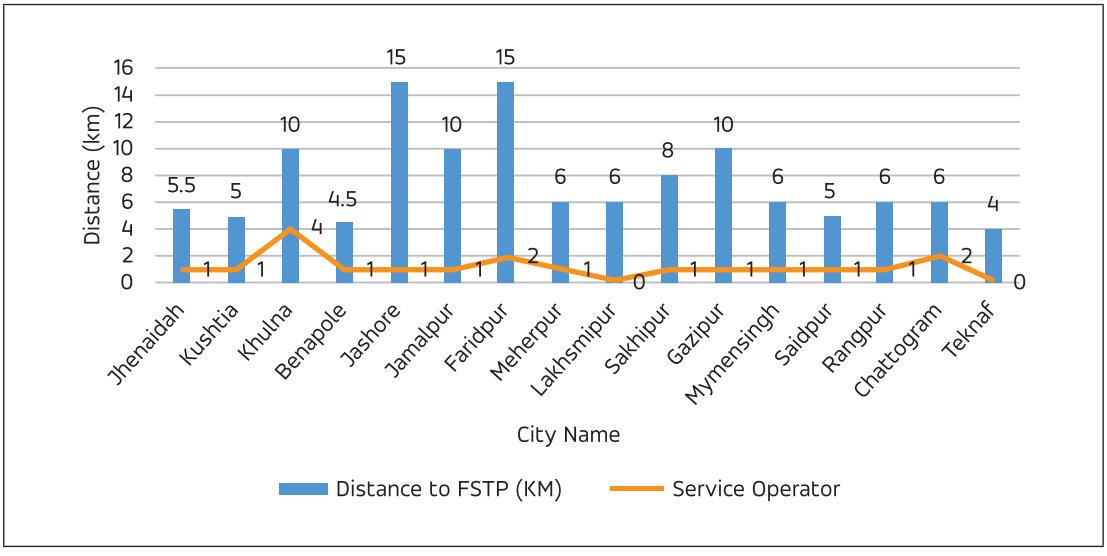


Figure 12: Maximum distance travelled by emptying and transport Operators to serve their clients.

3.2 Emptying and Transport operations

Time needed to D-sludge an OSS (On Site Sanitation):

The actual process of emptying a pit or septic tank seems to be relatively simple. Most operators shared anywhere between 10 to 40 minutes for the process. With thicker sludge, more time is needed, and the process can take up to 1-1.5 hours. To ease the operations for their workers, they usually using kerosine, water etc.

Types of desludging vehicles:

Vacuum tankers: These are trucks that use suction pumps to remove fecal sludge from pits or septic tanks.

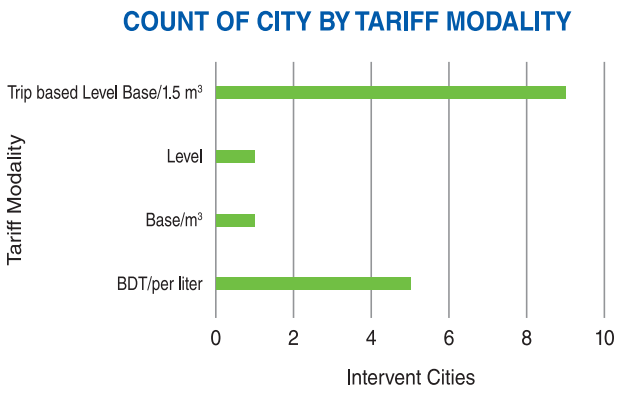
Manually operated equipment: These are devices that use manual pumps or hoses to extract fecal sludge, such as Gulper or Vacutug technology.

Manual tools: Manual emptying is performed generally in pits, using simple tools, such as buckets, spades, and ropes. Working in groups of 2–3, one emptier often climbs into a pit to empty it, while other(s) pass filled buckets to empty the contents nearby without using any personal protective equipment (PPE). Sizes of either type of vehicles are in the range of .8 to $7m^3$ by LGI's, with 1.5 to $2m^3$ being the most preferred size.

In the areas under study, both manual and mechanized emptying services are available. Manual emptying is typically carried out by informal sweepers, while mechanized services are offered by both the municipality and formal private operators. When it comes to manual emptying, households directly contact sweepers for the service. On the other hand, for mechanized emptying, households have the option to either call private operators or arrange for vacutug services through the Local Government Institution's (LGI) office. This process involves purchasing a booking voucher and making an upfront payment for the emptying service via a "challan" form (shown in figure 13). It is generally observed that users tend to prefer mechanized cleaning over manual cleaning due to the unpleasant odor associated with manual emptying and potential objections from neighbors. In terms of service providers, households show a preference for LGI services over private operators because LGI services are relatively more affordable and easier to access (many households are unaware of services provided by private enterprises).

Collected FS desludging sites and methods:

At present in Bangladesh 39 FSTP's are exist across the regions. Out of them, this document analyses fully operationalizing 16 municipalities FSM service delivery mechanism. Most the places found the landfill station or sloid waste dumping center near around the FSTP's. Following figure 14, Most of the municipalities have designated spots for emptying and transport operators to dispose of FS — typically isolated sites or open solid waste dump yards.



Tariff modality	Count of City	Category wise In BDT
BDT/per liter	5	R- 1.00/liter C-1.20 - 2.00/liter LIC- .50 -.60/litre
Level Based / m^3	1	R- 700.00 C-1050.00 LIC- 400.00
Level Based /1.5 m^3	1	R- 1500.00 C-2000.00 LIC- 500.00
Trip based	9	R- 700.00 -2500.00 C- 1300.00 - 2000.00 LIC- 400.00 - 500.00

Figure 13: Pricing band by City FSM Services in Bangladesh.

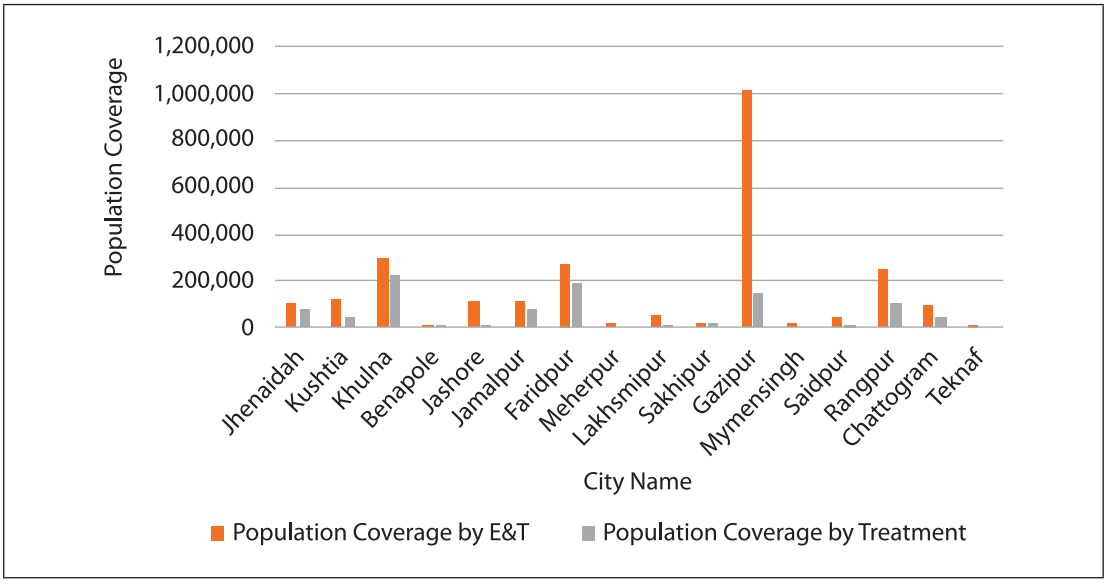


Figure 14: City wise Population coverage by emptying and transport with Treatment.

3.3 Key Issues in Emptying and transport

The emptying and transport sector is grappling with issues and challenges such as the distance to the household, distance to the designated disposal site, willingness of the operator to pay disposal fees, financial attractiveness of the business, and the challenges/ benefits of demand driven desludging. This section is based on the analysis of emptying and transport operators' responses in this context.

3.4 Measuring distance for Emptying and Transport Operations to FSTP Site

Major problem of FSM is lack of safe designated disposal sites after an OSS is emptied presently facing in Bangladesh. More than anticipated distance travelled with a full truck load is a non-value-added expense for the operator, and until the trucks empty, the next emptying service request merely be taken up. Hence, there is an opportunity cost associated with the time taken to dispose of the FS (Chowdhury S Kone. et al.). The emptying and transport operators are sensitive to these factors and prefer a distance of 05 km or less for disposal of FS.

In Table 1, the minimum and maximum distances are beyond standard statistical limits and hence can be considered outliers. The standard deviation (SD) is relatively low and shows that the variation in preferred distance is minimal. This preference is quite consistent across city population categories and probably reflects the tolerance limit in the profit margin. This has important implications for FSTP siting and/or tariff setting.

Table 1: Distance of emptying and transport operations to FSTP site.

Population Range	Average Distance	SD of Distance to FSTP (KM)	Min Distance to FSTP (KM)	Max Distance to FSTP(KM)
15000 - 50000	5.58	1.90	4	8
50000 - 150000	7.92	1.07	5	15
150000 - 500000	10.33	0.17	6	15
500000 & above	10	0	0	10

3.4.1 Profitability Assessment of Emptying and transport for FSM Business

Assessing the pricing strategies of emptying and transport operators is crucial before delving into profitability. From the above figure 13 illustrates that there is no straightforward correlation between the number of trips per truck per year and the price charged per trip. This is indicative of a typical market scenario where competition sets an upper price limit while the lower limit is determined by the necessary profit margin. It may also reflect customers' unwillingness to pay above a certain threshold. The figure further demonstrates that entrepreneurs managing between 650 and 1,500 trips and charging more than BDT 1,000 tend to remain profitable. Conversely, businesses running below 350 trips are at a higher risk of failure. Additionally, businesses that undertake a higher number of trips but charge less than BDT 700 typically operate at a loss. Therefore, both the volume of trips and the fee charged play pivotal roles in determining the overall health of the business. Figure 15 has shown an overall price per trip scenarios for FSM operators in Bangladesh.

When it comes to profitability analysis, one can consider factors such as gross or net profit margins, or even factor in the cost of deployed capital (which is currently not accounted for). Small entrepreneurs who self-finance their capital costs often overlook the need for returns on those funds and settle for operating profits that cover their lifestyle expenses. While most emptying and transport operators were hesitant to disclose exact profit figures, an average simulation was conducted to assess the feasibility of achieving predetermined profit levels. Data from field visits and desk reports were gathered for trips, pricing, and expense breakdowns. It was found that nine operators in the emptying and transport service generated sufficient cash flow for operators to earn a basic living, with only a few exceptional operators making substantial net profits. However, for the remaining seven service providers, recovering O&M costs appeared to be a significant challenge. This implies that as we move towards monitoring and reporting operators in each jurisdiction, it is imperative to establish minimum tariffs and ensure a guaranteed minimum number of emptying opportunities, thereby positively impacting the livelihoods of these competitive service providers.

As of June, 2023

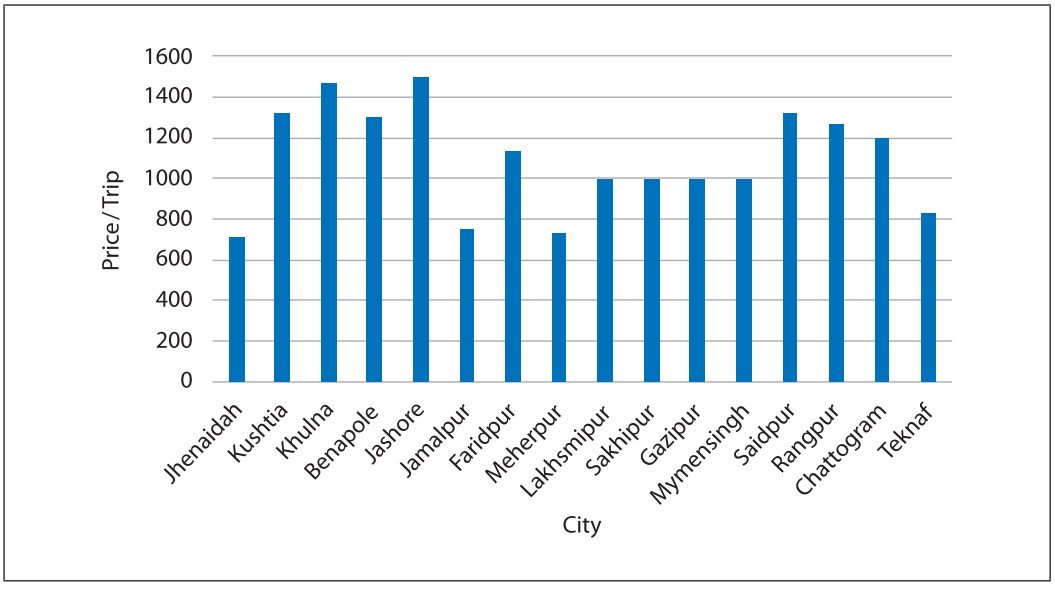


Figure 15: Price per trip of emptying and transport operators under FSM service in Bangladesh (As of June 2023).

3.4.2 Assessing the Impact of Scheduled Desludging on Emptying and Transport Operators

With the same pricing structure in place, does transitioning to scheduled desludging enhance the profitability of an emptying and transport operator? Implicitly, this question assumes that the current utilization of a typical truck is suboptimal, and that scheduled desludging would prompt households to increase the frequency of desludging. Recognizing that households may have limited motivation to do so, the service might be funded, for instance, through an added tax.

To validate this scenario, the disparity between peak and off-peak demand will be quantified for operators experiencing seasonal fluctuations. For those without seasonal variations, the average value of adjusted peak demand was employed. Instances where current utilization exceeded the average adjusted peak demand were excluded from the analysis. The findings indicate that scheduled desludging significantly enhances revenue due to an overall increase in the number of trips undertaken. With numerous trucks and sufficient FSTP/disposal capacity presently available, revenue stands to improve by 10% to 300% or more (subject to the number of containments in the area).

However, when factoring in operational costs, the gains are more moderate. This is primarily due to variable expenses like fuel constituting a substantial portion of the overall cost structure, leading to costs increasing proportionally with the number of trips. From a business standpoint, scheduled emptying results in heightened revenue, improved profitability, and a more consistent income stream.

Nonetheless, this does not imply that scheduled emptying should be universally implemented. The decision hinges on the characteristics of OSS in the area under consideration and should primarily be a technical determination. In summary, scheduled emptying is imperative for septic tanks (and, generally, for water-tight OSS structures with an outlet), while it remains optional for leach/soak pits. Given the tendency of many households to construct structures larger than necessary, the scheduled emptying interval should be carefully assessed before implementation.

Chapter 4: Financials of Treatment of Fecal Sludge

At the end of 2023, Bangladesh has about 39 FSTPs where 16 are now in fully under operation (Figure 15), another 74 number under construction, and over 60 FSTPs in various stages of procurement. The momentum for implementation of FSM started in 2017, triggered by the adoption of Institutional and Regulatory Framework for FSM (2017), and, later, National Action Plan for Implementation (2020) of FSM policies, guidelines, and regulations providing the road map of FSM p to 2030. The Sector partners advocacy efforts and Technical Support provided by DPHE, Local Government Division (especially CWIS-FSM Support Cell funded by the Bill & Melinda Gates Foundation [BMGF]) catalyzed an increase in the number of FSTPs across the country.

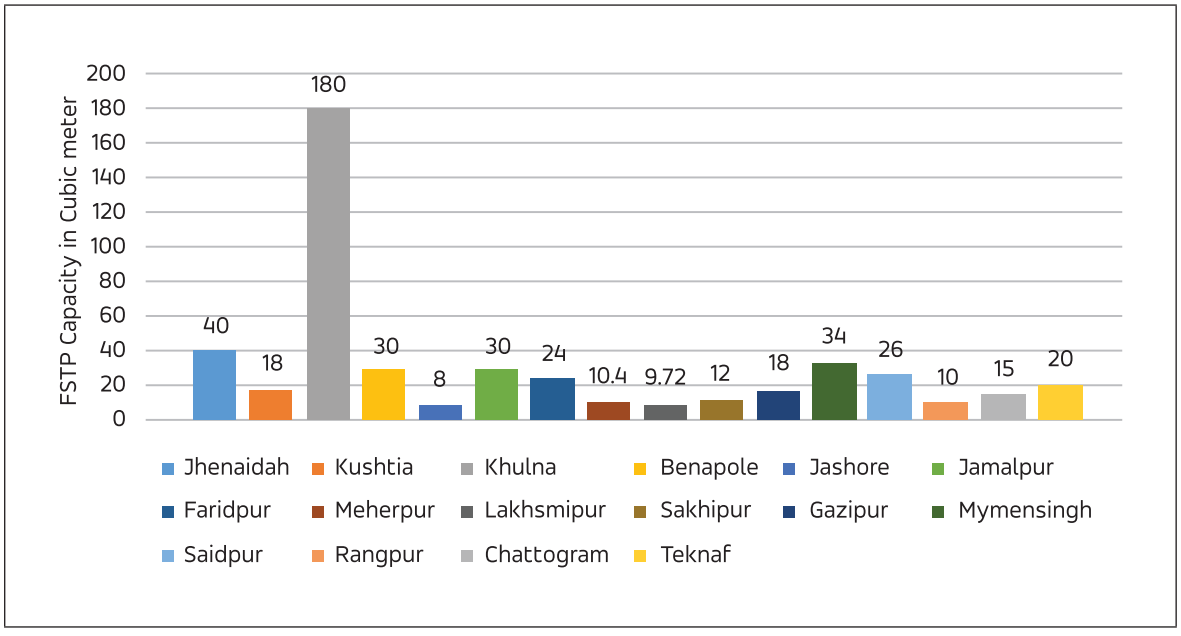


Figure 16: FSTP's In Bangladesh.

The analysis presented in this section is based on the 16 FSTPs that are in full operation and information obtained field survey, desk report and individual interviews with FSTP operators and LGI's, Stakeholders involved in establishing these FSTPs.

Given that the sector is nascent, most of the FSTPs commissioned were Donor supported/ funded and piloting projects, and recently Department of Public Health Engineering through different GOB-Donor supported projects standardize costs for the planning of future FSTPs. The evolution of FSTP technology will continue as the sector matures. The chapter presented Technology information, capital and operating cost of the technology, land area required for an FSTP, and potential for reuse to recover FSTP operational costs. Please refer to the Annex for key data points from the 16 FSTPs.

4.1 FSTP Treatment Technology

Passive treatment:

The technology used for solid-liquid separation, effluent treatment, and treatment of solids is a natural and biological process. Settling/thickening tanks and/or unplanted or planted drying beds are used for solid-liquid separation. Effluent is treated using aerobic/ anaerobic processes such as planted gravel filters, anaerobic baffle reactors, anaerobic filters, and sand filters. Solids are treated using composting, storage or solar/sun drying.

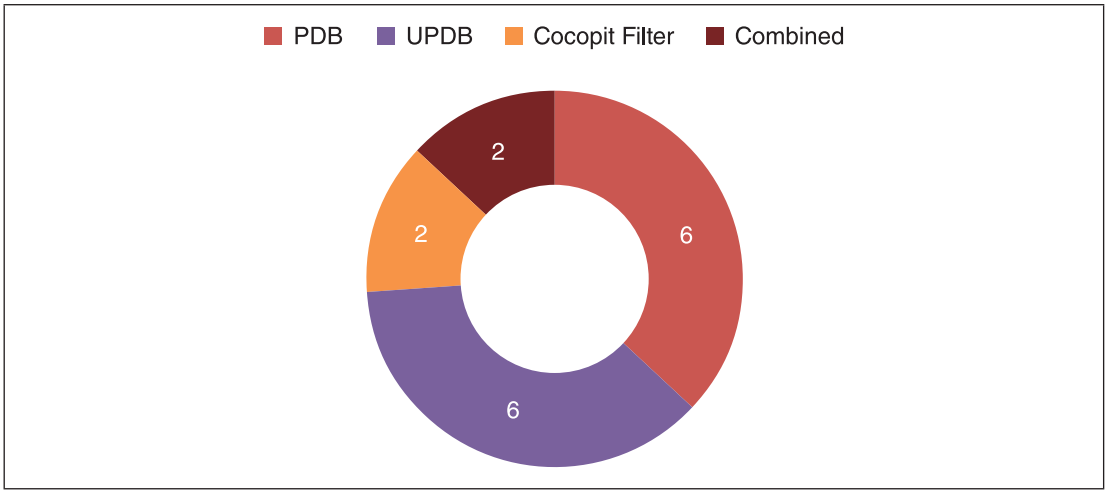


Figure 17: FSTPs by types of Treatment.

4.2 FSTP Funding Sources in Bangladesh

Financing of the capital and operating costs of 60% of operating FSTPs in Bangladesh is by donors funded – technically supported and public entities.

Capital cost: The FSTPs in operation have been implemented to demonstrate the concept and technology. Hence, the capital cost of almost all FSTPs has been financed through loans & grants. Most FSTPs are funded by public entities (e.g., municipalities or DPHE, LGED), followed by donors. The experience of private entities (Donor Supported) in financing the capital cost is not limited but to seven FSTPs – Kushtia, Jhenaidah, Khulna, Sakhipur, Rangpur, Chattogram and Teknaf.

Operating cost: Financing of the operating cost is mostly done by public entities. Donors/ Development Partners have provided financing in the form of grants for the first two to four years of FSTP operations. Thereafter, the FSTP operations are transferred to the municipality. Engaging private entities under PPP or SLA contracts to operate FSTPs seems to be the preferred mode. The private entity is given a performance-based contract for at least 5 years under agreed fees. Typically, the private entity has to pre-finance several months of working capital, as the payment from the municipality is rarely transferred on a monthly basis. The funding for the operating cost borne by the municipality typically comes from the municipal budget, sanitation tax levied, or funds from the Local government supported programs. FSTPs can generate revenue from the sale of reuse products (e.g., compost, biochar, briquette.). However, this revenue is very limited and usually, cannot cover the entire operating cost.

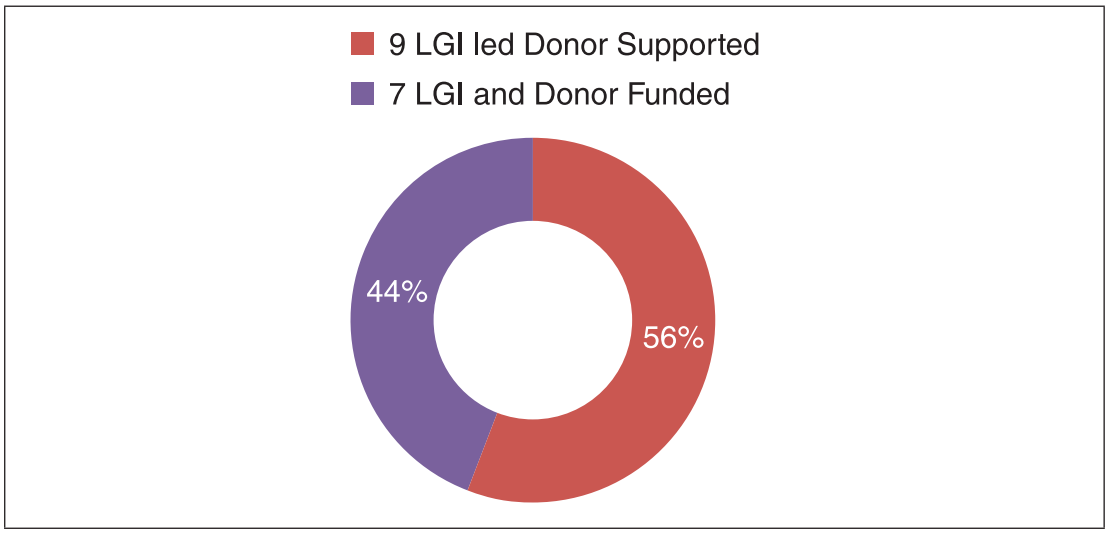


Figure 18: FSTPs BY CAPITAL COST FUNDING SOURCES in Bangladesh.

4.3 FSTP Capital and Operating Costs

The size of FSTPs installed varies from 8 to 180 m^3/month, and most of them are in the range of 8 to 10 m^3/day, serving populations of 30,000 to 50,00,000. The analysis presented here is constrained by the availability of granular data on the breakdown of costs and the specific resource requirements such as land, labor, skills, raw material inputs such as chemicals, and the actual maintenance cost of the plant.

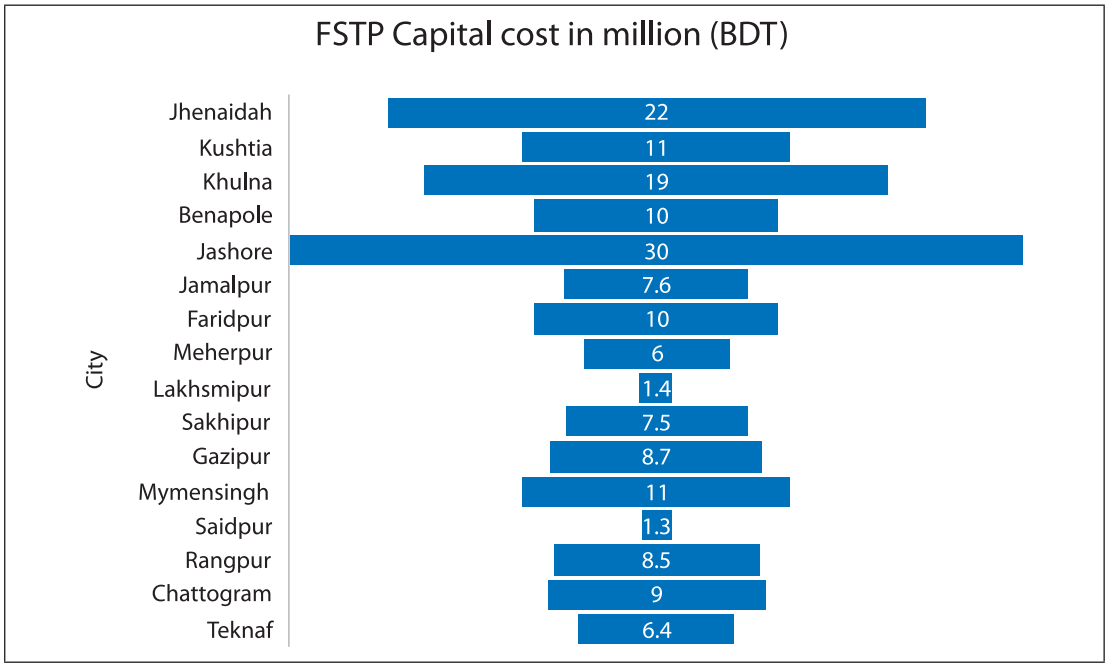


Figure 19: FSTP Capital Cost In million (BDT)

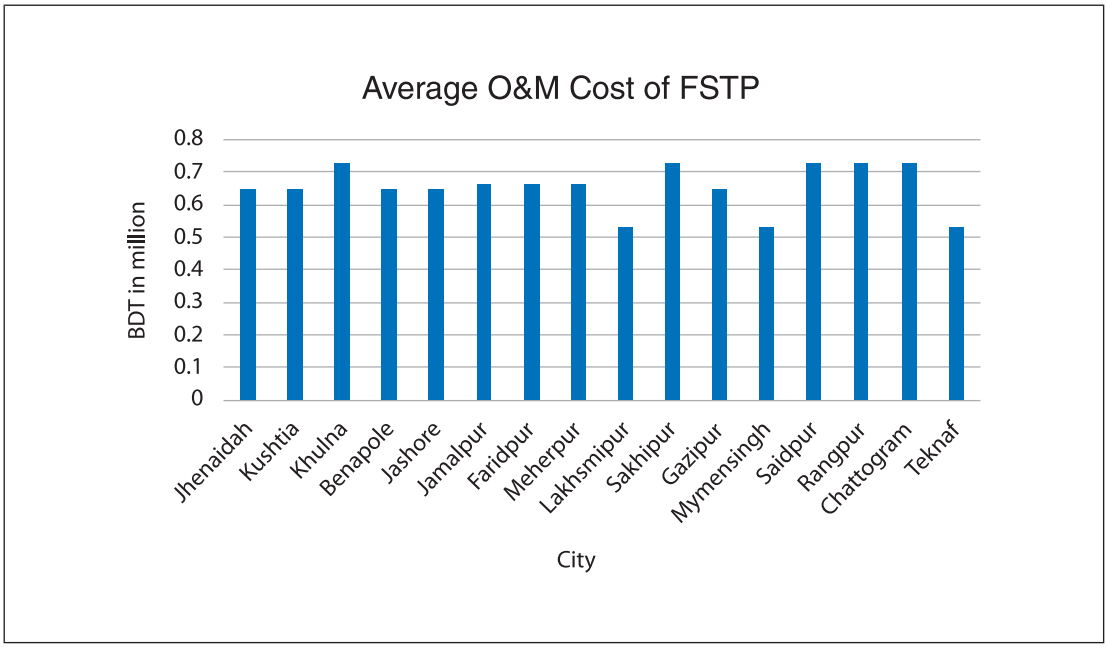


Figure 20: Average operation and maintenance Cost of FSTP's in Bangladesh.

4.3.1 Capital and operating costs of FSTP's

Following the figure 20, the analysis suggests that Planted FSTPs have the lowest capital and operating costs, followed by passive treatment. However, there is limited data or analysis available for Bangladesh in this regard, except for a few secondary sources. The assessment reveals that the life cycle cost of passive treatment (UPDB) is initially the highest expense, but it significantly decreases as treatment capacity increases. One notable challenge lies in the availability of data regarding the costs associated with boundary walls, office buildings and equipment, laboratories, engineering design, treatment units, ancillary facilities, and utilities. Additionally, information on actual utility costs, maintenance expenses, and labor required for ongoing treatment plant upkeep, landscaping, as well as the production, packaging, marketing, and sale of reuse products is essential. It is important to consider that the costs associated with landscaping and maintaining site aesthetics can contribute to higher capital and operating expenses when comparing observed costs for passive treatment systems. Furthermore, the value of the land is factored into capital expenditures. This is particularly pertinent as several of these plants have been established as demonstration facilities, with plans for scale-up underway or being considered in various municipalities.

4.4 FS Treatment for Reuse – Operational Cost Recovery

FS contains resources such as organic substances, plant nutrients and energy that can be recovered to offer monetary gain for the treatment plant. This can be revenue but also avoidance of disposal costs (if any). Over time, management of solids will become an issue in FSTP operations if solutions to either treat solids for reuse or dispose them appropriately are not incorporated. Similarly, the treated effluent in the FSTP needs to be managed if there is no waterbody nearby or means to discharge it safely. The quantity of treated effluent is typically not very high, and it can be used within the FSTP to water plants and trees. Figure 21 gives a snapshot of the resources recovered from FSTPs in Bangladesh. Most of the FSTPs do not have recovery of resources planned. The FSTPs that have incorporated reuse recover one or two of the resources, At FSTPs recovering nutrients, co-compost is sometimes produced onsite and sold to farmers – for example, in the cases of Sakhipur, Sakhi compost now receiving good feedback from the next-door farmers. The revenue from compost sales covers part of the operating cost which is very negligible still now. The price of compost and scale of operations influence operating cost recovery (Illustrated by table 2). The study does not consider investment in marketing and distribution of compost (See figure 22). Resource recovery from FS may not always make business sense; however, when considering externalities – benefits to soil and improved food, energy, and water security, reuse is highly valuable for the environment and economy. Moreover, even if a sludge-based compost or co-compost is sold under production value, the need to dispose of it safely would also have costs that resource recovery can reduce.

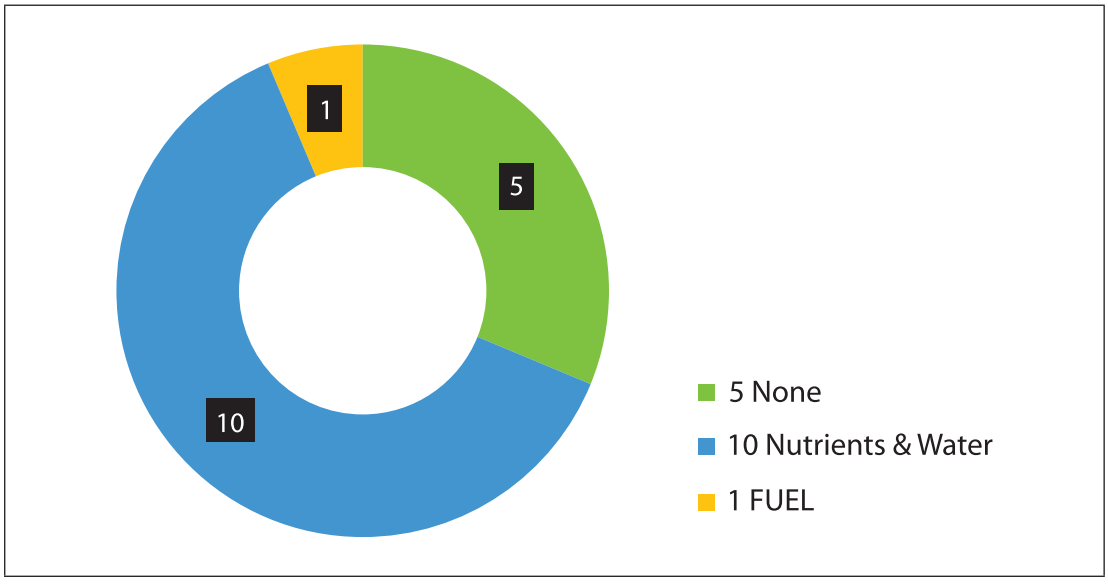


Figure 21: FSTP's by types of resource recovered in Bangladesh.

4.5 IWM Financials for FSTP's In Bangladesh

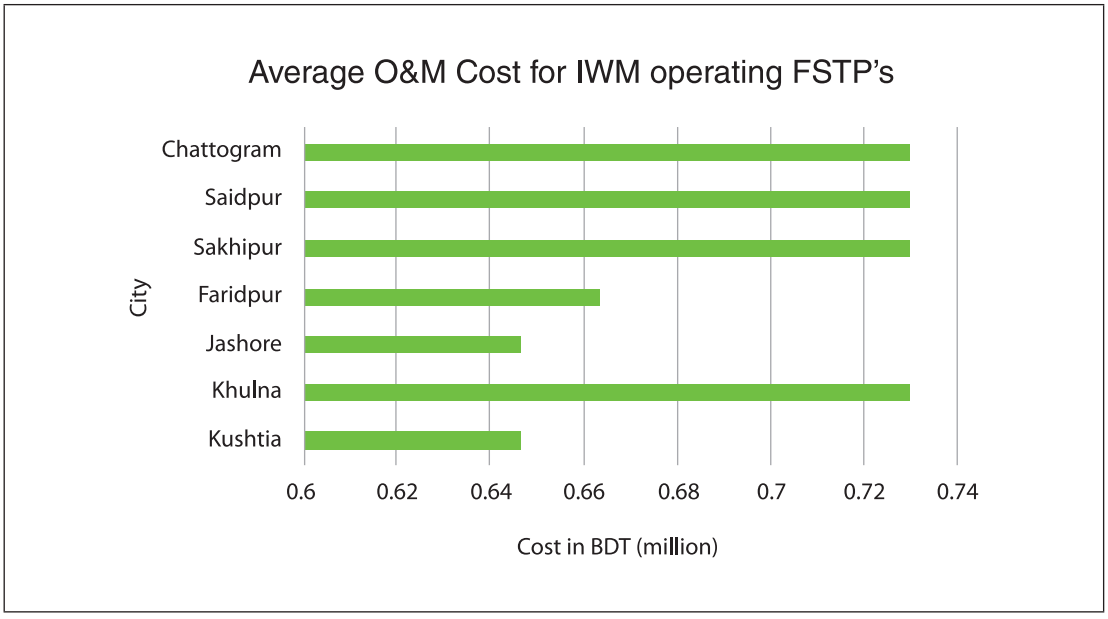


Figure 22: Average operation and maintenance cost for IWM operating FSTP's in Bangladesh.

Table 2: Operating cost recovery.

FSTP Location	Compost Price/kg	Cost recovery (%)
Kushtia	10	22
Khulna	10	2
Jashore	15	60
Faridpur	10	20
Sakhipur	15	23
Saidpur	16	29
Chattogram	15	9

Chapter 5: Key Takeaways for FSM in Bangladesh

Since 2016, Bangladesh has been piloting FSM in various ways. Several municipalities have now adopted FSM as their primary approach to sanitation. With Bangladesh poised to scale up FSM, it is imperative to draw lessons from the journey so far. A review of similar reports highlights the following key lessons:

There is a need for promotion of business opportunities to attract more private players, bundled contracts to attract larger private players, innovative financing mechanisms, customized contracting structures, and development of reuse markets (NAP, IRF, 2020).

There is a need for closing the loop by promoting reuse, which helps meet multiple SDGs and also has potential to serve as a source of revenue for the FSM business (WAB Report. 2017). Scheduled desludging needs to be advocated as a way to enable regular desludging, thus increasing the demand for emptying and transport operators and making desludging a public service (NWSS 2021; WAB Report. 2017).

This report, based on the analysis of execution of FSM business models, including the entire project cycle (planning, implementation, and operations) for successful scaling up of FSM across Bangladesh, lists the following recommendations:

Prioritize FSM to provide urgent sanitation needs:

Given that 39% of Bangladesh's population is dependent on OSS, FSM provides a rapidly scalable and lower cost option for providing basic sanitation coverage to all. FSM enables Bangladesh to achieve Target 6.2 of the SDG for safely managed sanitation. Hence, the central and state governments should prioritize FSM through allocation of financial resources under a specific time bound FSM mission. The FSM mission should be designed to ensure public health and environment outcomes and be inclusive of gender, disabled, and most vulnerable sections of the society.

Willingness to charge for treatment of FS: FSM has successfully demonstrated willingness to pay, by households for installation of OSS and for emptying and transport services. When it comes to treatment of FS, it is unclear if there is willingness to pay as there is no direct perceived benefit. Other sources of revenue for the FSTP, such as sale of reuse products are too low to cover the O&M costs. Therefore, the most suitable option is to collect user charges indirectly, such as through water bills or property tax (e.g., Kushtia, Jhenaidah), or directly through a specific sanitation user charge. There is a need for political will to charge for sanitation services and ring-fence budgets to gradually move away from the subsidization of O&M costs.

Incentives for operators emptying manually to purchase mechanical emptying and transport equipment:

The government should provide support to enable operators emptying FS manually (also known as manual emptiers/sweepers in Bangladesh) to upgrade their tools and invest in mechanical emptying equipment, thereby improving their livelihoods and ensuring increased safety.

Need for investment in behavior change: People relying on OSS have to be appraised of the benefits of desludging and treatment of FS collected. This will help municipalities raise tax revenues and, in the process, fulfil the Polluter Pays principle in FSM, especially to cover the O&M cost of FSTPs. The government needs to invest in creating awareness among citizens on FSM and payment for desludging and treatment services.

Promote reuse: Tenders should have emphasis on reuse; otherwise, they miss circular economy opportunities and possible revenue, while disposal of solids may become a serious issue and impact FSTP operations. One approach could be to amend the Soil Nutrients Standard Guidelines (SNSG) definition of city compost to include treated/composted FS (so called 'co-compost' or Integrated Waste Management), thus making it eligible for prevalent subsidies.

Standardization of tender documents:

FSM is a nascent sector, lacking standards and specifications, clarity on responsibility, degree of risk sharing, and so forth; thus, tender document standardization is needed. FSM projects are of smaller size but involve relatively complex technical solutions. In integrated Emptying and Transport and FSTP O&M contracts, the division of responsibility between the LGI's and the service provider should be well defined. The sector needs standardized procurement templates to ensure all elements of the bidding documents are addressed and well structured.

PART B

Description of Studied Business Models and Case Studies

Chapter 6. Business Model for Integrated Waste Management with Operation & maintenance plan

Globally, Bangladesh stands out as a country that has made remarkable progress in eliminating the scourge of open defecation. However, this success has created a 'second-generation' sanitation challenge of how to deal safety with the fecal sludge collected from pit latrines and septic tanks. As on-site sanitation solutions develop, the question of sustainable and inclusive fecal sludge management (FSM) business models is now at the heart of the challenge

in Bangladesh. This case study looks at existing Fecal sludge management service delivery mechanism towards a sustainable FSTP operationalizing through enterprise development, treatment, reuse and financial viability perspective, applying a holistic and multi-stakeholder focus. Based on good practices for FSM service provision in Kushtia, Faridpur, Sakhipur, including others successful examples demonstrate building the capacity of the public and private sector partners in operating safe FSM, to improve public health and provide business and labour opportunities. The examples illustrate good practices along the fecal sludge value and service chain, Institutional set up to engage stakeholders from start-up to scale-up in a viable way to serve poor households in urban Bangladesh. It is now considered by many to be a viable solution alongside sewer-based systems in achieving citywide inclusive sanitation, and fecal sludge treatment plants (FSTPs) are starting to be constructed across the country, this scaling up is urgently needed, as every year tons of fecal sludge are discharged directly into the environment. However, there is a lack of adequately functioning FSTPs, and a lack of information on operating FSTPs, upon which to base this scaling up. The key lessons from structuring FSM as a viable service and business include:

- Public sector ownership of the FSM system is strategic, and agencies should carefully consider the complexity of the political economy factors urban sanitation in changing contexts.
- Successfully engaging the private sector depends on viable business incentives that can be jointly designed for enterprises to crowd-in. Ultimately, an FSM service model should also be structured around the level of business competition and the potential among local cooperatives, / businesses to engage in human waste management.
- Mechanical FSM services can serve the poor and are viable in urban Bangladesh Providing that institutional support and appropriate differential pricing strategies are established by the private and/ or public actors with business development support, lower income consumers can be served without jeopardizing a company's bottom line.
- Finally, FSM as a viable service relies entirely on awareness raising and the capacity to generate sufficient and sustained demand from a varied customer base. For a public private partnership (PPP) which can be addressed in contextualize as Service Contract mechanism to be able to offer a strong framework in which multi-stakeholders can operate, an in-depth analysis of customers' demand, their willingness and ability to pay is essential in order to ultimately design models and tariff structures that enable the poor to access this service.

6.A Sustainable IWM Service Delivery Framework

The Municipality facilitated Community Led Service Contract Business Model is proposed by keeping in mind the following objectives: (a) to minimize the liability to the government and increased financial sustainability, (b) incentive's private players to provide services, and (c) ensuring that the local government plays the role of a regulator for delivering holistic integrated waste management intervention.

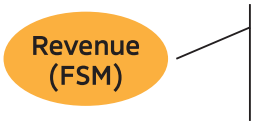
In this model, communities take an active role in combined waste management. It involves organizing local community groups or cooperatives that are responsible for solid waste as well as fecal sludge collection, transportation, and treatment in the designated FSTP. This model promotes community ownership, empowerment, and engagement in decision-making processes.

6.B Revenue Sources

The possible revenue sources for the different waste management interventions are following:

Service Operator/CBO's	Municipality/City Authority
1. Fecal Sludge Collection Fee 2. Solid waste Collection Fee 3. Sale of compost by co-composting 4. Tipping fee from FSTP (While Scheduled Desludging)	1. Royalty/month from service operator under service contract 2 Licensing fee/year 3 Sanitation tax/ scheduling desludging tax from city dwellers (based on monitoring mechanism/IMIS)

R1: Revenue from user fee for pit/septic tank emptying services



Tariff

Category	BDT/ Liter	Desludging service
HH	.75	On Demand
Commercial	1.00	On Demand
LIC	.40	On Demand

R2: Monthly revenue from DtD (door to door) solid waste collection

Collection

Category	BDT/Unit	Service
HH	50.00	Daily
Commercial	100.00	Daily
LIC	20.00	Daily

R3: Revenue from sale of Compost

BDT 10.00/kg

6.C Planning for periodic Operation and Maintenance (O&M) of Integrated waste Management Treatment Plant (IWMTP)/FSTP

In order to address the existing inadequacies in the IWM value chain, specific interventions will be required to be implemented in projected towns, in a time bound manner. The IWM plan presents the operating costs, potential revenue sources and operation plan for FSTP.

Table 3 : Operation & Maintenance (O&M) Cost for FSM & SWM Services (01 year)

SL. No.	Description of Items	Month	Unit Cost/ month (TK.)	Quantity (nos.)	Total Cost in BDT (01 Yr.)
1	**For SWM Manpower (Salary & benefits)**				1704000
	a) Supervisor	12	23000	1	276000
	b) Truck/ equipment Operators	12	23000	1	276000
	c) Helper	12	16000	2	384000
	d) Van operator	12	16000	3	576000
	e) Sweeper/ labor's	12	16000	1	192000
2	**Maintenance of Vehicles / Tools**				300000
	a) Maintenance of vehicles (Roller, Trucks etc.) – safety gears for drivers & operators, replacement of Tyers etc.	12	15000	1	180000
	d) Tools and equipment	12	10000	1	120000
3	**Operating Cost**				144000
	a) Fuel & Lubricants	12	12000	1	144000
4	**For FSM and STP Manpower (Salary & benefits)**				960000
	a) Supervisor (SAE)				
	b) Vacutag & Equipment drivers	12	16000	1	192000
	c) Helper	12	16000	1	192000
	d) Sweepers / Labours	12	16000	2	384000
	e) Office stuff	12	16000	1	192000
5	**Operating Cost**				1200000
	a) Fuel and Lubricants	12	15000	1	180000

	c) Repair & maintenance (plant)	12	15000	1	180000
	b) Electricity	12	50000	1	600000
	c) Repair & Maintenance (generator maintenance, lab test of STP sample, maintenance of screen sheet, filter materials, repayment of SDB roof sheets)	12	10000	1	120000
	d) Plant maintenance (replacement of Plasma cracking chamber)	12	10000	1	120000
	Total : Operation and Maintenance Cost for FSM & SWM Services (01 year)				**4,308,000**

It is assumed that that the vacutag, Dump truck and FSTP will operate, at not less than 80 percent of their capacity, always. The annual operation and maintenance costs for IWM and FSTP will be BDT 43,08,000.00 lakhs for Year 1.

Considering the above value, to operationalize the FSM and SWM services, the proposed tariff has given before and based on the tariff rate and field data on compost sale value total revenue will be generated for a year of BDT 4302000.00 while the O&M cost is proposing for BDT 4308000.00.

Which represents that 100.14% expenses will be incurred from revenue generation from 1st year for the municipality but from the next and onwards the service will be in positive and sustainable mannner. While analyzing the calculation of revenue generation, population growth rate 1.37% are considered on an average per year. Cost inflation 10% considered for every year, cost analysis including the depreciation rate assumed 8% as per present financial practices for project documentation. Below the are summary;

Items	**Yr- 1**	**Yr-2**	**Yr-3**	**Yr-4**	**Yr-5**	**Total Average**
Total Revenue Generation	4302000	5714346	6797104	8096629	9660631	34570709
Total Operation and maintenance Cost	4308000	4472400	4653240	4852164	5070980	23356784
% of Opex incurred from total Revenue	100.14	78	68	60	53	68

6.D Operation Plan of Integrated Waste Management Plant

6.D.1 Schedule of FS (Fecal Sludge) disposal in planted drying bed

Option-1

(Number of drying bed-03 ; duration of operation – minimum 01 year)

FS disposal cycle	Day	Disposal of FS from vacutugs to planted drying beds	Dry slude cake transfer from planted drying beds to co-composting plant	Cleaning and readiness of planted drying beds	Operation Day
Cycle-1	1	Bed-1			Saturday
	2	Bed-2			Sunday
	3	Bed-3			Monday
	4	Bed-1			Tuesday
	5	Bed-2			Wednesday
	6	Bed-3			Thursday
	7	Gap/Interval			Friday
	8	Bed-1			Saturday
	9	Bed-2			Sunday
	10	Bed-3			Monday
	11	Bed-1			Tuesday
	12	Bed-2			Wednesday
	13	Bed-3			Thursday
	14	Gap/Interval			Friday
	15	Bed-1			Saturday
	16	Bed-2			Sunday
	17	Bed-3			Monday
	18	Bed-1			Tuesday
	19	Bed-2			Wednesday
	20	Bed-3			Thursday
	21	Gap/Interval			Friday
	22	Bed-1			Saturday
	23	Bed-2			Sunday
	24	Bed-3			Monday

FS disposal cycle	Day	Disposal of FS from vacutugs to planted drying beds	Dry slude cake transfer from planted drying beds to co-composting plant	Cleaning and readiness of planted drying beds	Operation Day
Cycle-1	25	Bed-1			Tuesday
	26	Bed-2			Wednesday
	27	Bed-3			Thursday
	28	Gap/Interval			Friday
	29	Bed-1			Saturday
	30	Bed-2			Sunday
	31	Bed-3			Monday
	32	Bed-1			Tuesday
	33	Bed-2			Wednesday
	34	Bed-3			Thursday
	35	Gap/Interval			Friday
Cycle-2 to Cycle-10	Cycle-1 has to be repeated.				
Cycle-11	351		Bed-1		Saturday
Ce-12	352		Bed-2	Bed-1	Sunday
Cycle-1	353	Bed-1	Bed-3	Bed-2	Monday
	354	Bed-2		Bed-3	Tuesday
	355	Bed-3			Wednesday

Option-2

(Number of drying beds = 03, duration of operation = 01 year minimum)

FS disposal cycle	Day	Disposal of FS from vacutugs to planted drying beds	Dry slude cake transfer from planted drying beds to co-composting plant	Cleaning and readiness of planted drying beds	Operation Day
Cycle-1	1	Bed-1			Saturday
	2	Bed-1			Sunday
	3	Bed-2			Monday
	4	Bed-2			Tuesday
	5	Bed-3			Wednesday
	6	Bed-3			Thursday
	7	Gap/Interval			Friday

Cycle-1	8	Bed-1			Saturday
	9	Bed-1			Sunday
	10	Bed-2			Monday
	11	Bed-2			Tuesday
	12	Bed-3			Wednesday
	13	Bed-3			Thursday
	14	Gap/Interval			Friday
	15	Bed-1			Saturday
	16	Bed-1			Sunday
	17	Bed-2			Monday
	18	Bed-2			Tuesday
	19	Bed-3			Wednesday
	20	Bed-3			Thursday
	21	Gap/Interval			Friday
	22	Bed-1			Saturday
	23	Bed-1			Sunday
	24	Bed-2			Monday
FS disposal cycle	**Day**	**Disposal of FS from vacutugs to planted drying beds**	**Dry slude cake transfer from planted drying beds to co-composting plant**	**Cleaning and readiness of planted drying beds**	**Operation Day**
Cycle-1	25	Bed-2			Tuesday
	26	Bed-3			Wednesday
	27	Bed-3			Thursday
	28	Gap/Interval			Friday
	29	Bed-1			Saturday
	30	Bed-1			Sunday
	31	Bed-2			Monday
	32	Bed-2			Tuesday
	33	Bed-3			Wednesday
	34	Bed-3			Thursday
	35	Gap/Interval			Friday
Cycle-2 to Cycle-10	Cycle-1 has to be repeated.				
Cycle-11	351		Bed-1		Saturday
Cycle-12	352		Bed-2	Bed-1	Sunday
Cycle-1	353	Bed-1	Bed-3	Bed-2	Monday
	354	Bed-2		Bed-3	Tuesday
	355	Bed-3			Wednesday

Option-3

(Number of drying beds = 04, duration of operation = 01 year minimum)

FS disposal cycle	Day	Disposal of FS from vacutugs to planted drying beds	Dry slude cake transfer from planted drying beds to co-composting plant	Cleaning and readiness of planted drying beds	Operation Day
Cycle-1	1	Bed-1			Saturday
	2	Bed-2			Sunday
	3	Bed-3			Monday
	4	Bed-4			Tuesday
	5	Bed-1			Wednesday
	6	Bed-2			Thursday
	7	Gap			Friday
	8	Bed-3			Saturday
	9	Bed-4			Sunday
	10	Bed-1			Monday
	11	Bed-2			Tuesday
	12	Bed-3			Wednesday
	13	Bed-4			Thursday
	14	Gap			Friday
	15	Bed-1			Saturday
	16	Bed-2			Sunday
	17	Bed-3			Monday
	18	Bed-4			Tuesday
	19	Bed-1			Wednesday
	20	Bed-2			Thursday
	21	Gap			Friday
	22	Bed-3			Saturday
	23	Bed-4			Sunday
FS disposal cycle	**Day**	**Disposal of FS from vacutugs to planted drying beds**	**Dry slude cake transfer from planted drying beds to co-composting plant**	**Cleaning and readiness of planted drying beds**	**Operation Day**
Cycle-1	24	Bed-1			Monday
	25	Bed-2			Tuesday
	26	Bed-3			Wednesday
	27	Bed-4			Thursday

Cycle-1	28	Gap			Friday
	29	Bed-1			Saturday
	30	Bed-2			Sunday
	31	Bed-3			Monday
	32	Bed-4			Tuesday
	33	Bed-1			Wednesday
	34	Bed-2			Thursday
	35	Gap			Friday
	36				Saturday
	37	Bed-4			Sunday
Cycle-2 to Cycle-10	Cycle-1 has to be repeated.				
Cycle-11	371		Bed-1		Monday
Cycle-12	372		Bed-2	Bed-1	Tuesday
Cycle-1	373	Bed-1	Bed-3	Bed-2	Wednesday
	374	Bed-2	Bed-4	Bed-3	Thursday
	375	Gap			Friday
	376	Bed-3		Bed-4	Saturday
	377	Bed-4			Sunday

Option-4

(Number of drying beds = 04, duration of operation = 01 year minimum)

FS disposal cycle	Day	Disposal of FS from vacutugs to planted drying beds	Dry slude cake transfer from planted drying beds to co-composting plant	Cleaning and readiness of planted drying beds	Operation Day
Cycle-1	1	Bed-1			Saturday
	2	Bed-1			Sunday
	3	Bed-2			Monday
	4	Bed-2			Tuesday
	5	Bed-3			Wednesday
	6	Bed-3			Thursday
	7	Gap			Friday
	8	Bed-4			Saturday
	9	Bed-4			Sunday
	10	Bed-1			Monday
	11	Bed-1			Tuesday

Cycle-1	12	Bed-2			Wednesday
	13	Bed-2			Thursday
	14	Gap			Friday
	15	Bed-3			Saturday
	16	Bed-3			Sunday
	17	Bed-4			Monday
	18	Bed-4			Tuesday
	19	Bed-1			Wednesday
	20	Bed-1			Thursday
	21	Gap			Friday
	22	Bed-2			Saturday
	23	Bed-2			Sunday
	24	Bed-3			Monday
	25	Bed-3			Tuesday
FS disposal cycle	**Day**	**Disposal of FS from vacutugs to planted drying beds**	**Dry slude cake transfer from planted drying beds to co-composting plant**	**Cleaning and readiness of planted drying beds**	**Operation Day**
Cycle-1	26	Bed-4			Wednesday
	27	Bed-4			Thursday
	28	Gap			Friday
	29	Bed-1			Saturday
	30	Bed-1			Sunday
	31	Bed-2			Monday
	32	Bed-2			Tuesday
	33	Bed-3			Wednesday
	34	Bed-3			Thursday
	35	Gap			Friday
	36				Saturday
	37	Bed-4			Sunday
Cycle-2 to Cycle-10	Cycle-1 has to be repeated.				
Cycle-11	371		Bed-1		Monday
Cycle-12	372		Bed-2	Bed-1	Tuesday
Cycle-1	373	Bed-1	Bed-3	Bed-2	Wednesday
	374	Bed-2	Bed-4	Bed-3	Thursday
	375	Gap	Gap	Gap	Friday
	376	Bed-3		Bed-4	Saturday
	377	Bed-4			Sunday

6.D.2 Operating schedule of plasma gasification unit

03 operating schedules are mentioned below for proper utilization of plasma gasification unit capacity. This schedule is to be used based on the quantity of solid combustible waste,

Operating Schedule of Plasma Gasification Unit – 1 (Combustion 3 times in a week)

Day	Amount of Combustible Solid Waste Into Plant Daily (kg)	Amount of Cumulative Total Solid Waste (kg)	Operation day
1	800-1600	800-1600	Saturday
2	800-1600	1600-3200	Sunday(combustion)
3	800-1600	800-1600	Monday
4	800-1600	1600-3200	Tuesday(combustion)
5	800-1600	800-1600	Wednesday
6	800-1600	1600-3200	Thursday (combustion)
7	Gap/Interval		Friday
8	800-1600	800-1600	Saturday
9	800-1600	1600-3200	Sunday(combustion)
10	800-1600	800-1600	Monday
11	800-1600	1600-3200	Tuesday(combustion)
12	800-1600	800-1600	Wednesday
13	800-1600	1600-3200	Thursday (combustion)
14	Gap/Interval		Friday
15	800-1600	800-1600	saturday
16	800-1600	1600-3200	Sunday(combustion)
17	800-1600	800-1600	Monday
18	800-1600	1600-3200	Tuesday(combustion)
19	800-1600	800-1600	Wednesday
20	800-1600	1600-3200	Thursday (combustion)
21	Gap/Interval		Friday
22	800-1600	800-1600	saturday
23	800-1600	1600-3200	Sunday(combustion)
24	800-1600	800-1600	Monday
25	800-1600	1600-3200	Tuesday(combustion)
26	800-1600	800-1600	Wednesday
27	800-1600	1600-3200	Thursday (combustion)
28	Gap/Interval		Friday
29	800-1600	800-1600	saturday
30	800-1600	1600-3200	Sunday(combustion)

Operating Schedule of Plasma Gasification Unit - 2 (Combustion twice in a week)

Day	Amount of Combustible Solid Waste Into Plant	Amount of Cumulative Total Solid Waste (kg)	Operation day
1	800-1600	800-1600	Saturday
2	800-1600	1600-3200	Sunday
3	800-1600	2400-4800	Monday (combustion)
4	800-1600	800-1600	Tuesday
5	800-1600	1600-3200	Wednesday
6	800-1600	2400-4800	Thursday (combustion)
7	Gap/Interval		Friday
8	800-1600	800-1600	Saturday
9	800-1600	1600-3200	Sunday
10	800-1600	2400-4800	Monday (combustion)
11	800-1600	800-1600	Tuesday
12	800-1600	1600-3200	Wednesday
13	800-1600	2400-4800	Thursday (combustion)
14	Gap/Interval		Friday
15	800-1600	800-1600	Saturday
16	800-1600	1600-3200	Sunday
17	800-1600	2400-4800	Monday (combustion)
18	800-1600	800-1600	Tuesday
19	800-1600	1600-3200	Wednesday
20	800-1600	2400-4800	Thursday (combustion)
21	Gap/Interval		Friday
22	800-1600	800-1600	Saturday
23	800-1600	1600-3200	Sunday
24	800-1600	2400-4800	Monday (combustion)
25	800-1600	800-1600	Tuesday
26	800-1600	1600-3200	Wednesday
27	800-1600	2400-4800	Thursday (combustion)
28	Gap/Interval		Friday
29	800-1600	800-1600	Saturday
30	800-1600	1600-3200	Sunday

Operating Schedule of Plasma Gasification Unit – 3 (Combustion 1 time per week)

Day	Amount of Combustible Solid Waste Into Plant	Amount of Cumulative Total Solid Waste (kg)	Operation day
1	800-1600	800-1600	Saturday
2	800-1600	1600-3200	Sunday
3	800-1600	2400-4800	Monday
4	800-1600	3200-6400	Tuesday
5	800-1600	4000-8000	Wednesday
6	800-1600	4800-9600	Thursday (combustion)
7	Gap/Interval		Friday
8	800-1600	800-1600	Saturday
9	800-1600	1600-3200	Sunday
10	800-1600	2400-4800	Monday
11	800-1600	3200-6400	Tuesday
12	800-1600	4000-8000	Wednesday
13	800-1600	4800-9600	Thursday (combustion)
14	Gap/Interval		Friday
15	800-1600	800-1600	Saturday
16	800-1600	1600-3200	Sunday
17	800-1600	2400-4800	Monday
18	800-1600	3200-6400	Tuesday
19	800-1600	4000-8000	Wednesday
20	800-1600	4800-9600	Thursday (combustion)
21	Gap/Interval		Friday
22	800-1600	800-1600	Saturday
23	800-1600	1600-3200	Sunday
24	800-1600	2400-4800	Monday
25	800-1600	3200-6400	Tuesday
26	800-1600	4000-8000	Wednesday
27	800-1600	4800-9600	Thursday (combustion)
28	Gap/Interval		Friday
29	800-1600	800-1600	Saturday
30	800-1600	1600-3200	Sunday

Table 4: Calculation of electricity cost for operation & maintenance of Plasma Gasification Unit

Name of Unit	Workload (KW)	Daily Operation (Hour)	No. of operating days /month	Total Consumable Unit (KWH or BOT unit)	Cost/ unit (BDT)	Total Cost in BDT
Plazma Gasification Unit	12	8	12	1152	12	13824
	12	8	8	768	9	6912
	12	8	4	384	9	3456

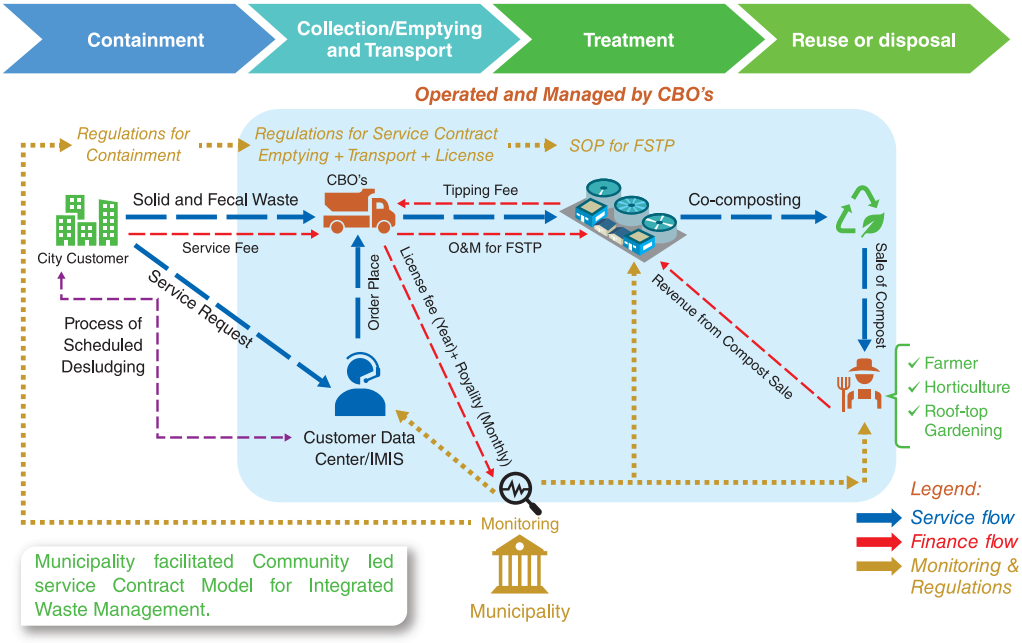


Figure 23: Proposed financial flow and service flow diagram for Integrated Waste Management in Bangladesh

6.E Service Delivery mechanism

In this model, Private Operator or Cooperative society will engage through Service Level Agreement with concerned LGI's where a certain percentage of royalty from monthly service fee/income will get from service providers under the agreement for

5-10 years (Figure 23). Service provider will directly collect the SW(Solid Waste) and on demand FS emptying which will be monitored by Municipality by its authorized department (conservancy/ City Planning/Mechanical) through remotely / in digital systems (Call centers/IMIS) which will ensure the safe and transparent accountability on city Waste management service smoothly. SW and Fecal Sludge collection fee will be collected directly by the operators and monitored directly through municipality information systems by monthly basis. Service operators will also operate the Treatment plant by their own management where Municipality will be monitoring through regulations & SOP aspect. Lumpsum of maintenance for TP site can be disbursed from LGI's as per contract agreement (on condition basis). FSTP operation and Maintenance (O&M) cost will be incurred partially by selling the compost to relevant customers at city level.

Under the CWIS Framework, this LGI's facilitated Community led service contract model will ensure the indicators as below;

- Service Operators will be licensed by the city authority for ownership of assets and city service accountability
- Municipality will provide the OHS training to service operators on safety compliance to ensure the safety and equity phenomena.
- Municipality will oversee the entire operation and & Management of SWM and FSM= FSTP Management according to the national guidelines/(IRF and NAP) and SOP which will comply the responsibility to sustainability for IWM.

Regular waste service providing through the monitoring under Municipality Call center or Integrated Municipality Information systems will be able to fostering the Schedule desludging process which will confirm the sustainability of financial resources to service operators as well as municipalities continues elegant support to establish green city concept.

6.F Key Propositions for Sustainable IWM service Plan

Cities need to move more towards scheduled desludging due to its many advantages:

Current practice of on-demand desludging through private operators or municipalities is the most prevalent model across cities and states in Bangladesh. However, scheduled desludging is needed to ensure regular and timely desludging as per norms due to it has many advantages:

- achieves inclusive and equitable services covering all residential and non-residential properties, including the poor;

- can help reduce costs due to efficiency gains;
- can lead to positive environmental impact;
- removes the need for manual labour; and can help to build a good database on real situation of onsite facilities.

In scheduled desludging, it is easier to collect revenues through specific sanitation taxes rather than user charges, as users may not be willing to pay at the time of collection when there is no urgent need.

6.F.1 Limited need for government investment, but CSR and impact investment can help demonstrate mechanical emptying models that helps to achieve the SDG 6.2:

In conveyance, capex funding can be typically provided by private players in both demand and scheduled desludging practices. Cost recovery is typically from specific taxes, tariffs or user charges, with rare instances of government grants or philanthropic funds. Business models in conveyance can therefore be viable (and profitable for private players), with limited requirement for non-commercial assistance.

6.F.2 Preferable option from government perspective:

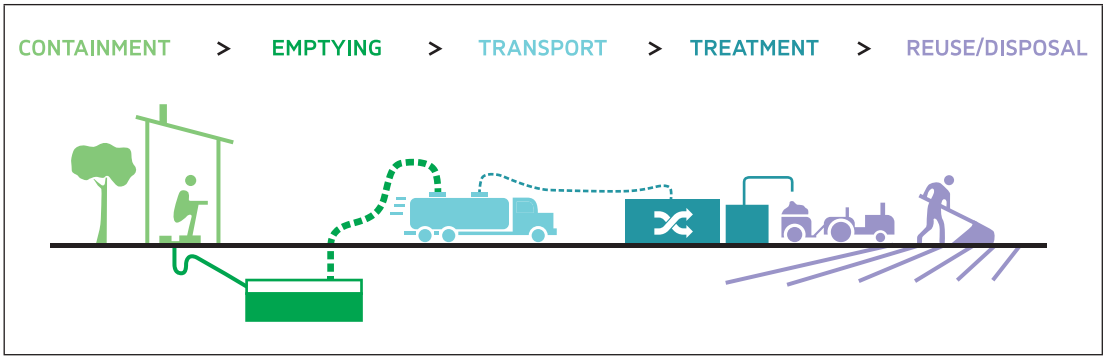
From the LGI perspective a single operator for Emptying-Transport and Treatment may imply ease and simplicity of reporting and monitoring, Limited number of private players for integrated options

Currently there are limited private players who have capacity to manage both emptying and transport (E&T) and treatment operations. Integrated approach will require to cultivate partnerships among players in treatment and desludging to work together.

Thus, from the perspective of private operators, integrated contracts maybe be difficult as very few private enterprises are in both areas of business, and thus they have to take on work which may not be their forte, or form consortia.

In this process, it may lead to crowding out of expertise of smaller independent service providers. Community led service contract model is a vital service delivery model in this respect.

Sanitation Value Chain



6.1 Model A: Public Sector Led Model- Municipality owned and Operate

Under this model, the government takes the lead in providing fecal sludge management services. This can involve the establishment of treatment plants, collection services, and operation and maintenance of the entire system. The government may allocate funds for the construction and ongoing operation of the facilities and employ trained personnel to manage the operations.

6.1.1 Economic Value Propositions

- Improved Sanitation and Public Health
- Regulatory Compliance
- Job Creation and Local Economic Development
- Separate Sanitation budget formation
- Reduced Dependency on Informal Service Providers
- Integration with Urban Planning
- Access to Financing and Technical Support from Development Partners.

Lakhsmipur
Teknaf
Mymensingh

6.1.2 Case Study: Lakhsmipur Municipality

The first initiative to implement FSM in Bangladesh was under the Secondary Towns Water Supply and Sanitation Sector Project (STWSSP) from 2006 to 2014, executed by the Department of Public Health Engineering (DPHE). The Asian Development Bank (ADB) approved the STWSSP with co-financing from the OPEC Fund for International Development (OFID). From the 16 project municipalities, or Pourashavas, Lakhsmipur showed strong political will to implement an improved FSM system. The commitment of the Mayor of Lakhsmipur Pourashava played a vital role in successfully building a fecal sludge treatment plant (FSTP) under the Government of Bangladesh and ADB funded project. The FSTP was established during Phase 2 of the project with a trial run in December 2012. The plant was set up by DPHE and handed over to the Pourashava after construction in 2014.

6.1.3 Treatment

The implemented Fecal sludge treatment plants are the conventional sludge drying beds with simple impermeable beds filled with different layers of gravel and sand including planted vegetation for evapotranspiration which enhance the drying phenomenon. Planted drying beds do not need desludging before each new application / loading of sludge as root system of the plants maintains the permeability of the beds. _e constructed treatment plant at required around 0.30-acre land area which consists of two beds for alternative use. Each bed consists of 144 m2 area and has been designed to run around 5-7 years i.e. waste water and septage sludge can be disposed in a bed continuously 5-7 years with septic tank emptying interval 2-3 days per week. Currently, the Fs collection is about 22 m^3 per month. The liquid effluent generated from the plant is reported to satisfy the national discharge standards and are discharged into open environment. End-use of treated sludge has not yet been considered and there is no data on the quality of compost or dried sludge produced at the treatment plant.

6.1.4 Service Delivery Mechanism

In Lakhsmipur municipality, people usually desludge their septic tanks/pits when they overflow; some also reported desludging at fixed regular interval. The municipality introduced mechanical desludging service in 2013, and many people are availing this service. The municipality has received three mechanical desludging equipment (Vacutug) from the Secondary Town Water Supply and Sanitation Sector project (funded by the GoB and ADB) run by DPHE. When a customer places his/her demand of emptying Septic tank.

The present service offered by the Pourashava charges BDT 500 to 1000 (excluding cost of salt, kerosene, bamboo, rope, etc.) per trip that means BDT 1 /liter. Customer has segmented in 3 categories; HH, Commercial and LIC. It involves applying and paying the fee, after which the service would be offered in 1-3 days. However, the extent of service at this stage is limited; more resources would be required to expand the service. People also avail manual desludging services, especially in areas inaccessible by Vacutug; manual desludging is slightly cheaper than the mechanical service.

Figure 24: Lakhsmipur- Desludging vehicle and planted drying bed.

6.1.5 Financial and Business Model

The cost of plant construction and technical assistance was provided by the STWSSP but the operation and maintenance cost is now borne by the Pourashava who also provided the access road and the land for the treatment plant. The Pourashava is responsible for tariff collection and for the desludging services including employment of the Vacutug operators (who also collect solid waste). The service charge collected per week is about USD 125 and USD 18,500 was collected from customers since the beginning of the operation of the plant. The operation and maintenance cost of the Vacutug is stated to be around USD 15 per week: the main cost is the fuel as the plant does not require much maintenance. The business model for the FSM operations is not developed and there are no plans from the Pourashava to enhance the efficiency and coverage of FSM services and performance of the treatment plant due to lack of external funding. It is difficult to assess the financial sustainability of the model, given the lack of information.

6.1.6 Remaining Challenges

Collection of fecal sludge: Lack of access of Vacutugs to difficult areas affects coverage and service levels especially for the poorest.

Availability of spare parts: Spare parts are not available locally for Vacutugs procured during the project.

Demand for de-sludging low: Since the project initiation, there has not been any strategic demand creation and convincing people to use the new services has been challenging. The demand is low, with average of one trip/day.

Monitoring: There is currently limited performance monitoring of the plant.

Reuse: very low considered yet. Social stigma and habitual unacceptance of new approaches have proven to be a challenge in considering the reuse of dried sludge.

Lack of capacity: Municipality staff (technical, managerial, financial) do not have the necessary skills to sustain FSM interventions (increase coverage, operation and maintenance and monitoring performance of the treatment systems). The technical assistance unit of the external partner could help to build capacity in these areas before transferring operational responsibility.

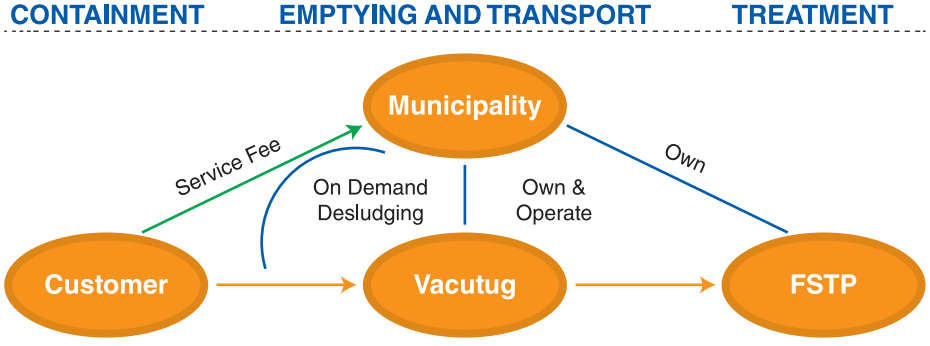


Figure 25: FSM Service Delivery Framework in Lakhsmipur.

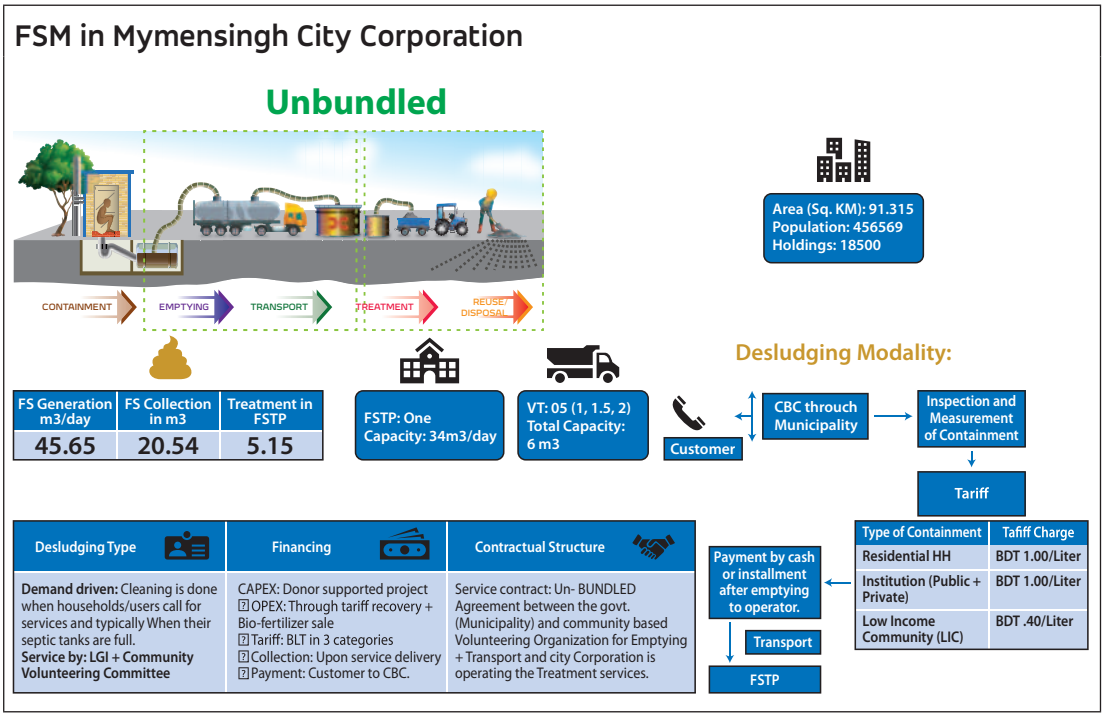


Figure 26: FSM In Mymensingh City Corporation.

Figure 27: Construction of Planted drying bed at Mymensingh City Corporation, FSTP.

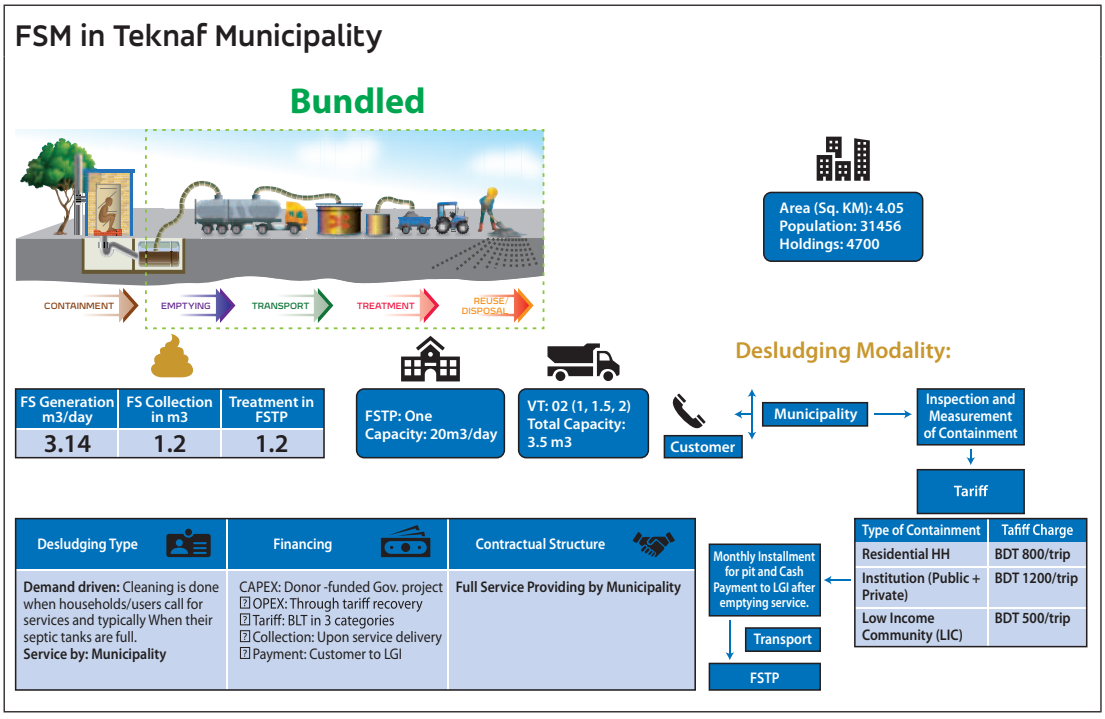


Figure 28: FSM In Teknaf Municipality

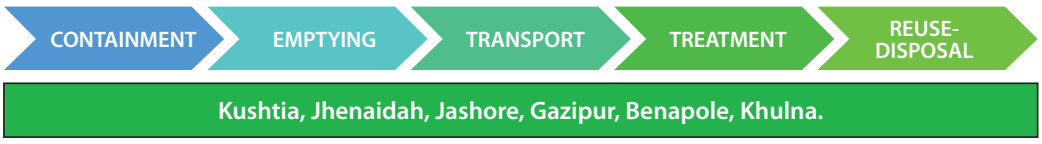
Figure 29: Virtual FSTP diagram of Teknaf Municipality.

6.2 Model B: Public-Private Partnership Model (PPP)

PPP models involve collaboration between the government and private sector entities. The government provides the policy and regulatory framework, while private companies or entrepreneurs are responsible for implementing and operating fecal sludge management services. This model can bring together the strengths of both sectors, including public oversight and private sector efficiency.

6.2.1 Economic Value Propositions

- ✧ Leveraging efficiency in Service Delivery often leads to cost-effective and well-managed operations.
- ✧ Invest in infrastructure and technology upgrades, leading to improved service quality and coverage.
- ✧ Cost Sharing reducing the strain on government budgets.
- ✧ Revenue sharing mechanism and Cost Recovery.
- ✧ Risks associated with operations, such as fluctuations in demand or technical challenges, can be shared between the public and private partners, reducing the overall risk for both parties.
- ✧ Technology Transfer and Innovation, which can lead to better waste treatment and management practices.
- ✧ Improved Asset Management
- ✧ PPP models can facilitate the scalability and expansion of FSM services to underserved areas, improving sanitation coverage in urban and peri-urban regions.
- ✧ Compliance and Accountability ensuring that private partners adhere to quality standards and regulatory requirements.



6.2.2 Case Study: Kushtia Municipality

Kushtia FSTP is located about 5 [km] west from the city centre (coordinates: 23.911983, 89.094932). This is the only sludge treatment facility in the city, which is fully relying on onsite sanitation. It was initially established as a composting plant in 2008 but was later extended as an FSTP in 2012. Waste Concern designed it and the local government, SNV and UNESCAP funded the construction. The FSTP started operation in 2012 and was designed for a capacity of 9 [m^3/d]. The treatment consists of two sludge holding tanks followed by two unplanted drying bed. Each bed is divided into four compartments. The leachate is treated in two parallel semi-mechanized coco-peat filters and the dried sludge is co-composted with organic waste in the composting plant.

6.2.3 Service Delivery Mechanism

The municipality owns the FSTP and three small vacutugs (1, 2 and 4 [m^3]). The municipality has delegated its operation to ERAS. The municipality is responsible for sludge collection and transportation to the FSTP and strictly monitor where their trucks discharge or dump the collected sludge. The households pay fixed emptying fees to the municipality.

6.2.4 FSTP Treatment

Designed cycle: 25 to 36 days Design capacity: 18 [m^3/d]			
Days		Operation details	
SHT (1)	0.2–0.5	Several loading (1–4 [m^3] per load) per day	This cycle is repeated until the drying beds are full (15–21 days).
0.2–2		Short settling (1–2 hours) after each load. The sluice gates are opened and the sludge flows to the UDBs (beds 1 to 4). The settled solids are emptied after a further drying of up to 2	
10–15		Resting period, while the other line of the treatment is used	
UDB (2–5)	15–21	Loading period with several loading per day. The sludge flows until the last one.	
0.2–21		Drying cycle: In general, the sludge is shoveled out as soon as it can be. Bed 4 is emptied before each new loading; Bed 2 and 3 are emptied typically once or twice per week; Bed 1 is not emptied during loading period but after 15 to 21 days of drying when the alternate line is loaded.	
1		Emptying and cleaning	
0–15		Resting period, while the other line of treatment is used	

Operating cycle: 7 to 25 days Receiving volumes: 0–18 [m^3/d]

The design and operating loading cycles are similar with the exception that receiving volumes are on average lower than design. However, the operator indicated that the FSTP could not take more sludge and is regularly refusing discharge to trucks coming at the FSTP.

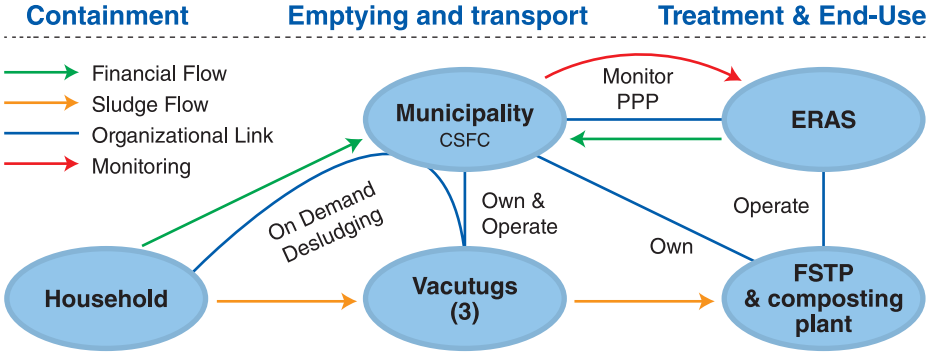


Figure 30: FSM Service Chain Diagram for Kushtia Municipality

6.2.5 Remaining Challenges

Although Kushtia has a higher emptying rate than other visited municipalities in Bangladesh, a major portion of the emptied sludge is still being dumped directly into the environment. Main challenges include difficulties in enforcing legal discharge of sludge at the dedicated sites (i.e. the FSTP or two new trenches), and that there is not adequate capacity at the FSTP. The FSTP has a unique design, and is difficult to operate based on O&M Costing.

Figure 31: FSTP of Kushtia Municipality

Photo Courtesy: Kushtia Municipality and CWIS-FSM Support Cell, DPHE.

6.2.6 Case Study: Jhenaidah Municipality

Jhenaidah FSTP is located 5.5 [km] west from Jhenaidah city centre, in (coordinates: 23.548868, 89.121251). It was first constructed through a DPHE project in 2014 and then refurbished by SNV with funding from BMGF in 2016.The FSTP started operation January 2017 and was designed for a capacity of 36 [m^3/d]. The municipality is fully relying on onsite sanitation and this is the only FSTP. The treatment consists of five planted and three unplanted drying beds. The leachate is treated in two parallel horizontal flow constructed wetlands and the dried sludge is stored in a storage shed. The unplanted drying beds are not in use.

6.2.7 Service Delivery Mechanism

In Jhenaidah two types of emptying services are being practiced. First, AID foundation (local NGO) has been providing emptying, transportation and treatment service through 2 vacutug. Second, manual emptiers, belongs to harijan community, provides emptying service through generation.

1. AID Foundation Operated Mechanical Service

AID provides mechanical emptying service to citizen through 2 vacutugs following same tariff structure which Paurashava fixed earlier. Any citizen can take this service

by filling up a form to provide information about the pit/septic tank size, road size in front of house, machine to pit/septic tank distance etc. along with submission of the form, applicants has to submit pay-order issued from a local bank in favor of AID. Then, a supervisor visits the home to validate all the information of the application form within 24 hours. After the supervisor gives the go ahead, the vacutug truck reach the client's home within 48 hours. After sludge is pulled out from the storage, it is transported to the treatment plant.

2. Manual Emptier Provides Emptying Service

Customer can hire informal emptiers through contact in-person or calling them if phone number is available. Emptiers come to customer's house within 24 hours of getting the call. They usually make their demand based on the size & location of the pit/tank, distance between storage and dumping place. After negotiation and having confirmation from customers they start their work. Some of the manual emptiers even go door to door and vouch for emptying the HH tank. Generally, for a small pit, they charge around BDT 1,000-2000. However, for septic tank clearance, their charge is around BDT 2,000-5,000. This excludes costs of additives (tips for driver) and other materials, which are usually borne by the customer. They also receive around BDT 300-1,000 as tips for a satisfactory job.

6.2.8 FSTP Treatment

The Municipality owns the FSTP and two small vacutugs (1.5 and 2 m^3). AID Foundation is operating and maintaining both assets through a PPP with the municipality for 10 years. The households have to call the municipality for desludging services, which then inform AID foundation. The households pay fixed emptying fees directly to the vacutug drivers and AID foundation pays monthly lease fees to the municipality based on the number of containments emptied. The municipality is interested to develop co-composting activities at the treatment plant with municipal solid wastes.

Designed Cycle: 2.5 to 3.5 days (One Holiday/week) Design capacity: 36 [m^3/d]

Days	Operation Details
0.5	Loading of two beds (5x8 [m]) with 0.4-0.5 [m] sludge per day (about 36 [m^3/d]). One in the morning and one in the afternoon.
2-3	Drying cycle (two to three days drying cycles).

Operating cycle: 2 to 13 days Receiving volumes: 0-22 [m^3/d]

Days	Operation Details
1-3	Loading of bed typically with 8 to 12 [m^3] of sludge during one, two or three days in a row.
2-11	Drying cycle from two to 11 days depending on the amount of sludge coming, the judgement of the operator as well as operational and technical issues with the beds.

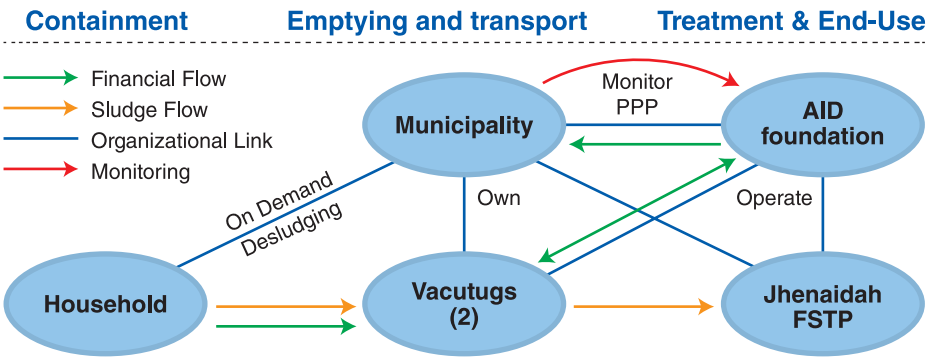
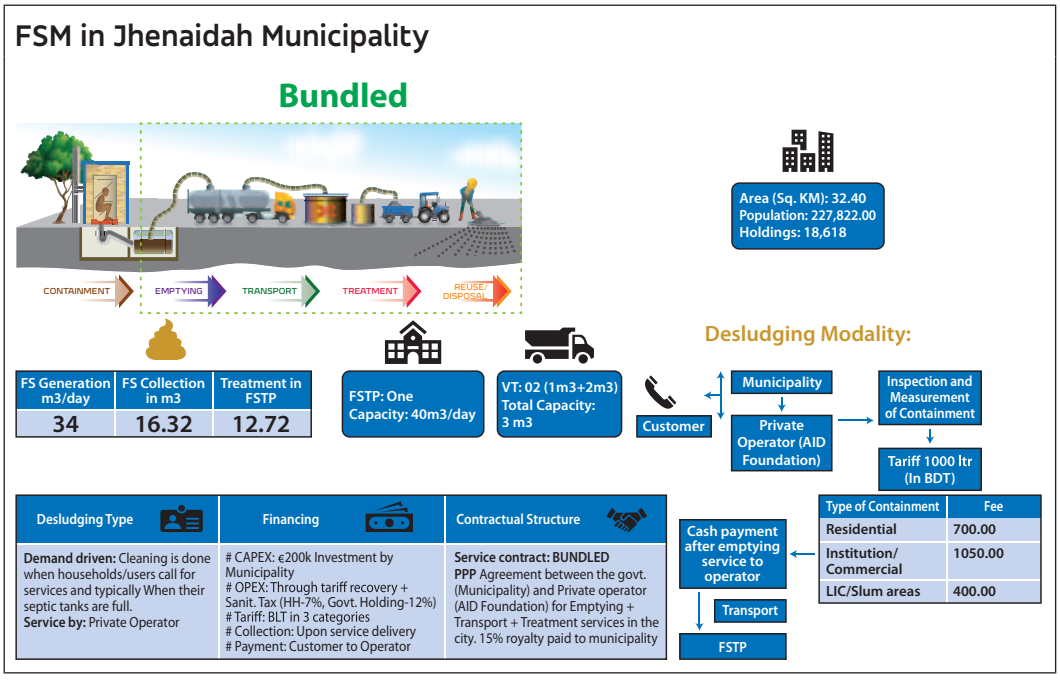


Figure 32: FSM Service Chain Diagram in Jhenaidah Municipality

6.2.9 Remaining Challenges

Challenges faced by the FSTP include the small quantities of sludge being discharged, and the lack of capacity to deal with the high variability of Q&Q of fecal sludge. A significant amount of sludge at the municipality level is dumped directly in the environment, threatening public health. In addition, irregular loadings result in mortality of plants in planted drying beds. This is being mitigated by a swivel pipe in the leachate chambers. However, loading one bed several days in a row, decreases treatment performance, stresses the plants and increases the risk of clogging of the filter media and the drainage system. One drainage pipe already clogged and had to be replaced. This could also be increased by officially including manual emptiers in the service chain.

Figure 33: Jhenaidah FSTP



6.2.10 Benapole Municipality

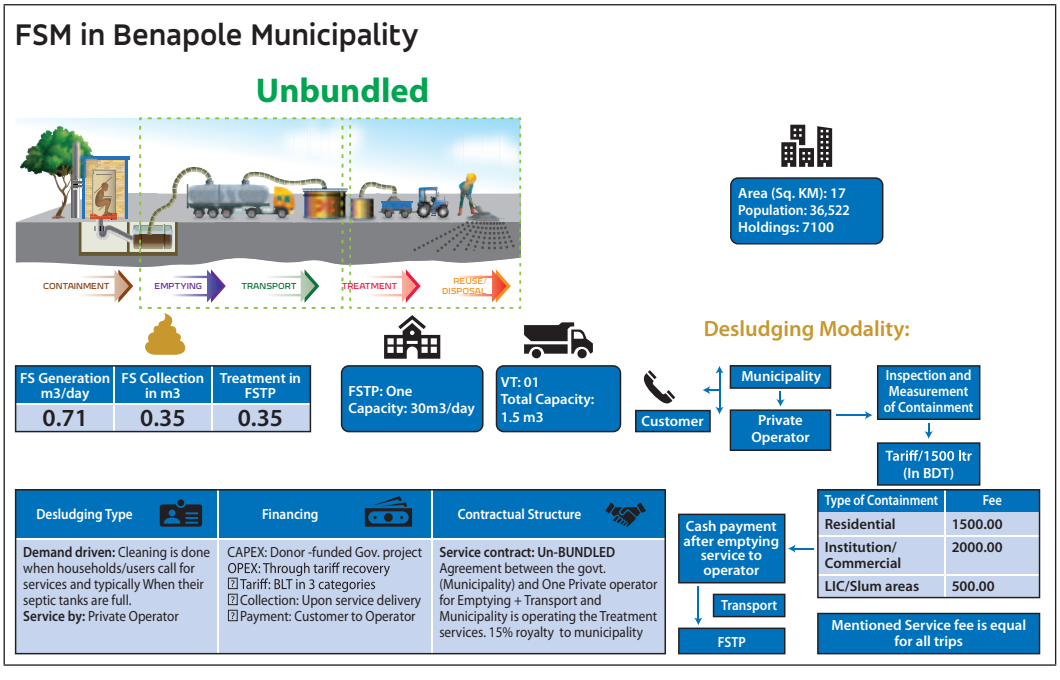


Figure 34: FSM Service diagram in Benapole Municipality

Figure 35: Benapole FSTP.

6.2.11 Jashore Municipality

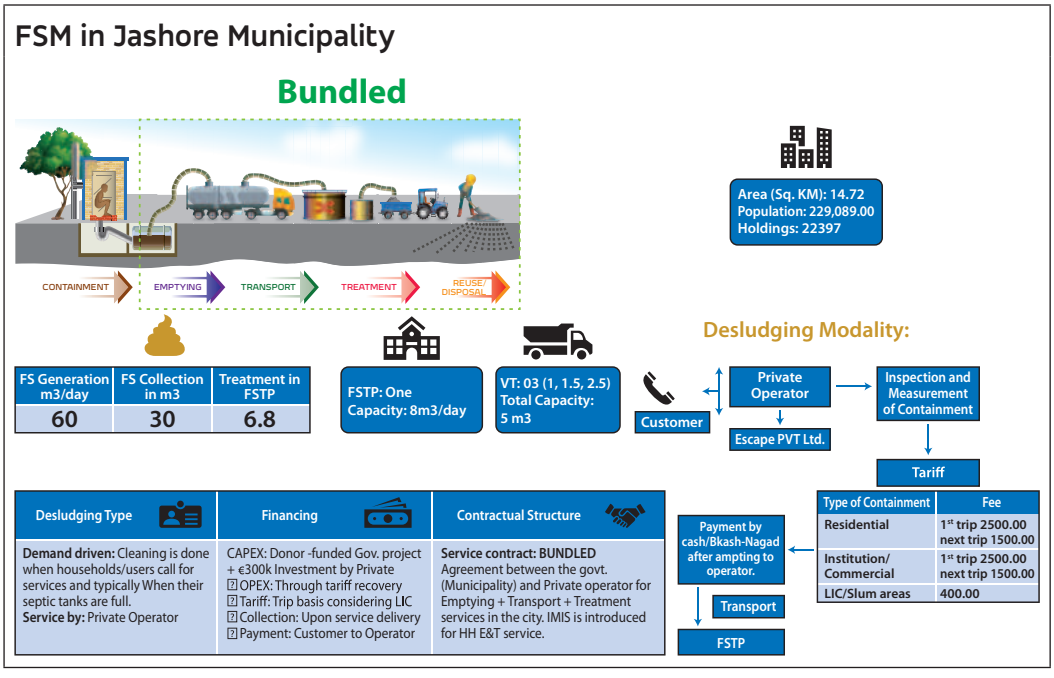


Figure 36: FSM Service diagram in Jashore Municipality

Figure 37: Jashore FSTP

6.2.12 Gazipur Municipality

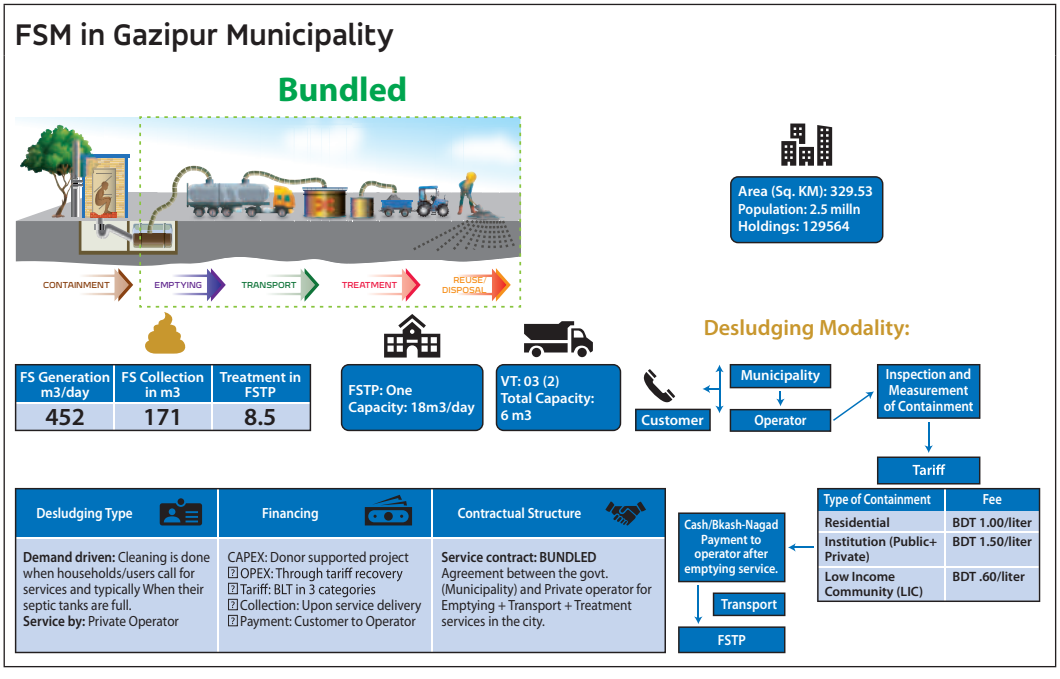
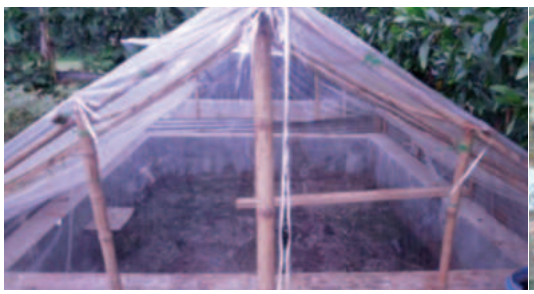


Figure 38: FSM Service diagram in Gazipur Municipality

(a) Drying beds - masonry work

(b) Drying beds - plastering work



(c) Drying bed 1 with plastic cover

(d) Drying bed 2 with rigid cover

Figure 39: Gazipur FSTP

Photo Credit: FSM Network, Bangladesh.

6.2.13 Case Study: Khulna City Corporation

Khulna FSTP is located about 8 [km] west from the Khulna city Centre (coordinates: 22.793750, 89.492111). The municipality is fully relying on onsite sanitation and this is the only FSTP. It was designed by KUET and AIT. It was constructed by the municipality with financial support from SNV and BMGF. The FSTP started operation in March 2017 and was designed for a capacity of 180 [m^3/d]. The treatment consists in 6 planted and 6 unplanted (used only for experiments) drying beds. The leachate is treated in a horizontal flow constructed wetland, followed by a vertical flow constructed wetland. There is no resource recovery practice but the municipality is planning on making briquette with the dried sludge. The beds have not been emptied yet because of the low inflow of sludge to the FSTP.

6.2.14 FSM Service Delivery System

Available Emptying Services in Khulna

In Khulna three types of emptying services being practiced. First, Khulna City Corporation (KCC) provides service through 2 vacutug. Second, three private operators provides service through 3 vacutugs.

6.2.15 Khulna City Corporation-run Mechanical Emptying Service

KCC provides mechanical emptying service to citizen through 2 vacutugs. Any citizen can take this service by filling up a form to provide information about the pit/septic tank size, road size in front of house, machine to pit/septic tank distance etc. along

with submission of the form, applicants has to submit pay-order issued from a local bank in favor of KCC. Then, a supervisor from the Conservancy Department of KCC visits the home to validate all the information of the application form within 24 hours. After the supervisor gives the go ahead, the vacutug truck reach the client's home within 48 hours. After sludge is pulled out from the storage, it is transported to the treatment plant located at Rajband. KCC has two vacutugs of 7,000- and 5,000-liters capacity. Presently the vacutug of 5,000 liter is non-functional. Currently, there are 2-3 calls a month for this vacutug.

6.2.16 Private Operators under PPP Agreement Operated Emptying Service

Three Private operators in other 3-zones designated by KCC provides mechanical emptying service through 3 vacutugs with 1,000-liter capacity each. In case of availing the private operator operated service, customers do not need to apply formally and can call directly to the service providers or vacutug truck drivers or helpers for emptying service. Sometimes KCC officials link customers with private operators if they require small capacity trucks or if they are too overburdened to meet customer requests within a reasonable amount of time. The private operators charges flat tariff starting from BDT 1,500.00 for each trip for different capacity of containments.

6.2.17 Manual Emptier Provides Emptying Service

Customer can hire informal emptiers through contact in-person or calling them if phone number is available. Emptiers come to customer's house within 24 hours of getting the call. They usually make their demand based on the size & location of the pit/tank, distance between storage and dumping place. After negotiation and having confirmation from customers they start their work. Generally, for a small pit, they charge around BDT 1,200-2000. However, for septic tank clearance, their charge is around BDT 3,000-6,000. This excludes costs of additives (tips for driver) and other materials, which are usually borne by the customer. They also receive around BDT 500-1,000 as tips for a satisfactory job.

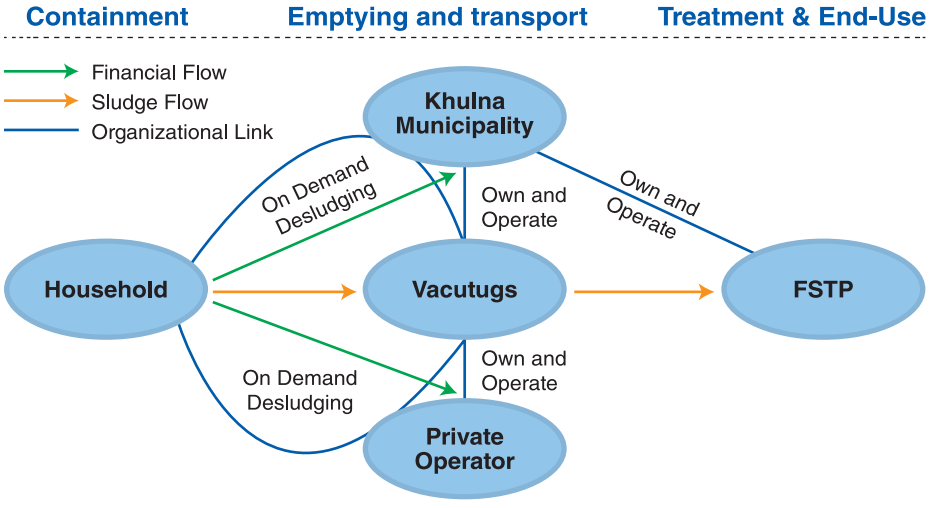


Figure 40: FSM Service Chain Diagram for Khulna City Corporation

6.2.18 FSTP Treatment

The municipality owns, operates and maintains the FSTP through its Conservancy Department. The municipality is engaged one private enterprize under PPP agreement through the bidding process to outsource the operation of the FSTP. SNV is providing technical backstopping and financial support for the maintenance. The municipality has trained 250 emptiers who are hired and paid as required by the municiaplity. The CDCs operate independently but bring sludge to the FSTP.

Designed cycle: 7 days (1 holiday/week) Capacity: 180 [m^3/d]

Days	Operation Details
1	Loading of one beds (32 x 12 [m]) with 180 [m^3] sludge per day.
6	Drying cycle

As per the logbook data, the average monthly inflow is 46 [m^3]. Sludge inflow increased up to 6 to 8 [m^3/d] by the second half of 2022. Thus, the daily sludge inflow is insignificant for an FSTP that is designed for 180 [m^3/d].

Figure 41: FSTP of Khulna City Corporation

6.2.19 Remaining Challenges

A major challenge faced by the FSTP is the small quantities of sludge being discharged. The municipality and its agglomeration have over 1 million inhabitants, with only insignificant volumes of sludge being discharged at the FSTP, meaning most fecal sludge is dumped directly in the environment, threatening public health. There are also infrastructure issues, such as clogging of the distribution pipes.

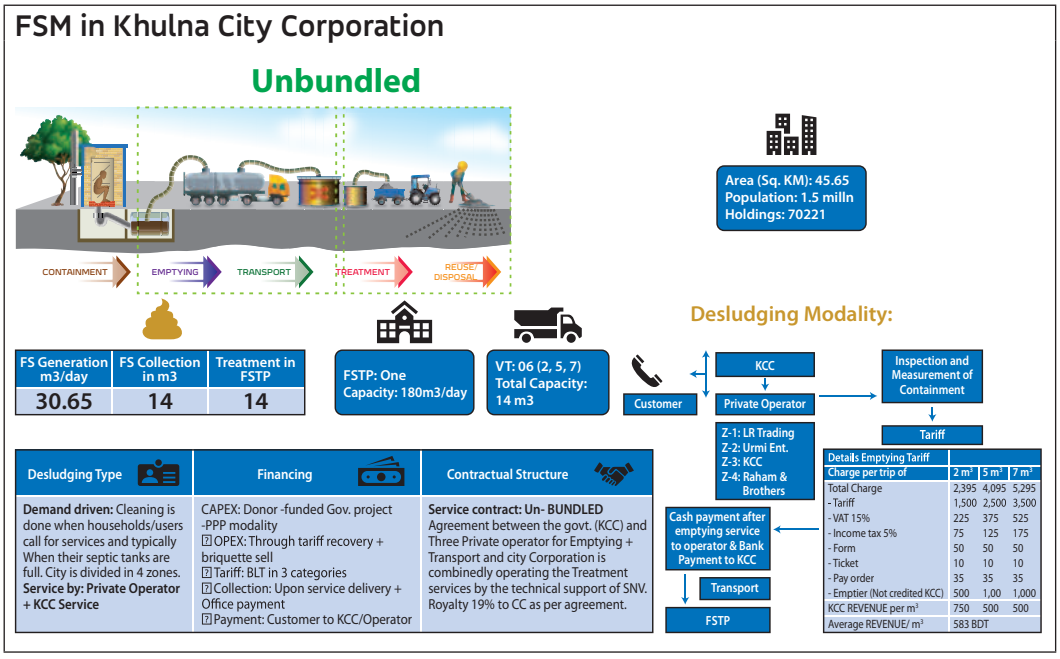


Figure 42: FSM Service Delivery Diagram in Khulna City Corporation

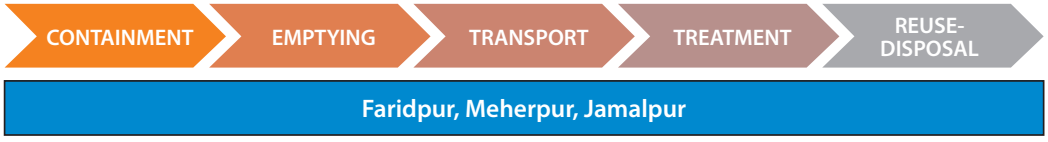
6.3 Model C: Private sector/ Community led Service Level Agreement Model

In this model, marginalized group of communities take an active role in fecal sludge management. It involves organizing local community groups or cooperatives that are responsible for fecal sludge collection, transportation, and treatment under the service level agreement with LGI's. This model promotes community ownership, social empowerment, and engagement in decision-making processes.

6.3.1 Economic Value Propositions

- ✧ Cost-Effective Service Delivery can help to manage operational costs and reduce waste, making services more economically viable.
- ✧ Performance-Based Payments incentivizes efficient and effective service delivery.
- ✧ Risk Mitigation outline responsibilities for managing unforeseen issues like equipment breakdowns or changes in demand, reducing financial risks.
- ✧ Investment in Infrastructure such as treatment plants and transportation fleets which reduces the burden on the government to fund capital-intensive projects.
- ✧ Revenue Generation can help offset operational costs and potentially lead to profits.
- ✧ Transparent Cost Structures help to understand the pricing structure and make informed decisions about service contracts.
- ✧ Efficient Resource Allocation ensures that resources like trucks and treatment facilities are optimally utilized to minimize operational costs.
- ✧ SLAs promote the long-term sustainability of fecal sludge management services, reducing the need for frequent renegotiations or disruptions in service provision.

- Accountability and Monitoring collectively ensures the treatment of FS for a healthy community and environment.
- Reduction of informal service providers.



6.3.2 Case Study: Faridpur Municipality

Faridpur FSTP is located 7 km north from Faridpur municipality, (coordinates: 23.622391, 89.845455). It was funded by the Department for International Development (DFID) and designed and by Practical Action Bangladesh (PAB). The FSTP started operation in January 2017 and was designed for a capacity of 24 [m^3/d]. It is the only sanitation treatment provider as the municipality is fully relying on onsite sanitation systems. The treatment consists of 16 unplanted and 12 planted drying beds. The leachate is treated in six baffled tanks (three without and three with filtering media), a series of horizontal flow constructed wetlands and a maturation pond. The dried sludge in pre-processed (grinded) in the dried sludge storage shed and then transported off-site to a co-composting unit for further processing.

6.3.3 FSM Service Delivery Mechanism

The municipality, which owns the FSTP, has delegated its operation to the private company SDC through a PPP. PAB is providing technical back stopping and financial support for maintenance of the FSTP. The emptying and transport of sludge is done by two desludging trucks owned by the municipality but rented and operated by two sweeper associations. For desludging services, the households have to call the municipality which will then mobilize one of the two associations. Type of Business model – The CRTC is operated as a PPP model, under this PPP model Practical Action develops the technical capacity of the private partner on IWM and O&M of the treatment plant.

Major capacity development was including waste collection, segregation, composting, quality control, branding, packaging and certification process for compost marketing, awareness of the community and stakeholders, demonstration for market promotion etc. In addition, Practical Action assists to facilitate registration from RJSC (Registrar of Joint Stock Companies and Firms) to play a private partner role for composting and market promotion, in 2020 SDC, get registration from RJSC and name as a SDC Argo. Imitated who are private operators of the FSTP (C-160535, 22 March 2020).

Practical Action has formed 2 Pit emptier co-operatives in Faridpur municipalities. To make them organized and work under the PPP model Practical Action has provided them with training supports, arrange Social Safety Schemes, OHS trainings, startup training and other capacity building training supports. There is an existing SLA between the municipality and the cooperative.

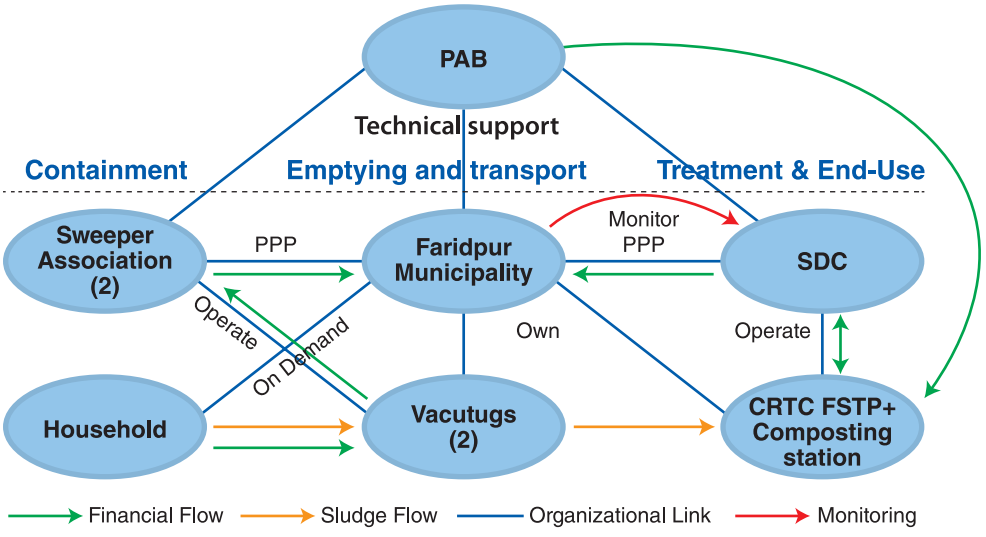


Figure 43: FSM Service Chain Diagram for Faridpur Municipality

Designed cycle: 18 (UDB) and 7 (PDB) days		Design capacity: 24 [m³/d]
	Days	**Operation Details**
UDB 6 [m³/d]	1	Loading one bed (3x10 m) with 0.2 m sludge per day
	13	Drying cycle
	2	Emptying and cleaning of one bed per day
PDB 18 [m³/d]	1	Loading one bed (8x8 m) with 0.3 m sludge per day
	6	Drying cycle

Operating cycle: Receiving volumes: 0-4 [m³/d]

Designed cycle: 18 (UDB) and 7 (PDB) days		Design capacity: 24 [m³/d]
	Days	**Operation Details**
UDB 0 - 14 [m³/d]	7-21 weeks.	Loading of one bed with approximately 42 m³ of sludge. Typically, during one to three
	12-17	Drying cycle
	2	Emptying and cleaning
	...	Resting period
PDB 0 [m³/d]		The PDB are not used regularly

Operating cost – BDT 2 lakh/year

6.3.4 Remaining Challenges

Challenges faced by the FSTP include the small quantities of sludge being discharged, and the irregular loading of beds. A few of the drying beds are overloaded, and the rest are underutilized, as maximizing revenue is prioritized over the long-term sustainability of the infrastructure. The PDBs are rarely used, and half of the UDBs are loaded several times with all the incoming sludge. This will result in clogging of their filter media.

Based on the current loading as well as on the requirements of the different stakeholders, a new optimized operation plan should be implemented that takes into account for dewatered sludge that is needed for the co-composting operations, as well as the long-term sustainable operation of both the UDBs and PDBs. Initially, each UDB should be loaded for a maximum of one day and 6 m^3 as designed, but should be adaptive and closely monitored.

Figure 44: Faridpur FSTP

6.3.5 Case Study: Meherpur Municipality

Around 70,000 people live in Meherpur municipality and more than 10,200 tonnes of fecal sludge are produced every year and the municipality is the only responsible authority for managing these huge amounts of human excreta. Building on the PPP led city-wide sustainable sludge management servicemodel in Faridpur, Meherpur municipality has launched a project with the support from Practical Action and Bill & Melinda Gates Foundation and integrating with the third Urban Governance & Infrastructures Improvement Project (UGIIP-III) to establish a sustainable FSM service for all the city dwellers in Meherpur.

6.3.6 Service delivery mechanism

The municipal authority has completed the plan for the Fecal Sludge Treatment Plant (FSTP). The land development and the construction work have started already. Moreover, they have developed a business calendar for the FSTP and are building capacity of the sanitation workers, city dwellers and municipal representatives through training, sensitization workshops, etc.

The municipality have already formed the Multi Stakeholder Steering Committee (MSSC) which will act as a monitoring and guiding entity for FSM services in general and will implement the city sanitation plan. Besides, two business cooperatives of the pit-emptiers have been formed there the formal registration process is underway.

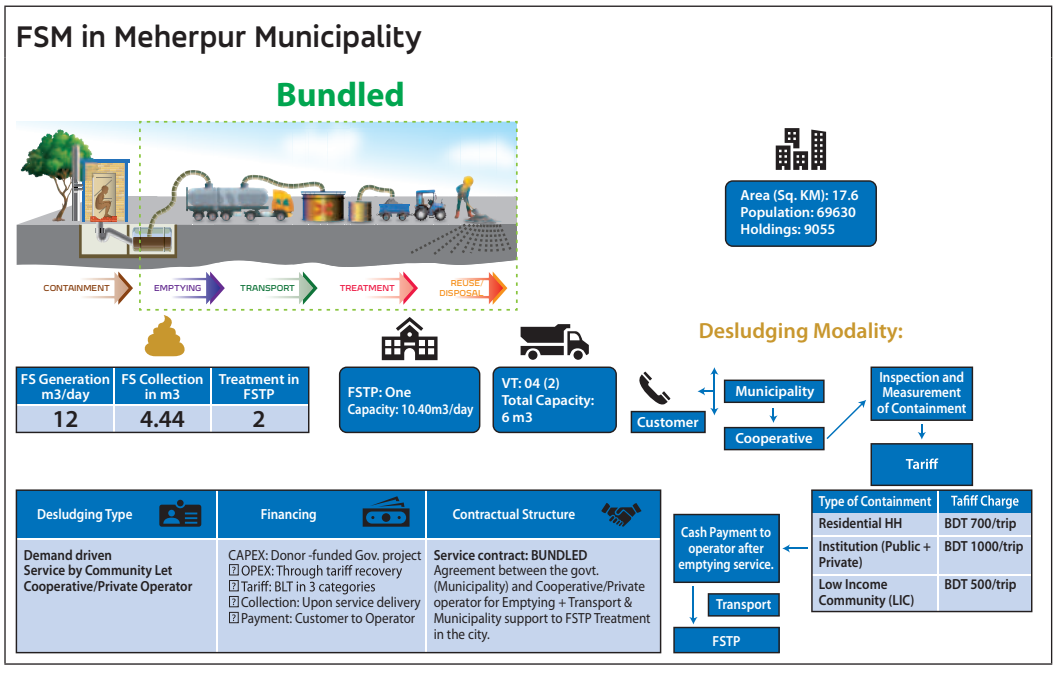


Figure 45: FSM Service delivery diagram in Meherpur Municipality

6.3.7 Remaining Challenges

Licensing of Cooperatives are still now lingering due to institutional formal lingering. FSTP's bed are not fully washed due to heavy bush and regular desludging was not observed due to lack to service delivery mechanism. PDB's are not properly managed due to lack of manpower and monitoring.

Figure 46: Meherpur FSTP (PDB).

6.3.8 Case Study: Jamalpur Municipality

The municipality started their FSM activities in 2017. BRAC WASH Programme supported the municipality for initiating FSM in Jamalpur and working as the implementation Organization of FSM. BRAC trained the local pit emptiers. They also ran a social awareness raising campaign. BRAC provides help for pit and tank emptying. Safe transporting is also a part of BRACs association with the municipality.

6.3.9 FSTP Treatment

Jamalpur Municipality owns and operates the sludge treatment plant. The plant is a 10 km round trip from the city centre. The treatment plant has an area of 336 m2. It can treat 2m^3 sludge a day. It uses sand bed drying method. After treatment, the sludge is used to produce fertilizer using the co-composting method.

6.3.10 Service Delivery Mechanism

The operation is being carried out in a cost-effective manner with high value for money. The pit emptiers are getting paid in a result-based incentive model. They are getting the basic salary from BRAC. They are also receiving half of the emptying fee as incentive which ensures their engagement in the whole process. This model is smoothly running since gradual increase in the call for emptying is visible.

In this process, the emptiers received HSE training provided by BRAC. They also started using safety equipment while emptying the septic tanks. Eventually, they are now providing technical pit emptying service for the house owners and ensuring their occupational health and safety.

A household owner has to pay 500 BDT per emptying trip. For emptying trip, municipality charges 500-1000 BDT depending on the sludge volume. For tanks, the fee is 1,000-5,000 BDT depending on the size. The pit emptiers receive payment on a result-based incentive model. They receive half of the emptying fees. It ensures their involvement with the whole process. The implementing agency also provides the emptiers with a basic income. They do it from the revenue generated from the composting pilot initiative. Presently, a locally manufactured vacutug is transporting the sludge.

Figure 47: FSTP Plant of Jamalpur Municipality

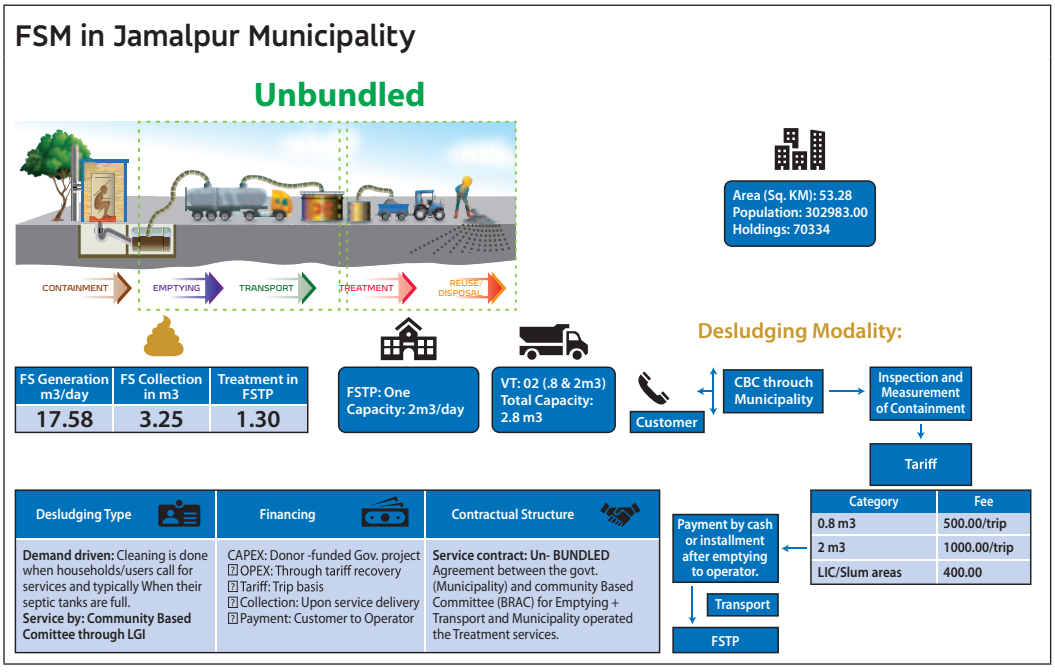


Figure 48: FSM Service Delivery Diagram of Jamalpur Municipality

6.3.11 Remaining Challenges

Dumping fecal sludge in open water bodies is still common in Jamalpur. If legal actions are taken against such activities, FSM will become more important and relevant. The basic salary of the emptiers and the emptying fee can be added into municipality taxes. Besides, the municipality is facing few more challenges like:

- Locations of the pit/tank are difficult to access (in most cases, the pits/tanks are positioned behind the house)
- Households content with the emptiers on emergency basis when pit/tank overflows. Immediately addressing the call is a challenge
- Emptying fee is not fixed and negotiation is a burden for the emptiers
- Locally manufactured vacutugs often face mechanical problems.

6.4 Model D: Hybrid Model: LGI Owned and Operated by Private Sectors

A hybrid model combines elements of the public and private sectors, as well as community participation. It may involve a mix of public and private service providers working together to deliver fecal sludge management services. For example, the government might establish & operate the treatment plants, while private companies/NGO's/sanitation enterprises handle the collection and transportation of fecal sludge.

6.4.1 Economic Value Propositions

- ✧ Accountability and Reporting
- ✧ Incentives or penalties for Performance
- ✧ Flexible Contractual Arrangements

- Expertise and Professionalism
- Private operators may efficiently allocate resources like collection vehicles and treatment facilities, reducing waste and operational costs.
- Private sector participation can reduce the reliance on public funds for the provision of FSM services, freeing up government resources for other essential services.
- Risk Transfer
- Competition and Quality Improvement
- Private operators can generate revenue through user fees and charges for their services, which can help cover operational costs and potentially yield profits.
- Private sector involvement creates job opportunities within the FSM sector, contributing to local economic development and poverty reduction.
- Private sector operators often bring efficiency and cost-effective practices to FSM services.
- Timely and safe emptying of containment units specially LIC focused as per municipalities priorities.

6.4.2 Case Study: Sakhipur Municipality

Sakhipur FSTP and co-compost Plant is located in Tangail District, 3 [km] south-west from the town centre (coordinates: 24.3092118, 90.154212). It is the only FSTP in the District. It was designed by WAB and constructed by BASA with financial support from WAB and the Municipality. The FSTP started operation in January 2016 and was designed for a capacity of 8 [m^3/d]. The treatment consists of 10 unplanted drying beds. Leachate is treated in settling tank, a constructed wetland and a polishing pond. The dried sludge is co-composted with organic waste in the co-composting plant located within the FSTP compound. The compost is packaged and sold in the local market.

6.4.3 FSTP Treatment

Sludge drying: 10 x 9m2 unplanted drying beds with a loading capacity of 8,000 litres per day of sludge at a loading depth of about 20cm. It takes three to five trips to fill one bed, where fecal sludge is kept for 14 days and refilled in cycles.

Liquid waste treatment: Constructed wetland with hybrid flow followed by polishing pond. Co-composting: Aerobic decomposition of dried fecal sludge and organic solid waste. The organic solid waste, dried fecal sludge and sawdust are mixed at a bulk volume ratio of 3:1:1. Current operations (annual): About 1,500 tonnes of fecal sludge and about 150 tonnes of solid waste are treated to produce 24 tonnes of compost in a year.

Coverage 2021: Increased proportion of fecal sludge produced that is safely managed from 0% to 58%

Designed cycle: 14 days Design capacity: 8 [m^3/d]

Days	Operation Details
1	Loading one bed 4 [m^3] sludge per day
12	Drying cycle
1	Emptying and cleaning of one bed per day

Operating cycle: 15 to 17 days Receiving volumes: 0-8 [m^3/d]

Days	Operation Details
1	Loading one bed with typically with 2 to 5 [m^3]
13-15	Drying cycle
1	Emptying and cleaning
....	The bed is left empty until next load

The Municipality owns the Plant and One vacutug (1 m^3). It operates the Plant with the technical support from BASA and following the developed O&M guidelines. The Municipality and WAB are sharing the HR and O&M Costs. Households submit an application form and pay emptying fees to Municipality. The conservancy department of the Sakhipur Municipality is responsible to provide the emptying services. The radius of service provision is 3-4 KM. Emptying service, by law service cannot provide at night time.

6.4.4 Financial of Business mechanism for service delivery system

Plant construction was financed by WaterAid Bangladesh and did not use any public funds. WaterAid also provided technical assistance. Resources provided by the municipality include the approach road, land and desludging vehicle. They also collect the tariffs for desludging services. An account operated by the municipality manages the fees collected from sludge and solid waste collection and the sale of compost. Currently the operation and maintenance of the plant is managed jointly by the Municipality and WaterAid. The Vacutug O&M and salary of 2 staff are provided by municipality, paid out of the account. The sorting of the solid waste is the costliest activity contributing to approximately 30% of the total O&M cost. In the first year, the O&M expenditure was USD 20,621 against an income of USD 13,051 (Al-Muyeed, et. al., 2017). It is estimated that an income of around USD 7,000 will come from solid and liquid waste collection tariffs and approximately USD 6,000 from selling the compost. Since January 2019 door-to-door solid waste collection has been done by a private entrepreneur who supplies segregated organic waste to the plant meaning that the sorting cost is borne by the entrepreneur.

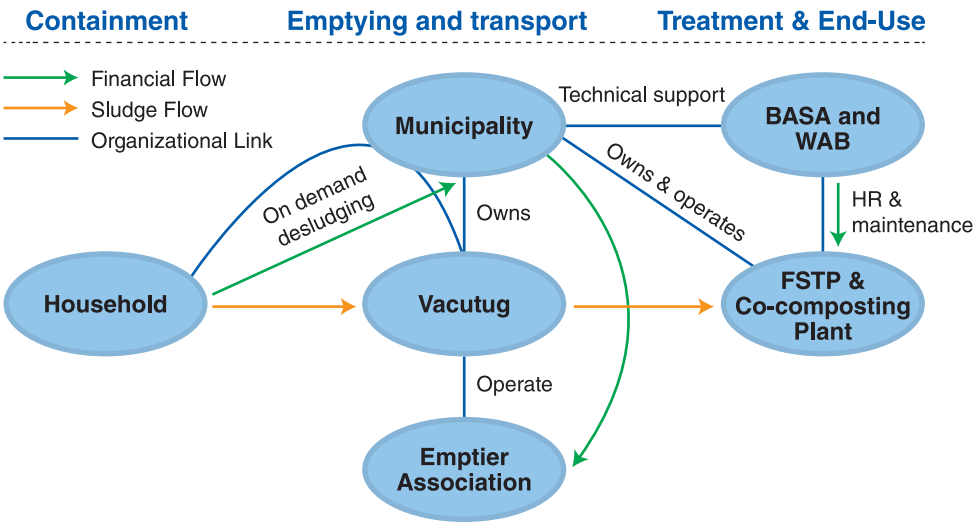


Figure 49: FSM Service Delivery framework for Sakhipur Municipality.

6.4.5 Remaining Challenges

Demand Creation: Convincing people to use a new service is difficult, although continuous advocacy is being done by BASA and the municipality.

Collection: Vacutugs cannot access many areas in the municipality, especially slums, though manual emptying exists. The services are also limited by the volume of one Vacutug. Treatment: The land provided by the city helped to reduce transaction costs and bureaucratic delays. However, the plant is located quite far from the city which contributes to higher transport costs, thus impacting the financial viability. Also, demand for collection and transport services is highest during the rainy season as heavy rainfalls result in overflowing of on-site systems. Consequently, the volume of dry sludge is reduced which has implications for the composting operation, and thus end product quality and income generation.

Reuse: The social stigma and unacceptance of unfamiliar approaches around feces and their reuse still needs to be addressed. This hesitation impacts distribution and use of the compost, and thus income generation.

Sustainability: The capital cost was covered by WaterAid Bangladesh and the plant is recovering about 13.50 - 70% of the cost with respect to O&M operations. The ability of the municipality to sustain services after WaterAid exits also remains a challenge.

Figure 50: FSTP & Co-composting Plant of Sakhipur Municipality. Photo Credit: WaterAid Bangladesh

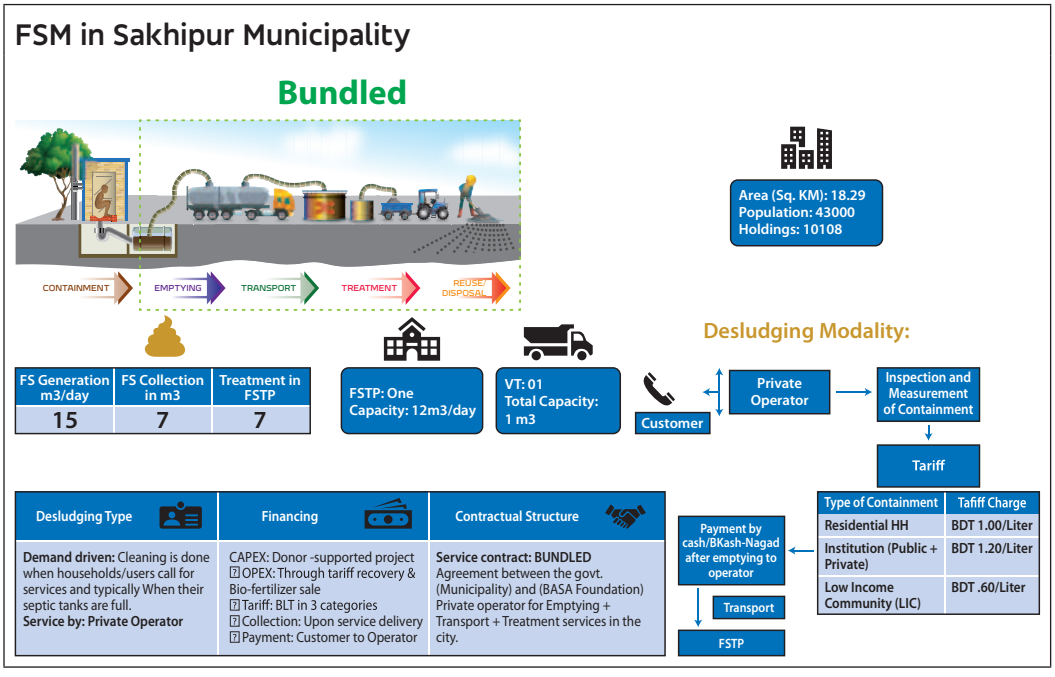


Figure 51: FSM In Sakhipur Municipality

6.4.6 Case Study: Saidpur Municipality

Saidpur municipality, like much of the country, lacks a centralized sewer infrastructure, on-site sanitation systems including pit latrines and septic tanks are used. These must be emptied on a regular basis, however despite the fact that the municipality provides a mechanized emptying service, over 98 percent of homeowners do not do so. Due to a lack of a permanent dumping location, garbage is often discharged directly into the environment, regardless of the method employed to empty it. Some residences also have toilets that dump straight into public sewers. According to the municipality and shit flow diagram, 87 percent of the excreta is not controlled and hence managed in a dangerous manner. As a result, sanitation management is a key concern in the municipality.

6.4.7 Service Delivery business model

The Saidpur Municipal authority set a tariff system through a participatory approach for collecting sludge through Vacutag. Fecal Sludge Collection and transportation fee is about 500-taka, 800-taka, 1500-taka, 2500 taka inside municipal area and taka 1000 liters 1000 taka & per kilometer 15 taka (Add additional), 2000 liters 2000 taka & per kilometer 25 taka (Add additional), 3500 liters 3000 taka & per kilometer 30 taka (Add additional) for outside area of municipality. It is estimated that annual around 11,14,237.00 BDT (Average) collected in fees from this service. Additionally, 5,40,000.00 BDT (Average) per year has been collected from selling compost.

Revenue source:

Fecal sludge collection fee
Solid waste management entrepreneur lease and monthly fee
Co-compost marketing

6.4.8 Treatment and Management scheme

6.4.8.1 Co-composting

The treatment process adopts a batch system, where a mixture of organic waste, dry fecal sludge, and sawdust is prepared and composted separately, generating intense biological activity within each batch until a final product is obtained. Therefore, the mixing ratio plays a crucial role in the composting process. In each batch, the organic solid waste (SW), dried fecal sludge (FS), and sawdust are added in a volume ratio of 3:1:1 to encourage efficient aerobic bacterial activity. Sawdust is included to maintain moisture levels at around 60%. The mixture is then subjected to aerobic decomposition for a period of eight weeks. Throughout the composting cycle, various activities such as turning, watering, temperature measurement, weighing, sampling, and laboratory analysis are conducted. Turning the composted mass is particularly important during the decomposition process as it ensures uniform mixing during the initial stages and helps release any inhibition effects during decomposition. The mixture is turned regularly at three-day intervals. Over the course of the eight-week composting period, the moisture content of the mixture decreases from 60% to approximately 35%. Subsequently, during the post-maturation process, which takes place for one week, the moisture content further reduces to less than 20%.

6.4.8.2 Current operations (annual)

The capacity of FS management is 215 M Ton/year and Organic SW is 825 M Ton/year and produces 379 M Ton compost per year. In last year April 2022 to march 2023 provides 52 M Ton FS out of 215 M Ton capacity and out of 825 M ton capacity, 58 M ton SW is managed. About 12.5 MT of the final product i.e. reusable soil conditioner can be produced out of 379 MT.

6.4.9 Integrated Waste Management

In the FSTP, the solid was is incorporated with the fecal sludge to produce the end product which is soil conditioner. Only organic solid waste is considered in this process and the rest remain underutilized. However, there is a huge potentiality to work on the integrated waste management in a larger scale to address all sorts of solid wastes.

6.4.10 Reuse

The compost produced in the treatment plant is safe for using soil conditioner as per Bangladesh standard as presented the results. About 379 ton/year of compost is produced by treating 215 tons FS and 825 ton of SW. The department of agricultural extension of the Saidpur municipality has been providing further technical guidance for proper reusing and distributing the compost among the local farmers for 10 BDT per kilogram.

6.4.11 Challenges

Emptying and transportation

- Existing services: informal and outside public sector control
- Small operators: difficult to run a profitable business
- Market: poorly regulated and enforced Often sludge does not reach official dumping site due to indiscriminate dumping of sludge

Treatment and disposal

- Only a small percentage is being treated due to lack of dedicated facilities
- Appropriate sludge treatment plants are needed to ensure a complete and effective sanitation value chain

Limited sludge disposal options

- Productive use of fecal sludge-current scenario
- Limited successful examples of models that can work at scale
- Limited interest from private sector due to lack of profitable business models

Figure 52: FSTP of Saidpur Municipality

6.4.12 Case Study: Rangpur and Chattogram City Corporation

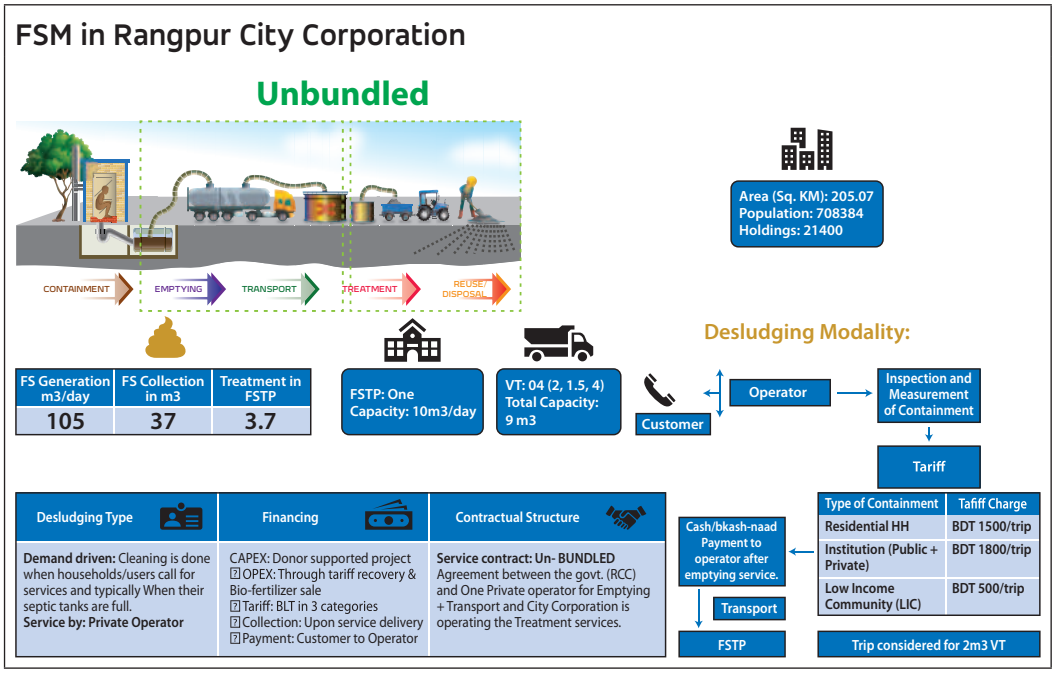


Figure 53: FSM Service delivery diagram of Rangpur City Corporation

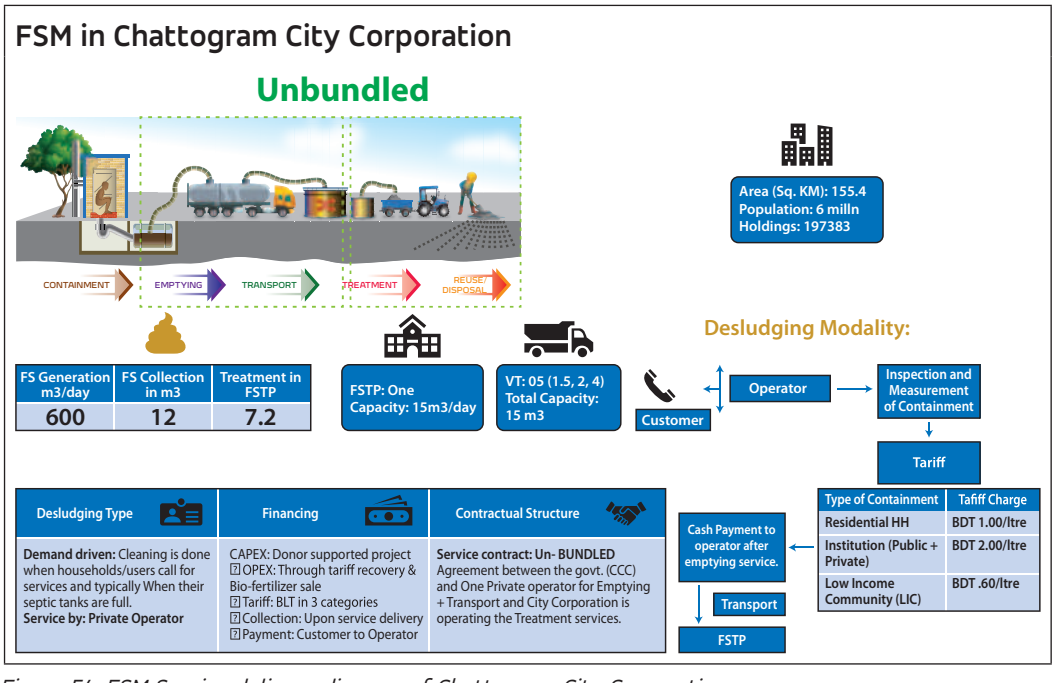


Figure 54: FSM Service delivery diagram of Chattogram City Corporation

6.4.13 FSM Service Model in Rangpur and Chattogram

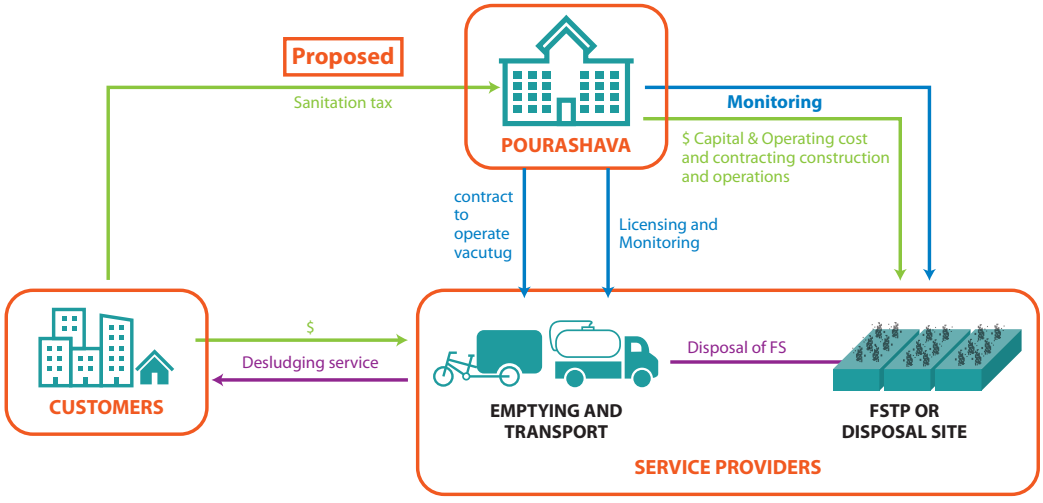


Figure 55: FSM Business model for Rangpur and Chattogram City Corporation.

To ensure financial viability for the private operator and affordability for low-income urban residents, the service model named SWEEP implemented a well-designed variable pricing structure. This structure allows the costs of serving residents in low-income communities (LICs) to be partially covered by higher prices charged to those in wealthier areas. As a result, the model becomes commercially viable for private operators. Customers benefit from the collection, safe transportation, and treatment of waste from their communities, while the public sector benefits from a stable income derived from leasing its equipment and capital assets, as well as the assurance that waste will be safely managed.

These businesses implement a differential pricing structure that allows them to serve households and institutions that pay more per liter of sludge removed from their tanks, while still maintaining a profitable venture. This approach enables the SWEEP project to create a profitable business while also catering to the needs of the base of the pyramid. The private entrepreneurs involved in SWEEP are already operating profitably, and their profits could be further increased by significantly improving the utilization of the vacuum trucks they lease, which are currently only operating at an average of 50% capacity.

6.4.14 Challenges

- ✧ Customer acquisition for all categories.
- ✧ Private Enterprises need to be more financially viable to engage under this model
- ✧ To cover the LIC people, hundred challenges faced off; like narrow access road!
- ✧ No clear agreement for FSTP operations.
- ✧ Loan and Lease contract sometimes creates big clash for tariff setting to service delivery mechanism.

Chapter 7: Proposition of Fund Flow for Sustainable Operation of FSM Services in Bangladesh

Considering the existing situation of fecal sludge management in a city or a municipal town, and the level of management among different stakeholders on the importance of FSM, a financial flow approach for the FSM service chain can be considered as suggested below (Figure 56-b),

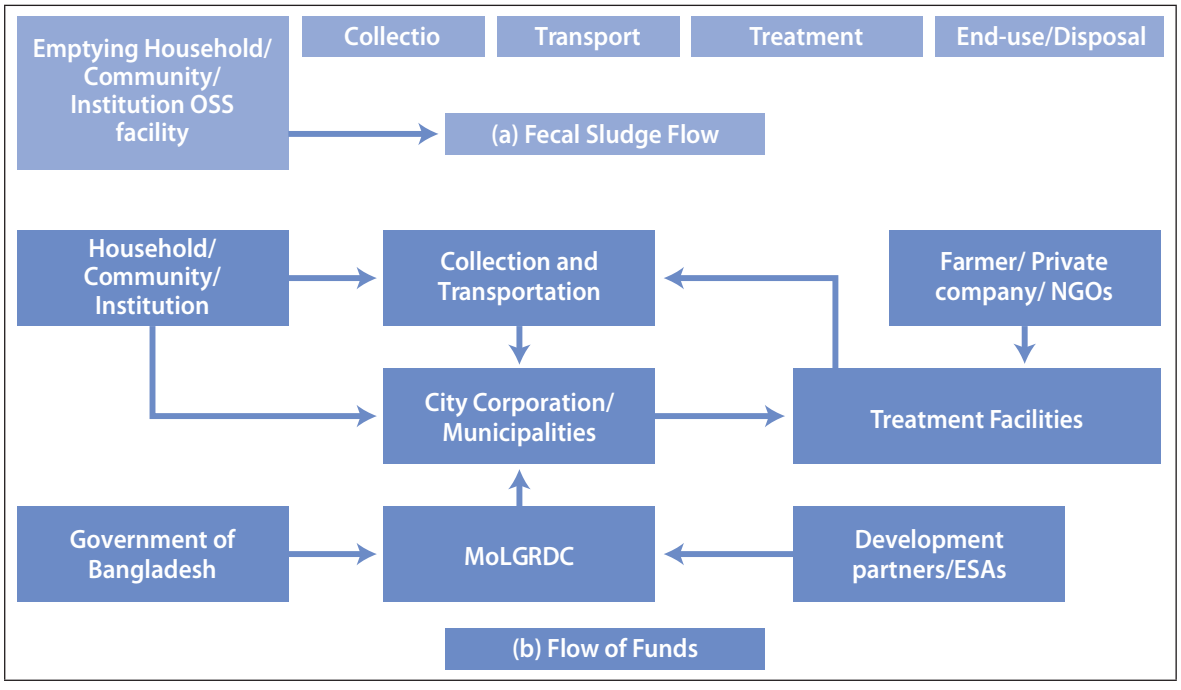


Figure 56: (a) Direction of sludge flow from HH to end use/ disposal of treated sludge; (b) Flow of Funds.

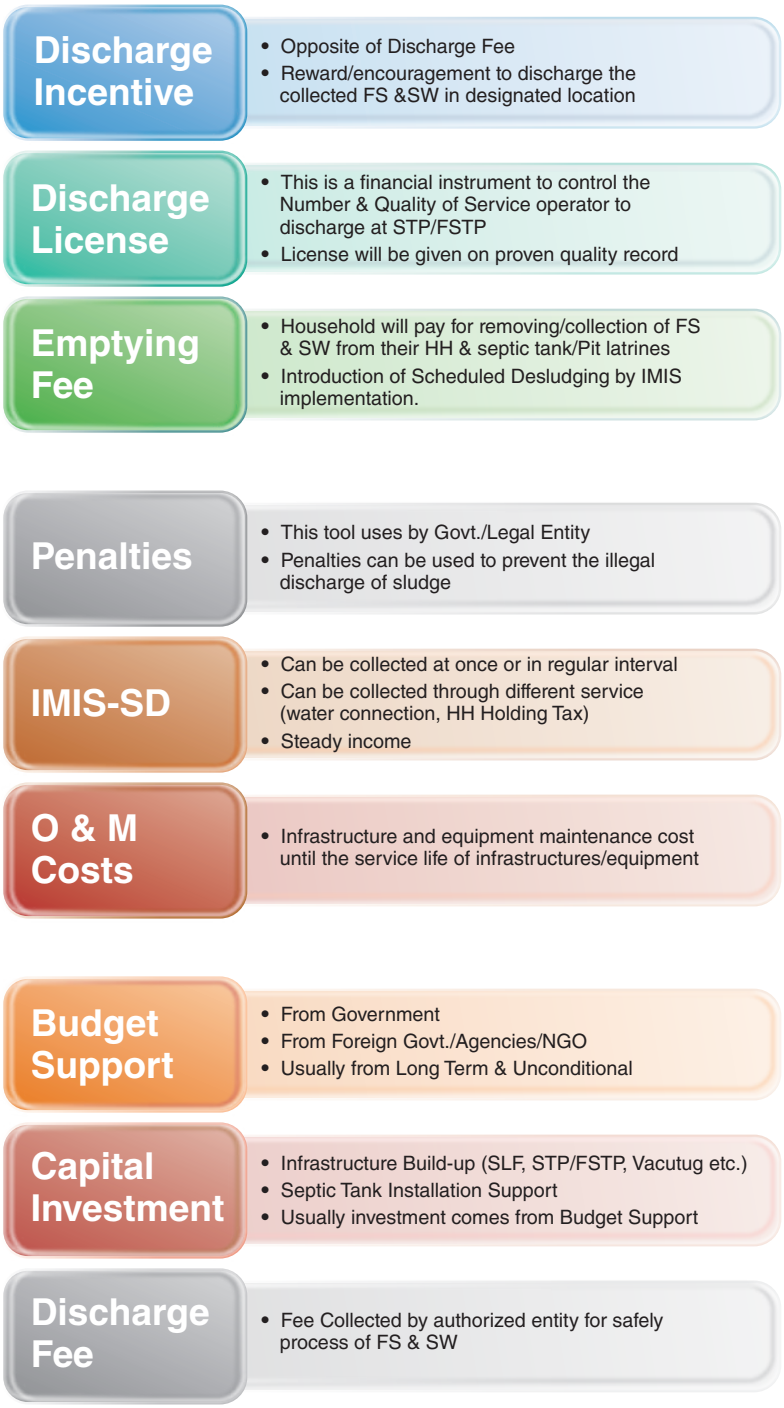
- In this approach, the financial process initiates at the household (HH)/Community/Institution level, which serves as the point of fecal sludge collection. Payments made by HH/Community/ Institution are divided into two streams – one for the Collection and Transportation service provider as a fee for septic tank/pit emptying, and the other for the respective Local Government Institution (LGI) as sanitation tax/charge, which also encompasses holding tax to cover additional expenses, including at least a portion of the fecal sludge treatment cost.
- The fee for emptying would be calculated using factors such as the rate of volumetric pumping (per liter) and other criteria set by the LGI. The sanitation tax/charge could be determined based on water usage or, more simply, as a flat rate relative to the holding tax. This should be decided through discussions involving the LGI, MoLGRD&C, and relevant stakeholders.
- This dual payment system aims to provide assistance to low-income individuals in slums. In many instances, the sanitation tax/charge will either receive partial subsidies or be completely waived. Instead, these costs will be covered by government funds allocated to City Corporations/Municipalities for fecal sludge treatment and associated expenses.
- In this fund flow approach, a crucial aspect is the allocation of funds to the treatment facilities. These facilities would compensate the collection and transportation service

provider with a discharge incentive for depositing the collected sludge at the FS treatment plant. This financial incentive is designed to promote socially responsible behavior, specifically encouraging proper sludge collection and discharge at the treatment plant while discouraging illegal disposal elsewhere. This approach allows the collection and transportation service provider to cover only a portion of the total operational costs through the emptying fee, with the remaining portion supplemented by the discharge incentive from the treatment facility. This makes the collection service more affordable for lower-income households, resulting in increased sludge collection, reduced environmental discharge, and overall benefits for the community.

- The treatment facilities would receive a portion of the sanitation taxes/charges collected by the Municipalities/City Corporation to cover operational and management costs of the treatment plant. Additionally, Municipalities/City Corporation may levy a fee for permits/ licenses related to collection and transportation. Furthermore, treatment facilities could potentially generate revenue from private enterprises or NGOs involved in marketing and selling the end products.
- Significant government assistance would remain crucial to address the financial shortfalls of the Municipalities/City Corporations, especially for funding major capital projects. The Government of Bangladesh (GOB) would need to augment its funding support to bridge these budget gaps and offer additional assistance, such as facilitating land acquisition for the construction of treatment facilities, to advance the development of FSM as well as IWM infrastructure.
- Development partners, whether multilateral or bilateral, have the potential to offer financial backing and/or technical expertise to Local Government Institutions (LGIs) for the establishment of FSM services, facilitated by the MOLGRDC.
- Public awareness and community engagement could be cover under the CSR, Media fellowships, Branding or referral programs.

7.1 Major Stakeholders involved in Financial Transfers

7.2 Ways of Financial transfers



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DEPARTMENT OF PUBLIC HEALTH ENGINEERING
14, SHAHEED CAPTAIN MANSUR ALI SARANI,
KAKRAIL, DHAKA-1000