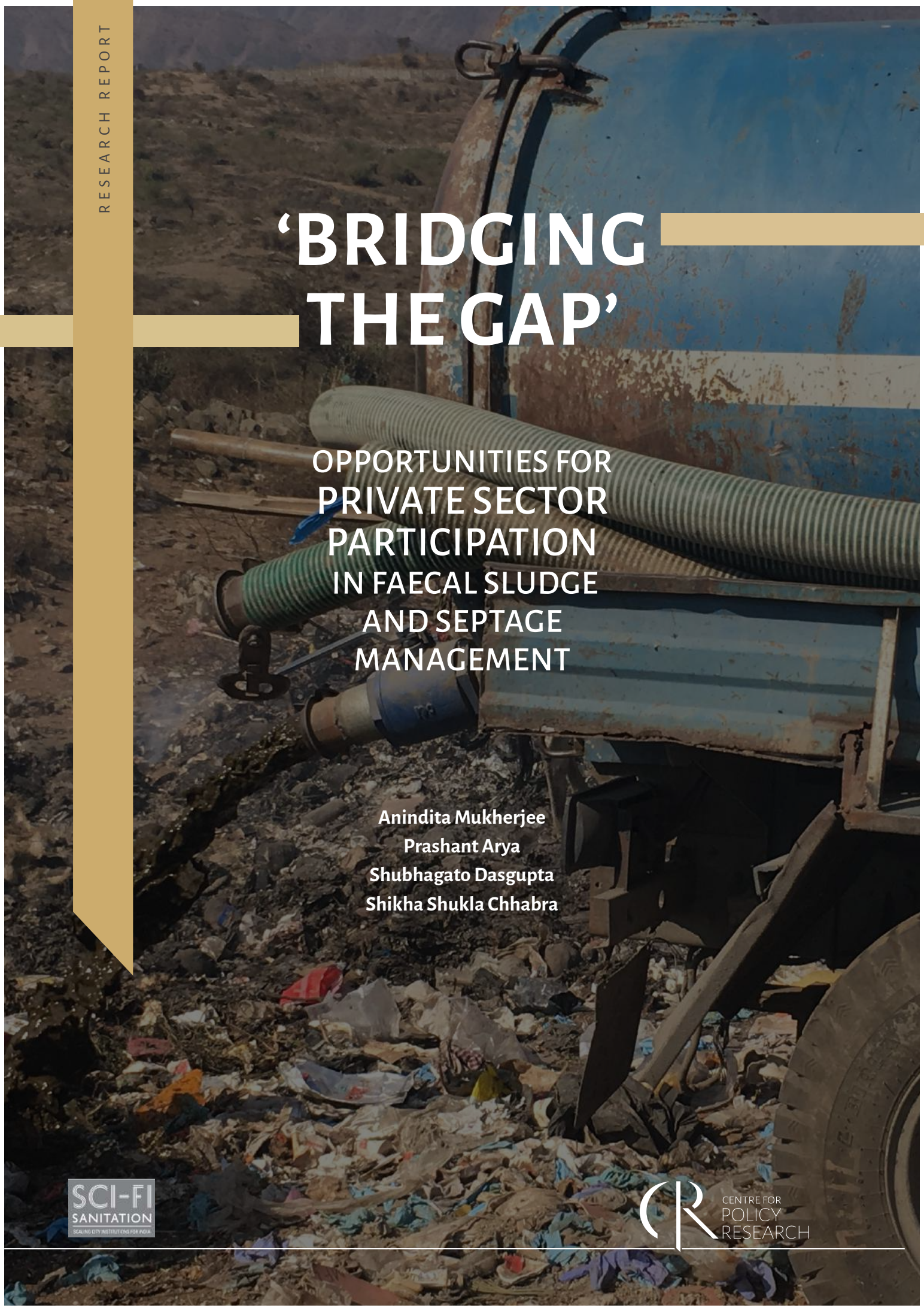

RESEARCH REPORT

‘BRIDGING THE GAP’

OPPORTUNITIES FOR PRIVATE SECTOR PARTICIPATION IN FAECAL SLUDGE AND SEPTAGE MANAGEMENT

Anindita Mukherjee
Prashant Arya
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ACRONYMS

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
CCP	City Corporation of Panaji
CHO	Chief Health Officer
CMC	Chennai Municipal Corporation
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
CPEEHO	Central Public Health and Environmental Engineering Organization
CSP	City Sanitation Plan
CT	Community Toilet
FSSM	Faecal Sludge and Septage Management
FSTP	Faecal Sludge Treatment Plant
GCMC	Greater Chennai Municipal Corporation
GoI	Government of India
GoMP	Government of Madhya Pradesh
GoTN	Government of Tamil Nadu
IEC	Information, Education and Communication
IHHL	Individual Household Latrine

ACRONYMS

JMC	Jabalpur Municipal Corporation
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
MBBR	Moving Bed Biofilm Reactor
MIS	Management Information System
MoHUA	Ministry of Housing and Urban Affairs
MPHB	Madhya Pradesh Housing Board
O&M	Operation and Maintenance
ODF	Open Defecation Free
OSS	On-site Sanitation
PHE	Public Health Engineering
PSP	Private Sector Participation
PT	Public Toilet
RoI	Return on Investment
RWA	Resident Welfare Association
SBM-U	Swachh Bharat Mission-Urban
SBR	Sequential Batch Reactor
SCM	Smart Cities Mission
SFBR	Semi-Fluidized Bed Reactor
SPCB	State Pollution Control Board
SPS	Sewage Pumping Station
STP	Sewage Treatment Plant
UA	Urban Agglomeration
ULB	Urban Local Body
UMC	Ujjain Municipal Corporation


नगर निगम जबलपुर
स्वच्छ भारत
एक कदम स्वच्छता की ओर
स्वच्छ जबलपुर स्वस्थ्य जबलपुर

1

BACKGROUND

India's urban system, consisting of 7935 urban centres[1], had a population of 377 million and accounted for 31 per cent of the country's population in 2011.[2] According to the UN World Urbanization Prospects (2018), India's urban population had reached 461 million in 2018 which is 34 per cent of the country's total population.[3] It is expected that most of the population increase between now and 2050 will take place in urban areas. Estimates suggest that by 2030 approximately 40 per cent of the country's population will be living in urban areas and this proportion is likely to increase to 53 per cent by 2050.[4]

In 2011, 81.4 per cent of urban households had access to Individual Household Latrines (IHHLs) while 6 per cent were using Public Toilets (PTs) and 12.6 per cent were defecating in the open.[5] The implementation of Swachh Bharat Mission-Urban (SBM-U) has resulted in substantial improvements improvements in ensuring access to sanitation facilities for urban households. During 2014-2019, 6 million IHHLs [6] and 0.5 million Community Toilets (CTs)/Public Toilets (PTs)[7] have been constructed, resulting in a significant reduction in the proportion of households defecating in the open – from 12.6 per cent in 2011 to 3.2 per cent in 2018 (FIGURE 1). Further, India was declared Open Defecation Free (ODF)[8] on 2nd October 2019, with 4320 ODF cities and towns. However, concerted efforts would be required to ensure access to sanitation facilities for the rapidly increasing urban population.

[1] Including 4041 Statutory Towns and 3894 Census Towns.

[2] Directorate of Census Operations, Goa, Series 31, Part XII B, 'District Census Handbook North Goa – District Wise and Town Wise Primary Census Abstract', http://censusindia.gov.in/2011census/dchb/3001_PART_B_DCHB_NORTH%20GOA.pdf, accessed on 25.03.2019.

[3] UN World Urbanization Prospects, 2018, https://population.un.org/wup/Download/Files/WUP2018-F03-Urban_Population.xls, accessed on 25.03.2019.

[4] Ibid.

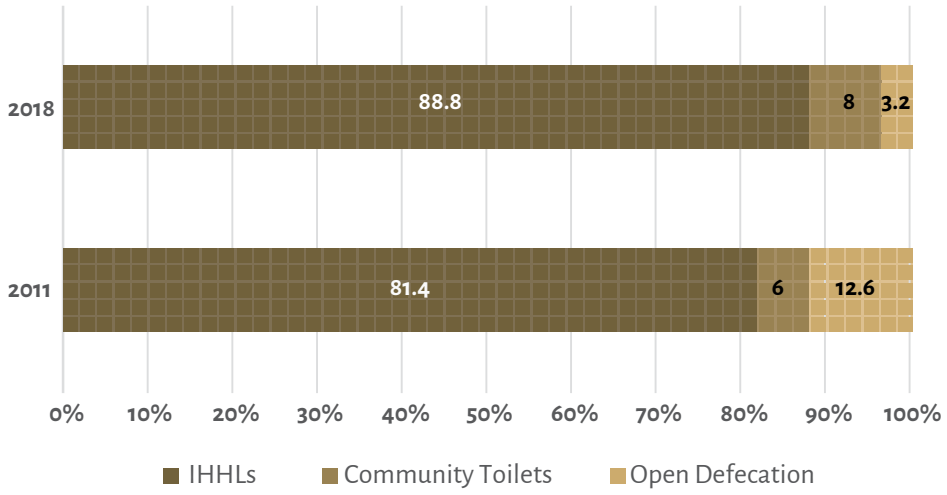
[5] Census of India, 2011, "Houses, Household Amenities and Latrines - Availability and Type of Latrine Facility 2001-2011", http://censusindia.gov.in/2011census/hlo/Data_sheet/India/Latrine.pdf accessed on 31.03.2019

[6] SBM-U Dashboard, http://swachhbharaturban.gov.in/dashboard/, accessed on 6 December 2019.

[7] Ibid.

[8] Ibid.

FIGURE 1: ACCESS TO SANITATION FOR URBAN HOUSEHOLDS – 2011 AND 2019



SBM-U as well as other Government of India (GoI) urban missions and programmes, including the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and Smart Cities Mission (SCM), have not accorded adequate attention to safe containment, conveyance, treatment, disposal and reuse of wastewater; this needs urgent attention if India is to fully leverage the public health and environmental benefits of improved sanitation access.

Till very recently the dominant approach for wastewater management in Indian cities has been in the form of provision of underground sewerage systems. However, the capital as well as Operation and Maintenance (O&M) costs are prohibitive and thus only 32.7 per cent of urban households were connected to sewerage systems in 2011.[9] Further, due to poor O&M one-third of the existing Sewage Treatment Plants (STPs) are not operational.[10] The operational treatment capacity (20,358 MLD) is sufficient to treat only 33 per cent of the total wastewater (62,000 MLD) generated by urban India.[11] Wastewater flow analysis for all urban centres in the country reveals that only 10-11 per cent of the total wastewater generated by urban households is safely treated (FIGURE 3).[12]

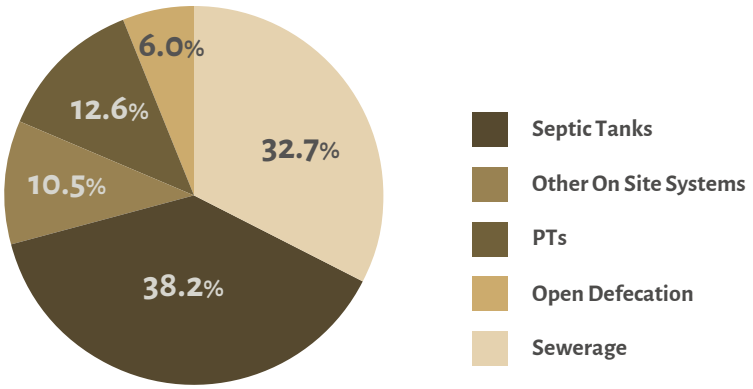
[9] Census of India, 2011, "Houses, Household Amenities and Latrines - Availability and Type of Latrine Facility 2001-2011", http://censusindia.gov.in/2011census/hlo/Data_sheet/India/Latrine.pdf accessed on 31.03.2019.

[10] Of the 899 municipal STPs listed across the country, only 605 (67 per cent) are operational. 77 STPs are non-operational, 149 are under construction, and 68 are proposed. CPCB, 'Inventorization of Sewage Treatment Plants', 2015, https://nrcd.nic.in/writereaddata/FileUpload/36590957INVENTORIZATION_OF_SEWAGE_TREATMENT_PLANT.pdf, accessed on 28.03.2019.

[11] The operational treatment capacity is 20,358.9 MLD. Ibid.

[12] Dasgupta, S., Murali, R., George, N., and Kapur, D, Faecal Waste Management in Smaller Cities Across South Asia: Getting Right the Policy and Practice, New Delhi: Centre for Policy Research, 2016.

FIGURE 2: DISTRIBUTION OF URBAN HOUSEHOLDS AS PER ACCESS TO WASTEWATER CONTAINMENT AND CONVEYANCE SYSTEMS



A large proportion of urban households (48.7 per cent) are connected to On-site Sanitation (OSS) systems including septic tanks and other OSS systems (FIGURE 2).[13] Anecdotal evidence indicates that most of the 5.57 million IHHLs constructed under SBM-U are also connected to OSS systems. OSS systems are essentially underground containment structures such as septic tanks and pits that collect, contain and partially treat faecal waste and wastewater. The faecal sludge accumulated in these systems needs to be periodically removed and treated before it can be safely disposed of the environment. While the responsibility for providing septic tank emptying services rests with Urban Local Bodies (ULBs), in reality the septic tank emptying and transportation business is operated largely by private cesspool operators, albeit informally. Further, due to lack of regulation, the collected faecal sludge is dumped indiscriminately in open areas and water bodies both within and outside cities and towns, leading to environmental pollution.

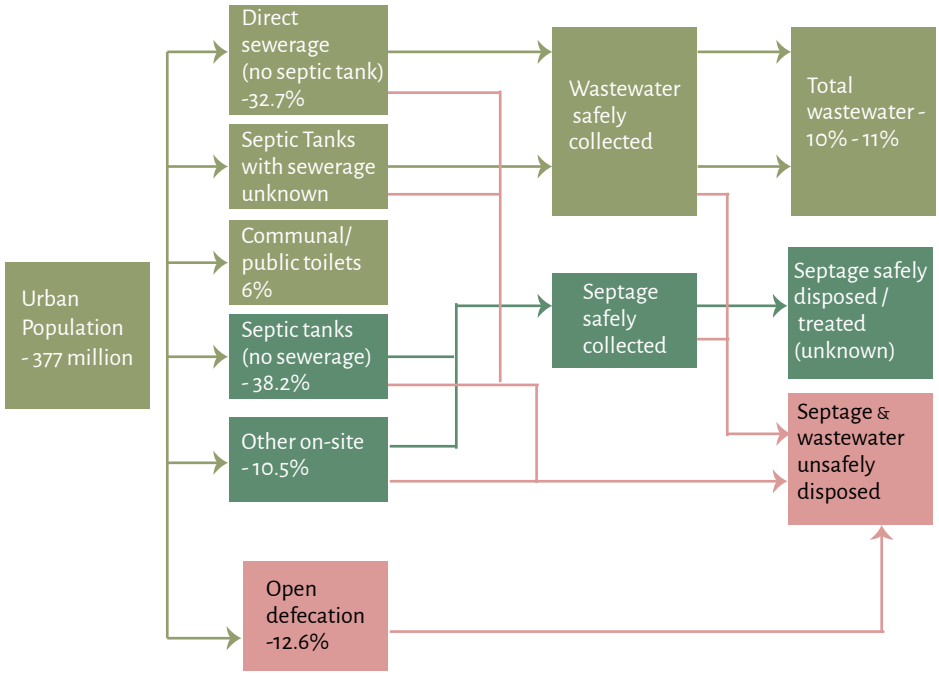
In order to provide an impetus to the implementation of Faecal Sludge and Septage Management (FSSM), the Ministry of Housing and Urban Affairs (MoHUA) launched the National FSSM Policy in February 2017. In response to this, many states have formulated their respective FSSM policies to ensure compliance with environment, health and safety laws as well as those prohibiting manual scavenging. With respect to the treatment of faecal waste and septage, most states/ULBs have adopted a two-pronged approach including (a) co-treatment of faecal sludge at existing STPs and (b) treatment of faecal sludge through decentralized and specialized Faecal Sludge Treatment Plants (FSTPs) (FIGURE 4). Recent research reveals that co-treatment of faecal waste and septage is being successfully undertaken at STPs in Goa, Chennai, Ghaziabad, Patna, Kanpur, Tiruchirappalli and Coimbatore.[14] In addition, some states (including Karnataka, West Bengal, Kerala, Jammu and Kashmir, Tamil Nadu, Odisha,

[13] OSS includes slab/ventilated open pit without slab/open pit, night soil disposed in open drains, and night soil disposed by animals and humans. Census of India, 2011, "Houses, Household Amenities and Latrines - Availability and Type of Latrine Facility 2001-2011", http://censusindia.gov.in/2011census/hlo/Data_sheet/India/Latrine.pdf accessed on 31.03.2019

[14] Gupta. S, Jain, S and Chhabra, S.S., "Draft Guidance Notes on Co-treatment of Septage at Sewage Treatment Plants in India", April 2017, https://www.fsmtoolbox.com/assets/pdf/150._Guidance_Note_on_Co-treatment_April_2018.pdf

Telangana, Andhra Pradesh, Maharashtra, Uttar Pradesh and Madhya Pradesh) are building decentralized FSTPs through private sector partnerships. While 22 FSTPs have been constructed, another 10 are under construction with treatment capacities ranging from 6 to 75 KLD.[15]

FIGURE 3: OUTLINE WASTEWATER FLOW DIAGRAM FOR ALL URBAN CENTRES IN INDIA[16]

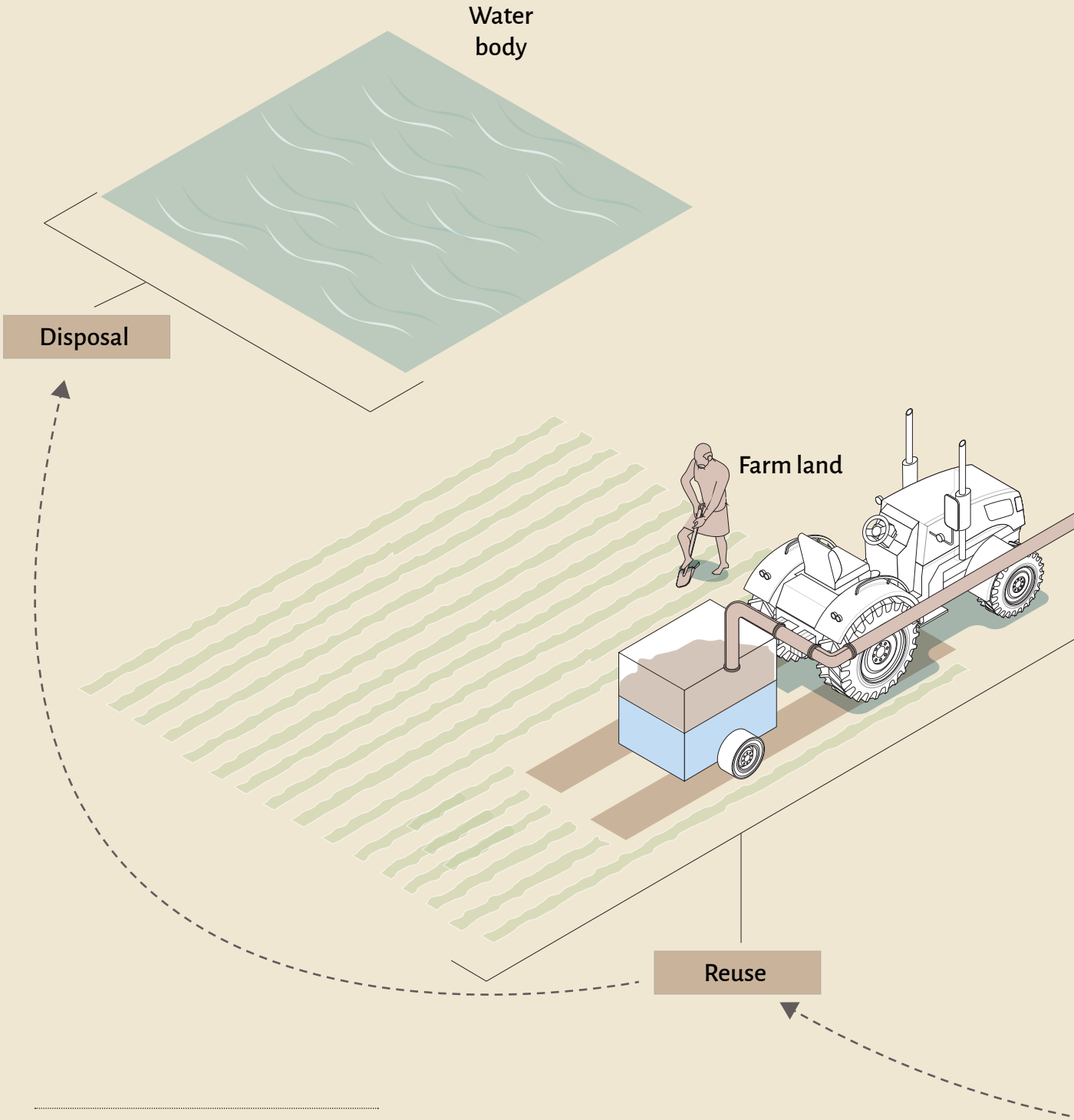


Experience from the field reveals that private operators are engaged at various points along the FSSM value chain. Specifically, private operators are involved in (a) emptying/ desludging of septic tanks and other OSS systems and transporting the collected faecal sludge to treatment facilities; (b) providing technology for treatment of faecal sludge; and (c) construction and/or O&M of treatment facilities (including STPs and FSTPs).

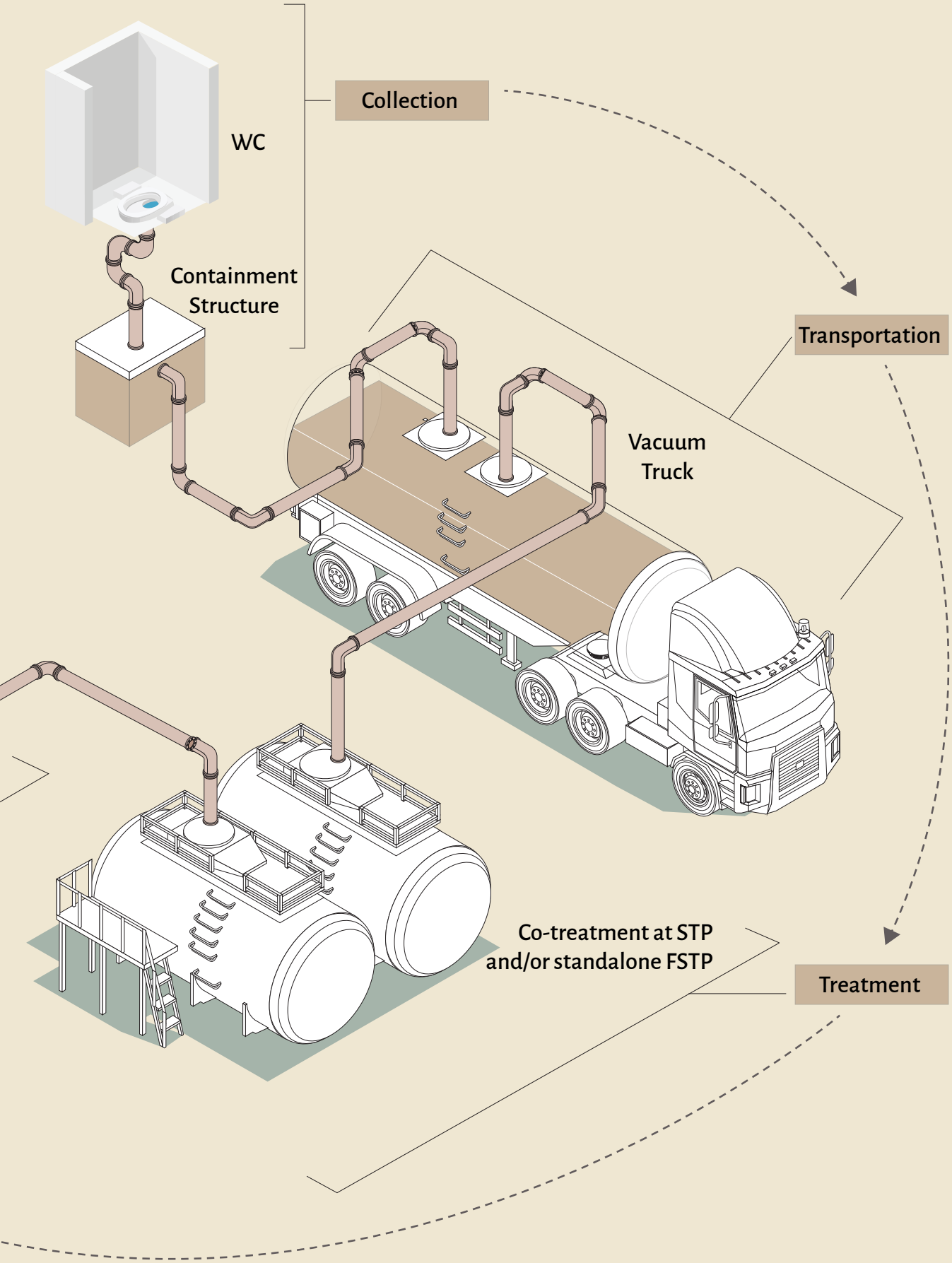
[15] MoHUA AMRUT – Technical Support Unit, FSTP database.

[16] Dasgupta, S., Murali, R., George, N., and Kapur, D., Faecal Waste Management in Smaller Cities Across South Asia: Getting Right the Policy and Practice. New Delhi: Centre for Policy Research, 2016.

FIGURE 4: SANITATION VALUE CHAIN FOR ON-SITE SANITATION SYSTEMS[17]



[17] Ibid.


Collection
WC
Containment Structure
Transportation
Vacuum Truck
Co-treatment at STP and/or standalone FSTP
Treatment

2

OBJECTIVES, APPROACH AND METHODOLOGY

2.1 OBJECTIVES

The main objective of this research is to build an understanding of the prevalent and emerging practices related to Private Sector Participation (PSP) in FSSM service delivery across the value chain (including emptying, transportation, treatment, disposal and reuse). The study also aims to map the policy and governance context and its influence on the models for PSP in provisioning of FSSM services. Through case studies of four urban centres in India, namely, Goa, Chennai, Jabalpur and Ujjain, the research seeks to estimate the market potential for FSSM services, the current arrangements for private sector engagement, and the risk-sharing/mitigation strategies being adopted by various stakeholders, including households, private entrepreneurs and local governments. The research aims to draw lessons from the four case studies and identify key takeaways that can potentially inform efforts towards creating an enabling environment for PSP in the FSM sector.

The key research questions of this study are:

- What is the degree of PSP across the FSSM value chain in the four case studies?
- What is the variation in the profitability of the operations of private vis-à-vis public providers of FSSM services?
- What is the nature of demand and its segmentation for FSSM services? What are the factors that drive (or inhibit) the demand?
- What are the key policy and governance elements that act as either enablers or barriers for PSP in the FSSM sector?

- What are the potential risks faced by households, private entrepreneurs and local governments and what are the risk sharing / mitigation strategies being adopted by them?
- What are the various models and contractual arrangements that are emerging across the FSSM value chain?

2.2 PREVIOUS WORK

In a previous research, informal FSSM service providers across four cities (including Jaipur, Dehradun, Bhubaneshwar and two neighbourhoods in Delhi) were interviewed to understand the scope and nature of the FSSM emptying/desludging market. These case studies of FSSM service providers provided insights into the growth and organization of small, informal enterprises that dominate the FSSM emptying sector. Based on the findings of this study, a business modelling exercise was carried out to assess the profitability and the impact of exogenous market shocks, such as new regulations or the creation of treatment sites.

2.3 CASE STUDY SELECTION FOR PRESENT RESEARCH

On the strength of the findings of the previous research, the current phase was planned to examine the FSSM market across the entire value chain (including emptying, transportation, treatment, disposal and reuse) . The research covers four urban centres, namely Goa, Chennai, Jabalpur and Ujjain. In Goa the study area broadly coincides with the North Goa district,[18] while in Chennai it coincides with the area under the jurisdiction of the Greater Chennai Municipal Corporation (GCMC).[19] The other two urban centres, namely Jabalpur[20] and Ujjain,[21] are Class I cities located in Madhya Pradesh.

These four urban centres were chosen from a list of 23 cities that have extant treatment facilities for faecal sludge. While two urban centres (Goa and Chennai) are undertaking co-treatment of faecal sludge at existing STPs that have spare treatment capacities, the other two cities (Ujjain and Jabalpur) have constructed FSTPs for treating faecal sludge. In Goa, co-treatment is taking place at the Tonca STP in Panaji while in Chennai co-treatment is being undertaken at five STPs (Kodungaiyur, Koyambedu, Nesapakkam, Perungudi and Alandur). In Chennai, bulk of the co-treatment occurs at Nesapakkam and Perungudi STPs where decanting stations have been constructed; at the other three STPs, the transported septage is dumped in Sewage Pumping Stations (SPSs) upstream of the STP. Jabalpur has three operational FSTPs of 50 KLD each, while Ujjain has only one FSTP of 50 KLD; another of the same capacity is under construction.

[18] The North Goa district covers an area of 1736 sq km and includes 7 Municipal Towns, 40 Census Towns and 188 inhabited villages. Directorate of Census Operations, Goa, Series 31, Part XII B, 'District Census Handbook North Goa – District Wise and Town Wise Primary Census Abstract', http://censusindia.gov.in/2011census/dchb/3001_PART_B_DCHB_NORTH%20GOA.pdf, accessed on 07.04.2019.

[19] Spread over an area of 152.53 sq km.
[20] Spread over an area of 152.53 sq km.
[21] Spread over an area of 92.68 sq km.

2.4 APPROACH AND METHODOLOGY

The present research is based on a mixed methods approach including use of secondary and primary research methodologies with a focus on strong evidence building. The secondary research was aimed at developing an understanding of the FSSM sector in urban India. It entailed review of national and state policies,and previous research reports and databases related to various GoI missions and programmes related to urban sanitation. The secondary research helped identify urban centres to be covered by the primary research.

The primary research covered an assessment of the demand for and supply of FSSM services across the sanitation value chain in the four urban centres (Goa, Chennai, Jabalpur and Ujjain). It included consultations and interviews with both demand-side stakeholders (including domestic, commercial and institutional users) and supply-side stakeholders (including private enterprises involved in emptying/desludging septic tanks and transporting the collected faecal sludge to the treatment facility, technology providers for faecal sludge treatment facilities, and private contractors responsible for construction and O&M of treatment facilities including STPs and FSTPs) (FIGURE 5).

FIGURE 5: PRIMARY RESEARCH – ASSESSMENT OF DEMAND AND SUPPLY OF FSM SERVICES

Demand Assessment

- Individual households
- Group housing colonies and condominiums
- Commercial establishments
- Institutions

Supply Assessment

- Private enterprises/informal sector involved in emptying/desludging of septic tanks and transportation of collected faecal sludge to treatment facility
- Technology providers for faecal sludge treatment facilities
- Private contractors responsible for construction and O&M of treatment facilities including STPs and FSTPs

3

VIABILITY OF THE FSSM MARKET

3.1 DEMAND FOR THE FSSM MARKET

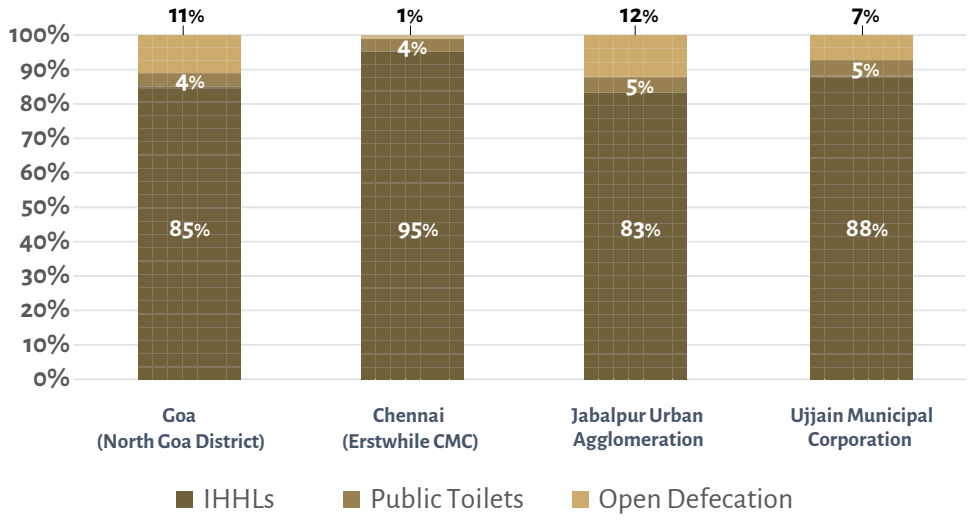
3.1.1 Factors driving demand

i. Improvements in access to sanitation services

In 2011 the proportion of households with access to IHHLs across the four case study locations ranged from 83 per cent in Jabalpur (Jabalpur Urban Agglomeration– UA) to 96 per cent in Chennai (erstwhile Chennai Municipal Corporation – CMC[22]) (FIGURE 6). With the implementation of SBM-U, access to sanitation services has been further enhanced in all case study locations. Given the construction of IHHLs, PTs and CTs under SBM-U during 2014-18, the proportion of households defecating in the open has become nil and all households now have access to sanitation facilities in the form of either IHHLs and CTs/PTs. In fact, in August/September 2018, Chennai, Jabalpur and Ujjain have been declared to be ODF.

[22] In October 2011, CMC's jurisdiction was expanded to include 42 local bodies (including 9 municipalities, 8 Town Panchayats and 25 Village Panchayats) lying contiguous to the core city, increasing the area under the jurisdiction of CMC from 176 to 426 sq km.

FIGURE 6: ACCESS TO SANITATION SERVICES IN NORTH GOA DISTRICT, CHENNAI, JABALPUR AND UJJAIN – 2011[23]



ii. Reliance on OSS systems

With respect to containment and conveyance systems Chennai (erstwhile CMC) is the only case study location that has a substantial proportion of households with IHHLs connected to underground sewerage systems (97 per cent) (FIGURE 7). According to the Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB), the agency responsible for planning, developing and regulating water supply and sewerage services in the GCMC area, all households with IHHLs in the erstwhile CMC area are now connected to underground sewerage systems. However, the local bodies (urban and rural) incorporated into CMC in 2011 are not yet fully covered with underground sewerage systems and still have a significant proportion of households with IHHLs connected to septic tanks and other OSS systems. Plans to ensure that the entire area under the jurisdiction of GCMC is fully covered with underground sewerage systems are currently being implemented at a rapid pace[25]. The establishment of a well-defined goal (of creating underground sewerage infrastructure) coupled with the presence of a dedicated utility (in the form of CMWSSB), as well as the availability of funding through GoI schemes such as AMRUT[26] and from multilateral agencies, are the key enabling factors for speedy implementation of an underground sewerage system in Chennai.

In the remaining three case study locations a significant proportion of households with IHHLs are connected to septic tanks and other OSS systems: 87 per cent in Jabalpur,

[23]Census 2011.

[24]In 2016, CMC was renamed the Greater Chennai Municipal Corporation (GCMC).

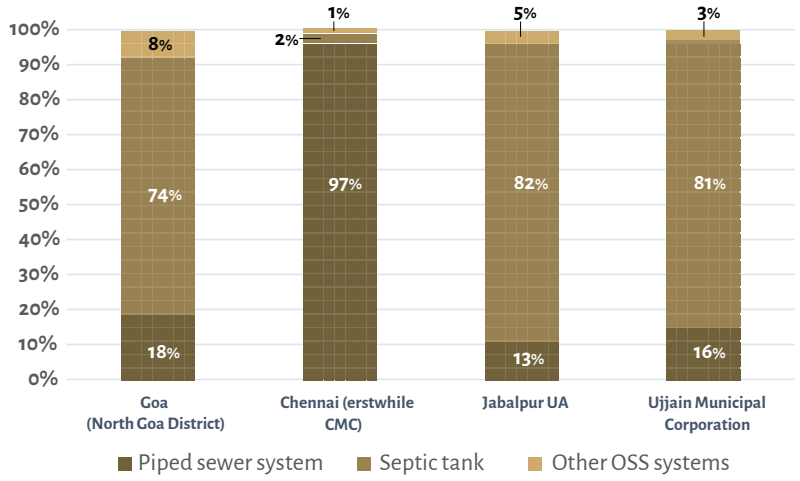
[25]Of the 42 local bodies (including 9 municipalities, 8 Town Panchayats and 25 Village Panchayats), work has already been completed in four (Madhavaram, Valasaravakkam, Alandur and Meenambakkam) and is in progress in another 17 local bodies. Further, planning and project formulation processes (including preparation of Detailed Project Reports) are underway in 21 local bodies.

[26]Under AMRUT there is a project for provision of underground sewerage system for eight recently added local bodies. For the provision of UGSS for eight added areas a sum of INR 482.72 crores was allocated of which 90 per cent of the allocated work has been completed and INR 317.29 crores utilized.

84 per cent in Ujjain and 82 per cent in Goa (FIGURE 7). Anecdotal evidence suggests that most of the IHHLs constructed under the ambit of SBM-U are also based on OSS systems. ***A predominant presence of IHHLs connected to septic tanks and other OSS systems points to an existing and sizeable demand for periodic emptying, transportation and treatment of the faecal sludge/septage that accumulates in these systems.***

The Jabalpur Municipal Corporation (JMC) plans to cover the entire area under its

FIGURE 7: CONTAINMENT AND CONVEYANCE SYSTEMS FOR WASTEWATER ACROSS CASE STUDY LOCATIONS (CENSUS 2011)



jurisdiction with underground sewerage systems by 2021 as a part of the AMRUT[27] and SCM[28] projects. Even with dedicated funding support, to the tune of INR 638 crores (under AMRUT and SCM), the provision of underground sewerage infrastructure has been abysmally slow. The tardy pace of implementation can be attributed to the presence of multiple land-owning agencies[29] within Jabalpur UA, lack of coordination between them, and absence of an institutional convergence mechanism.

In North Goa district, of the seven municipal towns, only Panaji has a well-developed underground sewerage system. As per the City Sanitation Plan (CSP) of Panaji, in 2015, 61 per cent of households in the area under the jurisdiction of the City Corporation of Panaji (CCP) were connected to the piped sewer system. During 2014-16 expansion of the sewerage network was undertaken in the uncovered areas, which has pushed the coverage figure to 80 per cent. Plans to cover the remaining uncovered areas[30] under the jurisdiction of the CCP and the seven urban outgrowths (OGs)[31] which are a part of Panaji UA by underground sewerage systems are being implemented in a phased manner.

[27]Approved funding of INR 600 crores for sewerage projects.

[28]Includes laying new sewerage network along a distance of 42.71 km (cost INR 34.17 crores); creating primary sewerage network for Decentralized Wastewater Treatment Systems (DEWATS) for 1.5 km (INR 2.25 crores), construction of two DEWAT plants of 6 MLD each (INR 24 crores), and STP construction and laying of sewer line at Non Motorised Transit (NMT) Corridor Omti Nala (INR 3.38 crores). Annexure 3 of Jabalpur Smart City Proposal.

[29]Including JMC, Cantonment Board, Ordinance Factory and Gun Ordinance Factory, among others.

[30]Including wards 29 and 30 in Ribander and some pockets inhabited by migrants belonging to the EWS/LIG sections.

[31]Panelim, Morambi-O-Grande, Renovadi, Morambi-O-Pequeno, Cujir, Taleigao, Durgawado.

[32]Of the 54 wards, while 34 wards will be fully covered under Phase I, 11 would be covered partially and the remaining 9 would be left uncovered.

In Ujjain, the Ujjain Municipal Corporation (UMC) is currently implementing a project aimed at covering the entire city with underground sewerage infrastructure. Funded under AMRUT, the approved project cost for the first phase is INR 402 crores. In the project's first phase, which is to be completed by 2020, 80,350 household connections will be provided along with laying of sewerage pipeline across 45 wards[32] and installation of an STP with a capacity of 92 MLD.

The above account reveals that even though most households with IHHLs are currently connected to OSS systems, ULBs remain focused on implementing underground sewerage schemes. Further, most of the ongoing projects related to the construction of sewerage infrastructure concentrate on laying a sewerage network and creating treatment capacity. There are hardly any projects (except for one in Ujjain) that pertain to providing house connections; this implies that even though capital-intensive infrastructure is created, the end-user remains unconnected. Further, given the huge land requirements, presence of multiple agencies with overlapping jurisdictions, and limited technical capacities within ULBs, the implementation of underground sewerage projects has been painfully slow. The preoccupation of ULBs with the creation of underground sewerage systems and treatment systems ***(in the form of STPs) has meant that FSSM is being adopted only as an interim solution, if at all.***

3.1.2 Issues that reduce/inhibit the market

i. Septic tanks: Design and construction practices

The standards pertaining to the design and construction of septic tanks are clearly spelt out in Section 25.3.1 of the 'Modern Building By-laws, Manual on Sewerage and Sewage Treatment' (Second Edition) issued by the Central Public Health and Environmental Engineering Organization (CPEEHO) and the Indian Standards Code.[33] Adherence to these standards is crucial for ensuring that these systems provide preliminary treatment on-site. However, field research and interactions with households across the four case study locations revealed that the design and construction of septic tanks mostly do not adhere to the prescribed standards. Households tend to construct large septic tanks (ranging from 10,000 cubic feet to 30,000 cubic feet) in order to delay the need for emptying and desludging due to the costs involved. Field interactions revealed that some septic tanks are so large that they don't need to be emptied even once in 10/15 years. Further, the lack of monitoring by ULBs and absence of regulation in this sector imply that there is no obligation for households to adhere to prescribed standards.

ULBs do not have a database of the size, type of construction and present condition of septic tanks and other OSS systems in the area under their jurisdiction. This constrains their ability to make an informed decision while developing contracts with private cesspool operators whom they might engage for carrying out emptying/desludging of septic tanks and other OSS systems. Interactions with private cesspool operators revealed that the absence of a database is a disadvantage for them as well as they enter into a contract with the ULB without adequate information on the market.

[33]Bureau of Indian Standards (BIS), 2470 (Part 1): Code of Practice for Installation of Septic Tanks, Part 2: Design Criteria and Construction (Second Edition), 1985

Such a database is of crucial importance to decide whether or not a city/town should implement a systematic desludging arrangement and also for planning the modalities of its implementation. A standard desludging frequency of three years may not be suitable for most cities as the size of existing septic tanks is large.

Across the four case study locations some attempts have been made to ensure adequate monitoring and regulation with respect to septic tank design and construction. In Goa, the Public Health Engineering (PHE) Department has taken a proactive role in regulating the construction of septic tanks in Panaji and PUA, and has prescribed a standard design for septic tanks. Households are required to adhere to the prescribed design and seek approval from the PHE Department prior to construction. In Tamil Nadu, the Government of Tamil Nadu (GoTN) has issued 'Operative Guidelines for Septage Management for Urban and Rural Local Bodies, which, among other aspects, require ULBs to *'evaluate existing septic tank designs and other storage/treatment systems and modify (in case of variation) based on the suggested design as well as issue notice to owners of septic tanks that do not meet the standard septic tank design under Tamil Nadu Public Health Act, 1939'*.

3.2 PRIVATE SECTOR INVOLVEMENT IN EMPTYING AND TRANSPORTATION OF FAECAL WASTE

The responsibility for providing septic tank emptying/desludging services rests with the ULBs; they can decide whether to provide these services on their own or contract a private agency. ULBs find it difficult to meet the demand for emptying/desludging of septic tanks due to lack of adequate vehicles and staff as well as their preoccupation with other functions. This has resulted in mushrooming of small and mid-sized entrepreneurs who provide mechanical (and manual) desludging of septic tanks/pits and transport the collected waste away from residential areas.

The models of engagement have developed organically in response to the local environment and thus vary considerably across the four case study locations. In Goa, there are around 40-50 individual owners who own approximately 60-70 trucks (capacity ranging between 6 KL to 12 KL) involved in emptying septic tanks.[34] Single-truck owners are predominant, while two owners reported having seven trucks each. Private cesspool operators collect around 120 truckloads of septage every day. The private cesspool operators are not required to register with any public or local body. They service most of North Goa district and have direct links with the customers who contact them via phone or in person. The service (of emptying and transportation of septage) is provided for a fee, ranging from INR 2000 to 3500 depending on the type of consumer. While individual households are charged INR 2000, commercial establishments (including hotels) are charged INR 3500 per trip. The public agency at the helm of this initiative is the PHE Department and its role is limited to overseeing the process of decanting, collection of the tipping fee (at INR 500 per truck per trip), and ensuring smooth treatment of the decanted septage along with the sewage inflows at the Tonca STP at Panaji.

In Chennai, the operations along the FSSM value chain are guided by the

[34]Interviews with PHE Department officials at the Tonca plant and individual cesspool operators.

recommendations of GoTN's 'Operative Guidelines for Septage Management for Urban and Rural Local Bodies'. All private desludging operators are required to be certified and licensed by the respective ULBs. While 60-70 desludging operators (having trucks with an average capacity of 9 KL), are registered with the Nesapakkam STP, more than 120 operators are registered with the Perungudi STP. As in Goa, the consumers contact the private cesspool operators directly as and when they require emptying and desludging services. The fee for emptying and desludging services charged by the private cesspool operators varies according to the type of consumers. For households, the fee ranges from INR 900 to 1500 while for institutions it usually ranges from INR 1500 to 3000. The fee is fixed based on negotiations between the service provider (private cesspool operators) and the consumer, and there is no intervention by the local body/CMWSSB.

In Jabalpur there are three municipal vehicles and an equal number of private vehicles providing emptying/desludging services with the latter registered as cooperative societies.[35] The demand for emptying/desludging is routed through JMC. There are three routes for registering demand, including the JMC centralized helpline number, Chief Minister's Helpline[36] (toll free number 181) and the office of the Chief Health Officer (CHO), JMC. All requests received are routed through the CHO who, along with her team, plans the allocation of vehicles. While municipal vehicles are deployed for non-revenue trips to collect sewage from MP Housing Board colonies[37] that have recently been handed over to the JMC for maintenance, private vehicles are sent to locations such as individual houses, apartment blocks and institutions which pay for the service.[38] The collected septage is decanted at the nearest FSTP (Garha, Polipathar or Adhartal).

In Ujjain, there are four municipal trucks (capacity ranges from 3 KL to 6 KL) involved in providing emptying/desludging services. All four trucks are operated by employees of UMC. There are no private cesspool operators in Ujjain. Cesspool operators collect about 20 truckloads of septage every day and decant it either at the Sadawal FSTP or one of the SPSs. Desludging requests are routed through a dedicated helpline number or the office of the CHO.

Details of cesspool operators across the study locations are presented in TABLE 1.

[35] Maa Narmada Safai Sanrakshak Kaamgaar evam Labour Contractor Co-operative Society and Sai Seva Safai Evam Labour Contractor Sahakari Samiti Marya.

[36] http://cmhelpline.mp.gov.in/, accessed on 15.04.2019.

[37] These colonies are devoid of any sewerage or OSS systems. The wastewater (including greywater and blackwater) from individual households accumulates in large low-lying areas of the colony. This is leading to poor environmental conditions in these colonies. Residents complained of foul smell and breeding of disease-spreading vectors (including mosquitoes).

[38] Based on a review of the vehicle logbooks of municipal and private vehicles.

TABLE 1: DETAILS OF CESSPOOL OPERATORS ENGAGED IN EMPTYING/DESLUDGING SEPTIC TANKS IN GOA, CHENNAI, JABALPUR AND UJJAIN

Study Location	Goa	Chennai		Jabalpur	Ujjain
Number of trucks providing emptying services	60-70 (private)	60-70 (private)	120+ (private)	3 municipal 3 private	4 municipal
Number of trips made every day	120	200	300	30	20
Capacity of trucks (in KL)	6–12	9	9	4	3 (3) 6 (1)
Volume of FS collected and decanted at the STP/ FSTP every day (MLD)	0.96	1.8	2.7	0.8	0.09
Volume of FS as a % of sewage flows received at the treatment facility	9.6	1.8	2.6	100	100

3.2.1 Demand segmentation

To assess demand segmentation, interviews were carried out with a cross-section of consumers, including individual households, apartment buildings, commercial establishments and housing colonies. In Ujjain and Jabalpur where the desludging requests are routed through the respective ULB, the records of these invoices were used to corroborate interview findings.

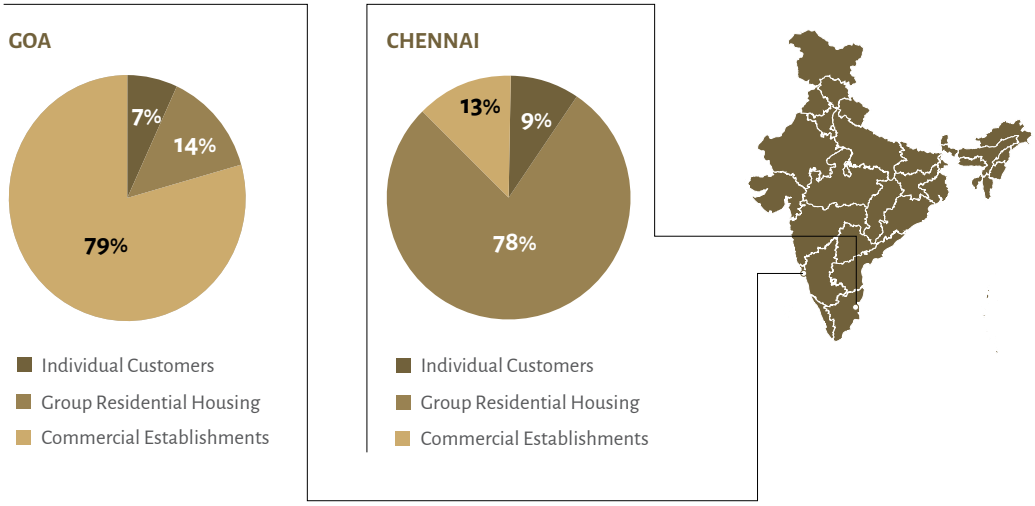
The nature of customer demand and market segmentation varies significantly across the four case study locations. The various categories of users include individual households, group housing (including apartment blocks and condominiums), commercial establishments, institutions, CTs/PTs and the ULB (related to provision of cleaning services for the sewerage network/desludging of low-lying areas). Two broad segments were identified in the desludging market, namely individual customers and bulk customers. While the former refers to single-family households of four to six members, the latter is a diverse category including high-rise apartments, large hotels/commercial establishments and buildings that house multiple families ('group residential housing'). The defining feature of a 'bulk customer', in relation to estimating demand for emptying/desludging services, is not the size of the containment structure but the number of individuals/families which rely on that structure.

Interviews with users (households) and private cesspool operators as well as an analysis of records maintained by the service provider/ULB indicate that individual customers formed only a very small part of the FSSM market across the four case study locations. In Goa and Chennai, demand from individual single-family households remains a peripheral driver of the market. While both markets benefit from a high proportion of bulk customers, the granular nature of this demand is inverted between the two locations (FIGURE 8). In Goa, private cesspool operators service mainly commercial establishments, primarily hotels (75 per cent), while in Chennai such operators mainly serve apartment and multi-family complexes of various sizes. This inversion of demand is a possible contributor to the differences in prices (see TABLE 5 below) and number

of operators between the two sites, seen in TABLE 1. The commercial establishments in Goa are spatially concentrated on the beaches of Anjuna, Baga, Calangute and Candolim, while demand in Chennai is somewhat concentrated around the respective STPs but certainly more spread out, relative to Goa. Serving Chennai's non-sewered buildings requires a higher number of operators, both due to the larger area served and higher demand. This drives a higher number of operators and consequently more competition, which keeps the prices lower in Chennai, relative to Goa.

Survey visits to bulk customers showed that they build large containment structures,

FIGURE 8: DEMAND SEGMENTATION ACROSS GOA AND CHENNAI



typically watertight septic tanks with no outlet, which fill up rapidly due to the large number of users. Most of these customers across both Chennai and Goa report desludging every week, with some even desludging twice a week. For example, when tourist numbers increase in Goa (from October to March), many hotels require frequent desludging.

In addition, though both cities have building bye-laws that mandate construction of on-site STPs for blackwater and reuse of greywater in commercial and residential buildings above certain sizes, interviews with masons and municipal officials revealed a lax enforcement of these regulations. This leads to most buildings and establishments constructing septic tanks which require periodic desludging services. The cost of maintenance of these STPs can often exceed the desludging cost, requiring multiple trained workers and frequent replacement of parts. As a result, and in the absence of penalties for non-compliance, Resident Welfare Associations (RWAs) and building managers often opt for construction of septic tanks over STPs.

The FSM emptying market in both Ujjain and Jabalpur shares one feature with Goa and Chennai: the low contribution of individual (single-family) households to overall market operations (10 per cent in Jabalpur and 5 per cent in Ujjain). In other respects, however, these markets are substantially different. While 'bulk customers' remain a key driver of the market, the demand for FSSM collection and transport services also includes components such as desludging services for CTs/PTs and cleaning services for drains and condominial sewers in housing colonies. These services have been

classified together as 'Others' in FIGURES 9 and 10 below, with a breakdown of that category accompanying each figure.

In Jabalpur, apartments and other forms of group residential housing contribute 43 per cent of the demand while another 20 per cent comes from housing colonies. The demand from housing colonies originates from colonies built under various schemes by the Madhya Pradesh Housing Board (MPHB) which are devoid of any sewerage or OSS systems. The wastewater (including greywater and blackwater) from individual households flows through covered drains and empties into a large low-lying area. Earlier, the wastewater flowed into large tanks from where it was emptied and transported for treatment; however, the land on which the tanks lay has now been built upon and thus all wastewater flows into an open area. Similarly, another 14.6 per cent of total demand comes from drain cleaning requests from around the city on account of choking of the existing sewerage or drainage network.

A key element of this demand configuration is that only 16 per cent of trips made by a cesspool truck in Jabalpur are revenue generating. This comprises 10 per cent of requests that are received from individual households and 5.59 per cent of requests that are for cleaning of PTs. Since nearly 84 per cent of trips are made without generating any revenue, the overall market becomes quite unviable in the short and medium terms.

A similar profile is found in Ujjain (FIGURE 10), a city whose urbanization profile and pattern have centred around tourism to its religious sites, characterized by a large floating population. Nearly 30 per cent of trips made by cesspool operators are to PTs/CTs, which are mostly operated and maintained by Sulabh[39], and thus generate revenue but others are operated and maintained by the ULB and thus the trips are non-revenue

FIGURE 9: DEMAND SEGMENTATION IN JABALPUR

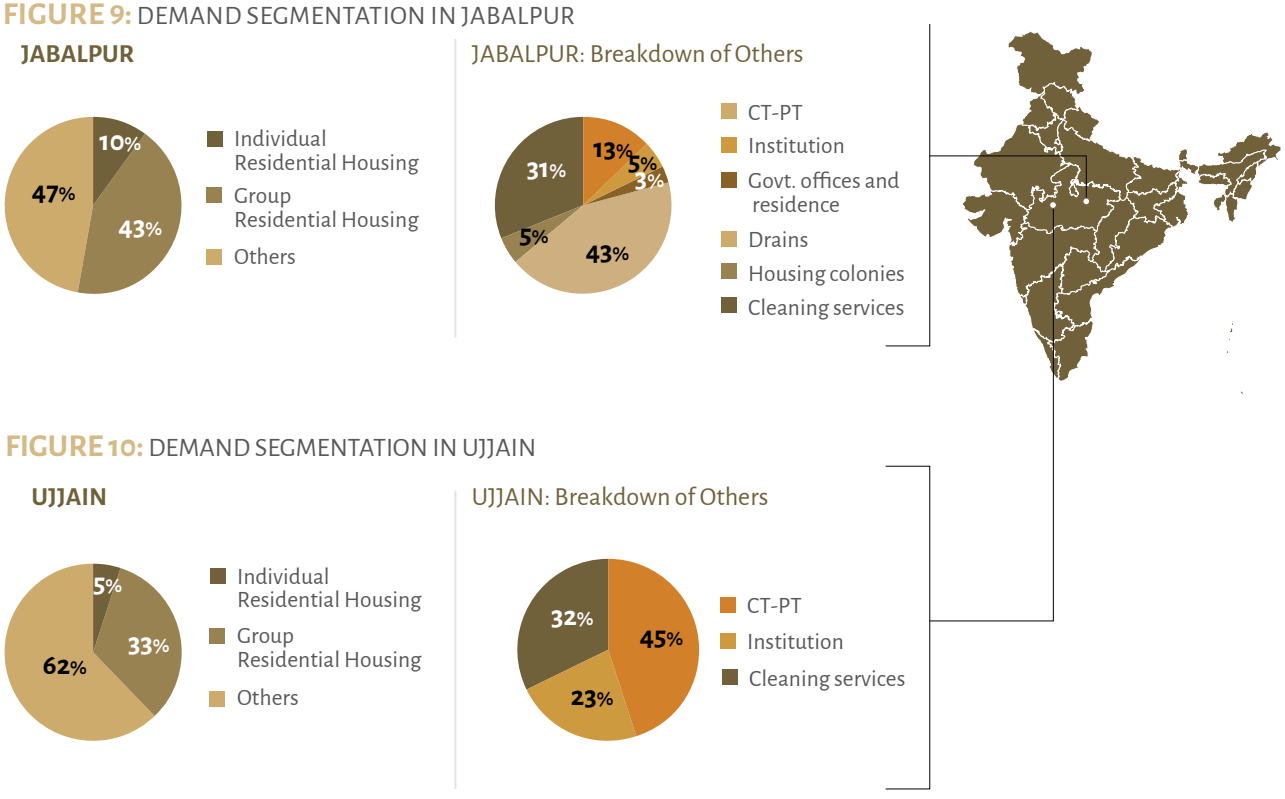


FIGURE 10: DEMAND SEGMENTATION IN UJJAIN

[39]Sulabh International Social Service Organisation is noted for achieving success in the field of cost-effective sanitation, liberation of scavengers, social transformation of society, prevention of environmental pollution and development of non-conventional sources of energy

generating. The 33 per cent of trips to 'group residential housing' comprise simply trips made to desludge or clean blocked drains in housing colonies; while these constitute a significant portion of total trips, they do not generate any revenue. Overall, only 32 per cent of the trips made generate revenue.

3.3. MODELS FOR TREATING FAECAL WASTE: CO-TREATMENT AT STPS AND TREATMENT AT FSTPS

3.3.1 Co-treatment at STPs

Goa and Chennai are undertaking co-treatment of faecal sludge at existing STPs. In North Goa, co-treatment is being undertaken at Tonca STP. In Chennai, it is being undertaken at all five STPs (Kodungaiyur, Koyambedu, Nesapakkam, Perungudi and Alandur) though in varying degrees.

The main enabling factor for initiating co-treatment in both Goa and Chennai has been the presence of spare treatment capacities. In Goa, the Tonca STP has a capacity of 12.5 MLD while it receives wastewater flows of 10 MLD, resulting in a spare capacity of 2.5 MLD (20 per cent of the plant's installed capacity).[40] In Chennai, the Nesapakkam STP has three treatment trains with a combined capacity of 117 MLD. The plant receives wastewater flows of 95-100 MLD, resulting in a spare treatment capacity of 17-22 MLD (19 per cent of the plant's installed capacity).[41] Perungudi STP also has three treatment trains of 54, 60 and 12 MLD. The plant receives wastewater flows of 103.5 MLD and has a spare capacity of 22.5 MLD which is 19 per cent of the plant's installed capacity (TABLE 2).[42]

TABLE 2: DETAILS OF STPS UNDERTAKING CO-TREATMENT IN GOA AND CHENNAI

Parameters/Study Area Location	Goa	Chennai	
Name of the plant	Tonca	Nesapakkam	Perungudi
Installed capacity (MLD)	12.5	117	126
Treatment train and capacity (MLD)	Single (12.5 MLD)	Three (23, 40 and 54 MLD)	Three (54, 60 and 12 MLD)
Current sewage flows (MLD)	10	95-100	103.5
Spare capacity (MLD)	2.5	17-22	22.5
Spare capacity (%)	20	19	18
Plant technology	Cyclic activated sludge[43]	Activated sludge process	Activated sludge process with anaerobic digestion and biogas

[40] S. Gupta, S. Jain and S.S. Chhabra, 'Draft Guidance Notes on Co treatment of Septage at Sewage Treatment Plants in India', April 2017.

[41] Ibid.

[42] Ibid.

[43] C Tech is an advanced Sequential Batch Reactor (SBR) technology.

Creating dedicated infrastructure for co-treatment[44]: Initiating co-treatment has required the creation of a dedicated decanting station at the STPs by the service providers (PHE Department at Tonca and CMWSSB in Chennai).

The decanting station at the Tonca STP is fairly rudimentary, consisting of a manhole located upstream of the STP preliminary treatment works into which cesspool operators decant septage. There is no equalization/storage tank for receiving septage. The decanting station has a boundary wall and there is enough space for only one or two trucks to decant at a given time. This results in long queues and waiting times for the trucks which remain parked on the two main access roads. As the decanting station is located in a residential area the movement and parking of large trucks create a lot of nuisance for the residents – including reduced space on colony roads, noise and air pollution.

The decanting station at the Nesapakkam STP in Chennai has been designed in line with the recommendations of the 'Operative Guidelines for Septage Management for Urban and Rural Local Bodies' issued by GoTN. Though located within the STP complex, the decanting station has a separate entrance. It allows for up to four trucks to decant simultaneously and another four to five trucks to be parked within the compound. It has a covered receiving tank, grit removal chamber and screens with the receiving tank being covered and connected to an odor control air scrubbing unit.

Making changes to treatment processes[45]: Mixing of septage with sewage prior to treatment has not resulted in any adverse impact on the Tonca and Nesapakkam STPs. Some modifications were, however, required in the O&M of the Nesapakkam STP. Each truckload of septage (average of ~9 KL) is estimated to require an additional 2 kg of air to maintain reactor performance and desired effluent quality. The operational hours for aerators have been increased to meet this additional need. Septage addition has also increased the sludge-handling load of the STP. However, plant engineers observed that the existing plant capacity was sufficient to handle higher loads.

3.3.2 Creation of dedicated facility for treatment of faecal sludge – FSTPs

In Jabalpur and Ujjain, the treatment of faecal sludge is being carried out through dedicated FSTPs. In Jabalpur there are three FSTPs (capacity of 50 KLD each) which have a combined capacity of 150 KLD. Based on Semi-Fluidized Bed Reactor (SFBR) technology all FSTPs were constructed by a private firm, Meco Technologies, in 2017. The same firm is also responsible for the plant's O&M. Official records show that there is spare capacity of 47.5 KLD (TABLE 3).

In Ujjain there is only one FSTP (capacity of 50 KLD) at Sadawal while another plant is under construction. The FSTP is located on the city's periphery right next to the Sadawal STP (TABLE 3).

[44] This section is based on secondary research (S. Gupta, S.Jain and S.S. Chhabra, 'Draft Guidance Notes on Co-treatment of Septage at Sewage Treatment Plants in India', April 2017) and field observations.

[45] This section is based on secondary research (S. ('Gupta. S, S. Jain, S and S.S. Chhabra, S.S., '"Draft Guidance Notes on Co-treatment of Septage at Sewage Treatment Plants in India"', April 2017) and field observations

TABLE 3: DETAILS OF FSTPS OPERATIONAL IN JABALPUR AND UJJAIN

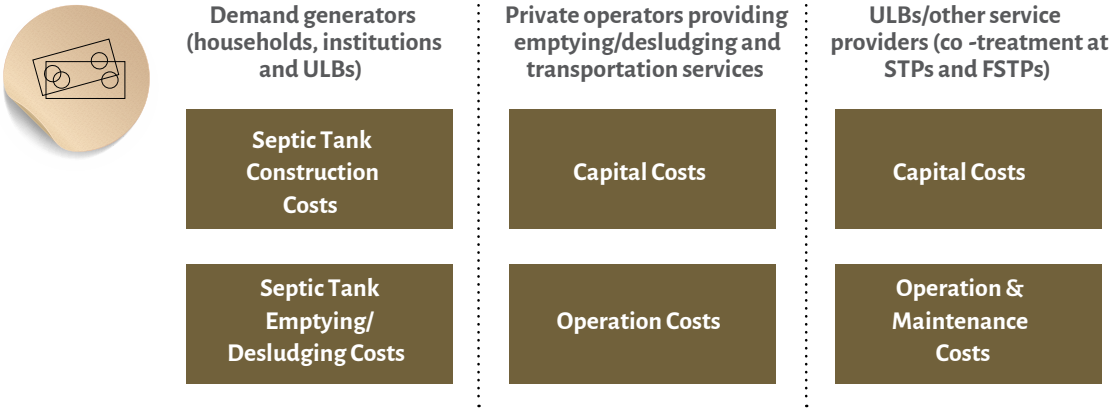
Parameter	Jabalpur	Ujjain
Number of plants	3	1 (1 under construction)
Individual plant capacity (KLD)	50	50
Total capacity (KLD)	150	50 (to increase to 100)
Operational since	2017	2018
Technology type	Semi-Fluidized Bed Reactor (SFBR)	Moving Bed Biofilm Reactor (MBBR)
Daily flows at inlet (in KLD)	102.5	24
Daily volumes at outlet (in KLD)	24 (Adhartal and Polipathar)	24
Spare capacity	47.5	26
Private partner – construction and O&M	Meco Technologies Pvt Ltd	DD Enviro Builders Pvt Ltd

3.4 COST ANALYSIS

3.4.1 Cost analysis framework

Cost analysis has been undertaken for three key stakeholders in the FSSM supply chain, including (a) demand generating stakeholders (including households, institutions and ULBs); (b) private operators engaged in emptying/desludging septic tanks and transporting the collected faecal waste away from residential areas; and (c) ULBs/ service providers/private operators undertaking construction and O&M of treatment facilities through co-treatment at STPs and/or FSTPs.

FIGURE 11: FRAMEWORK FOR COST ANALYSIS OF FSSM SERVICES



3.4.2 Costs for demand-generating stakeholders

i. Costs for construction of septic tanks

Users (including individual households and group housing) have to bear the cost of construction of septic tanks at a rate of INR 50 per cubic feet in Jabalpur and Ujjain. In case of prefabricated septic tanks, which appear to be the preferred option for households in Jabalpur, the cost depends on the number of users/family members and the location of the consumer (within or outside city limits). A family of five members has to pay INR 7500 (including INR 3500 for the prefabricated septic tank and INR 4000 for installation) while a family of ten members has to pay INR 9000 (including INR 5000 for the prefabricated septic tank and INR 4000 for installation). The costs increase to INR 12,500 and INR 14,500 for a family of five and ten respectively if the family lives outside the city limits. In case a soak pit is to be constructed the households have to pay an additional charge of INR 2000.

ii. Costs for emptying/desludging septic tanks

Users also pay for emptying/desludging services offered by private cesspool operators. The costs range from INR 900 to 3500 across the four case study locations (TABLE 4).

Differential pricing is adopted by private cesspool operators for different customer categories in Goa and Chennai. In Ujjain, UMC has fixed separate rates for households (INR 500) and commercial customers (INR 900). In Jabalpur, JMC has fixed a standard rate of INR 1500 per trip for all consumers (including households, commercial and institutional). The private cesspool operators in Goa and Chennai are found to charge households at a lower rate compared to institutional customers (including hotels and other commercial establishments) (TABLE 4).

TABLE 4: COST FOR EMPTYING/DESLUDGING SEPTIC TANKS FOR CONSUMERS IN GOA, CHENNAI, JABALPUR AND UJJAIN[46]

Demand Category/User	Location	Costs for Emptying/Desludging Septic Tanks (INR)
Households	Goa	1500[47]-3000
	Chennai	900-1500
	Jabalpur	1500
	Ujjain	500
Institutions (hotels, commercial establishments)	Goa	3000-3500
	Chennai	1500-3000
	Jabalpur	1500
	Ujjain	900

[46] Figures quoted are findings from field research conducted across the four case study locations.

[47] If the truck is run by the Panchayat (only Calangute and Candolim report owning their own cesspool truck).

Private cesspool operators are responsible for setting the charges for emptying/desludging services offered by them in Chennai and Goa. Discussions with private operators across these two case study locations revealed that they consider the following parameters while fixing a price: type of property (domestic, commercial or institutional); degree of ease/difficulty in accessing the property; length of pipes required for desludging/emptying; distance of the property from the decanting/treatment facility; quantity of faecal waste/septage to be desludged and transported; any taxes and/or tipping fee charged at the decanting/treatment facility.

FIGURE 12: PARAMETERS GUIDING PRICING OF EMPTYING/DESLUDGING SERVICES PROVIDED EXCLUSIVELY BY PRIVATE OPERATORS

3.4.3 Costs for private operators involved in emptying/desludging septic tanks and transportation

i. Capital costs

For a business using mechanical trucks for emptying septic tanks, the key capital cost is the truck itself. The cost of the truck depends on its capacity, which varies from 3 KL (in Ujjain) to 12 KL (in Goa). The capital costs varies from INR 10 lakhs to INR 24 lakhs (TABLE 6). In many cases, in order to reduce the capital costs, private cesspool operators use second-hand trucks after carrying out modifications to include vacuum pumps, hoses and containers.

ii. Operational costs

The operational costs include labour (one driver and one helper per truck), fuel, periodic repair and maintenance of the truck. O&M costs vary significantly with the frequency of desludging and the quantity of FS desludged (vs. tanker volume), which is linked to the number of people per household, number of trips which can be made per day, and distance required to travel to dispose of the sludge (TABLE 5).

TABLE 5: CAPITAL AND OPERATING COSTS FOR EMPTYING/DESLUDGING BUSINESS IN GOA, CHENNAI, JABALPUR AND UJJAIN

		Goa	Chennai	Jabalpur	Ujjain
1	Capital Costs				
i	Cost of trucks/ tankers (cost as per capacity of trucks)	INR 10-20 lakhs (6-12 KL)	INR 18-24 lakhs (9-15KL)	INR 18.63 lakhs (8-9 KL)	INR 20 lakhs (3 KL)
2	Operating Costs (INR)				
i	Labour (one driver)	INR 15,000-25,000	Drivers are paid INR 120 for every INR 1000 earned	Government vehicles: INR 30,000 (staff) Private vehicles: INR 300 per day	Government staff: INR 7000 per month (including PF)
ii	Labour (one helper)	INR 8000-10,000	Helpers INR 80 per INR 1000 earned	Government vehicles: INR 7000-10,000 (staff) Private vehicles: INR 250 per day	Government staff: INR 5000 per month
iii	Fuel costs	About INR 5000 for every 10 trips	INR 6000 per week	Government vehicles: 17 litres (INR 1200) per day; 488 litres (INR 34,183) per month; 5860 litres (INR 410,200) per year Private vehicles: 35 litres (INR 2500) once a week; 140 litres (INR 9800) per month; 1680 litres (INR 1,17,600) per year	Government vehicles: 25 litres (INR 1925) per day; 750 litres (INR 55,750) per month; 9000 litres (INR 6,93,000) per year
3	Repair and maintenance costs (annual figures per vehicle)	INR 120,000	INR 72,000	INR 90,000	INR 10,000-15,000
4	Costs for desludging at STP/FSTPs (INR)				
i.	Registration fee	Nil	2000	Nil	Nil
ii.	Tipping fee (per trip)	INR 500	INR 100	No tipping fee	No tipping fee

3.4.4 Costs for treatment

i. Co-treatment

Capital costs pertain to creation of a dedicated decanting station. While in Goa the PHE Department invested INR 0.14 million, in Chennai (at the Nessapakam STP) a total of INR 20 million was incurred for creating a state-of-the-art decanting station (TABLE 6).

There has been no change in the **O&M costs** of the STPs on account of any tweaking or change in the treatment process thus far. However, as septage loads increase there could potentially be some impacts on the O&M costs. In Goa, there have been no additional costs associated with the addition of septage. In the Nesapakkam STP in Chennai addition of septage required an increase in the aeration. Each truckload of septage (average of 9 KL) required an additional 2 kg of air to maintain reactor performance and the desired effluent quality. The installed aeration capacity was sufficient and no additional capital investments were required towards aeration; however, the operational hours for aerators have increased. This has also resulted in increasing the energy cost of the plant.

TABLE 6: CAPITAL COSTS OF STPS AT TONCA (GOA) AND NESSAPAKAM (CHENNAI)[48]

A.	STPs	Goa	Chennai
1	Capital costs for co-treatment		
i	Decanting station	INR 0.14 million	INR 20 million
ii	Retrofits/modification in treatment process	None	None
iii	Total	INR 0.14 million	INR 20 million

ii. FSTPs

The three FSTPs at Jabalpur were constructed at a cost of INR 12.4 million (the individual plant cost being INR 4.15 million). The capital cost for FSTP in Ujjain is also similar, at INR 5 million. The O&M costs are INR 0.5 million per FSTP in Jabalpur and marginally higher at 0.7 million in Ujjain (TABLE 7).

TABLE 7: CAPITAL EXPENDITURE (CAPEX) AND O&M COSTS OF FSTPS IN JABALPUR AND UJJAIN

	FSTP	Jabalpur	Ujjain
i	Number of FSTPs	3 (Garha, Polipathar, Adhartal)	1 (Sadaval)
ii	Capacity of one FSTP (KLD)	50	50
iii	Total capacity (KLD)	150	50
iv	CAPEX (per FSTP)	INR 41,49,999	INR 50,00,000
v	CAPEX (all FSTPs)	INR 1,24,49,997	INR 50,00,000
vi	O&M costs (monthly costs per FSTP)	INR 45,833	INR 58,333
vii	O&M costs (annual costs per FSTP)	INR 5,50,000	INR 7,00,000
viii	O&M costs (60-month/5-year costs per FSTP)	INR 27,50,000	INR 35,00,000
ix	O&M costs (annual costs for all FSTPs)	INR 16,50,000	INR 7,00,000
x	O&M costs (60-months/5-year costs for all FSTPs)	INR 82,50,000	INR 35,00,000
Total (CAPEX and O&M costs)		**INR 2,06,99,997**	**INR 85,00,000**

[48] S. Gupta, S. Jain and S.S. Chhabra, 'Draft Guidance Notes on Co-treatment of Septage at Sewage Treatment Plants in India', April 2017.

3.5 BUSINESS MODELS AND PERFORMANCE ACROSS GEOGRAPHIES FOR THE EMPTYING / DESLUDGING MARKET

Based on the findings from the four case studies, a business modelling exercise was carried out to assess the profitability of enterprises engaged in the emptying/desludging market and to analyse the load of various costs on their balance sheets. This section summarizes these results and aims to show how demand for FSSM services impacts revenues and bottom-line profitability. For this exercise, both public and private sector cesspool operators were considered in order to compare the relative profitability of operating under different regimes. The analysis here does not pertain to other private players in the value chain, technology providers and operators engaged in the construction and/or maintenance of treatment facilities. The model assumes a six-year break-even point, i.e. the point at which startup capital is repaid. Each loan is assumed to have a five-year tenure based on the average tenure found during interviews with operators and an average interest rate of 12 per cent per annum. Hence, we assume Year 6 is the reasonable Return on Investment (RoI) for enterprises in each of these four cities.

Each operator is assumed to be a single truck operator with a driver and a helper as labour. TABLE 5 highlights the operating costs incurred by these enterprises, primarily pertaining to labour, fuel and maintenance. In addition, the model includes tipping fees paid by enterprises operating in Goa and Chennai, which are fees levied by the STP operator per truck per trip. At Tonca (Goa), the fee is INR 500 per truck per trip while in Nesapakkam and Perungudi, it is INR 100 per truck per trip. The model also includes a flat depreciation rate of 10 per cent on the capital equipment, in line with reports that equipment should be replaced every 10 years. It should be noted, though, that many of these trucks were reported to have been plying for 12 years or longer. TABLE 8 shows the results of the modelling exercises.

TABLE 8: ENTERPRISE PROFITABILITY

Year	Goa	Chennai	Ujjain	Jabalpur
Year 1	33%	-17%	-86%	-63%
Year 2	36%	-14%	-86%	-62%
Year 3	39%	-12%	-85%	-60%
Year 4	42%	-9%	-84%	-59%
Year 5	46%	-6%	-83%	-57%
Year 6	87%	34%	-63%	-26%

Goa exhibits the highest RoI across all four geographies. This is due to the twin factors of a large demand base of hotels and a strong model of horizontal cartelization across cesspool operators that enables them to charge consistently high prices. In Chennai, the other large market surveyed, profitability levels are reasonable at 34 per cent by the end of Year 6, driven by the large number of apartment buildings emerging on the outskirts of Chennai. Chennai has nearly 200 unique owners servicing a catchment

area of nearly 40 sq km. While this has ensured steady returns, it has also complicated attempts at cartelization and competition between different owners has kept prices low.

As there is no independently operating private sector in Ujjain or Jabalpur, RoIs have been calculated for government-operated trucks. In Jabalpur, a single private operator exists under the aegis of the ULB and is allocated trips at the behest of the CHO. In TABLE 9, the RoI for Jabalpur represents a composite number for both this private truck and the other government-run operators.

The results show that cesspool operators in Ujjain and Jabalpur are consistently loss making. Though per-trip costs in these two cities are 35-65 per cent lower than in the larger, less-regulated markets like Goa and Chennai, per-trip revenues are on average 85 per cent lower. When analysing the expected unit economics of these enterprises post the break-even point, TABLE 9 below shows that due to the large number of non-revenue trips that private cesspool operators in Ujjain and Jabalpur are forced to make, per-trip earnings are negative, relative to other markets like Goa and Chennai.

TABLE 9: PER TRIP PROFIT/LOSS ACROSS THE FOUR MARKETS

Goa	Chennai	Ujjain	Jabalpur
INR 1495.19	INR 297.76	INR -469	INR -108.53

A detailed cost-level analysis of each market shows that private operator-dominated areas like Goa and Chennai incur over 70 per cent of their costs on tipping fees and fuel costs (after capital expenditures are accounted for), while areas like Ujjain and Jabalpur incur far lower operating expenses. Indeed, most of their costs are driven by capital costs, in the form of either loan payments or depreciation.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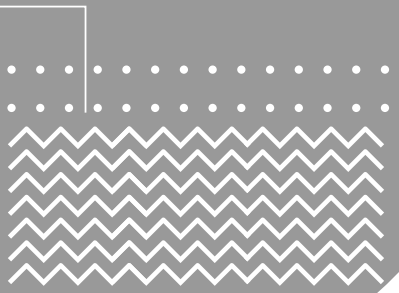
4

POLICY AND GOVERNANCE ENVIRONMENT: AN ASSESSMENT OF ENABLERS AND BARRIERS



4.1 NATIONAL LEVEL

In order to provide impetus to the implementation of FSSM in urban areas, the MoHUA, GoI launched the **National FSSM Policy** in February 2017. The policy recognizes that *'while city officials have the mandate to ensure service provision there is also an opportunity for the private sector to provide FSSM services in urban India'*. The policy also notes that the desludging services currently being provided, through a mix of municipal and private players, are far from adequate and that the sector is currently dominated by informal small-scale operators who are difficult to monitor and regulate; this in turn impedes the development of standards/norms around safe and scheduled desludging. Making a case for more organized private sector participation/engagement across the FSSM value chain, the policy places the responsibility for creating an enabling environment for this on state and local governments. It asserts that *'state and city governments should facilitate private sector participation through an easy and amenable PPP relationship framework, to ensure adequate financing and sustainability of FSSM projects'*.

Under the ambit of SBM-U, the GoI has been conducting **Swachh Survekshan**, a survey for ranking of cities[49] on set parameters related to six themes: Solid Waste Management (SWM) – collection and transportation;

[49] Covering 73 cities in January 2016, 434 cities in January February 2018, and 4203 cities in February 2019.

SWM—processing and disposal; sanitation; Information, Education and Communication (IEC); capacity building; and innovation. The inclusion of parameters related to FSSM in Swachh Survekshan[50] 2018 and 2019 has proved to be an incentive for ULBs, especially in Jabalpur and Ujjain, to (a) initiate a process for registering private cesspool operators undertaking emptying/desludging services in the city and (b) identify or create infrastructure for treatment of septage (through FSTPs), in an attempt to improve the city's overall score and the resultant national ranking. (Refer ANNEX 1 for details of FSSM-related parameters in Swachh Sarvekshan 2018 and 2019.)

Both the National FSSM Policy and the inclusion of parameters related to FSSM under Swachh Survekshan1 have ensured that there is a focus on FSSM and recognition of the role the private sector can play in the provision of these services. However, it is on the state and local governments that the onus lies for creating an environment that is conducive for private players to operate and help achieve the overall sector goals; these goals include ensuring: access to affordable and reliable FSSM services for all households with IHHLs that are based on OSS systems; safe collection, transportation and treatment of all faecal waste; and safe disposal and reuse to prevent environmental pollution.

4.2 STATE AND LOCAL LEVELS

In line with the National FSSM Policy some states have issued their own state level policies and/or guidelines for septage management for ULBs in order to ensure speedy implementation at the local level. These include Rajasthan, Delhi, Andhra Pradesh, Uttar Pradesh, Tamil Nadu, Odisha and Maharashtra.

Tamil Nadu has been a front runner among states in this respect. The GoTN notified the 'Operative Guidelines for Septage Management for Urban and Rural Local Bodies' in September 2014,[51] much before the National FSSM Policy. (Refer ANNEX 2 for further details.) It was quick to realize the inability of the local governments (both urban and rural) to provide adequate emptying/desludging and transportation services, and proactively put in place the 'Operative Guidelines' in order to achieve larger sector goals including ensuring (a) that all faecal waste and septage desludged is transported safely and treated prior to disposal and (b) that all private operators are adequately monitored and regulated. The guidelines are quite comprehensive and cover the entire FSSM value chain (including containment, desludging/emptying, transportation, treatment and final disposal). A decentralized approach to septage management has been implemented in Tamil Nadu wherein clusters of ULBs have been identified and STPs earmarked for each cluster. The role of the state government has been kept limited to outlining norms/standards for every stage of the FSSM value chain. Further, the ULBs have been accorded the role of regulation and oversight and are responsible

[50]Swachh Survekshan is a ranking exercise undertaken up by the MOHUA to assess urban areas for their levels of cleanliness and active implementation of SBM-U initiatives in a timely and innovative manner.

[51]Operative Guidelines for Septage Management in Urban and Rural Local Bodies' issued by the Municipal Administration and Water Supply Department, Government of Tamil Nadu. (http://muzhusugadharam.co.in/wp-content/uploads/2017/07/english-septage-operative-guidelines-tn.pdf), accessed on 12.04.2019.

for (a) registration and certification of private cesspool operators and (b) ensuring that the treatment facilities are present and functional. While the guidelines indicate a price for treatment services (INR 150-200 for a truck of 9 KL capacity), they do not make any suggestion regarding charges to be collected from households by private operators, leaving them to be determined by market mechanisms. This tactical move by the GoTN has ensured that the already existing private sector involved in desludging and transportation of faecal waste in Chennai continues to thrive.

In Goa, the provisions of the Goa Public Health (Amendment) Rules, 2010,[52] related to sanitation, have ensured a focus on FSSM. Specifically, these rules prohibit *'discharge of sewage, poisonous and polluting liquid into any water-course, lake, tanks, sea-water within five kms. of the shore*' and require local bodies to provide adequate infrastructure for '*safe disposal of sullage and sewage, etc*'. In Goa, as in Tamil Nadu, the state government has focused on larger sector goals (halting environmental pollution being caused by rampant dumping of septage); recognized the presence of a thriving private sector in emptying/desludging and transportation of septage; and acknowledged the inability of the local governments to provide these services. The state government has steered clear of making any suggestions or fixing fees to be collected from consumers (including households and commercial establishments) for these services. The PHE Department, which is responsible for overseeing the decanting and treatment of collected septage by private operators at the Tonca STP, has fixed the tipping fee at INR 500 per truck per trip. The overall high level of awareness and a heightened sense of ownership for the environment among the citizens have ensured that they have taken on the role of monitoring private cesspool operators to make sure there is no dumping into the open environment. In Goa as well as Chennai, the local bodies/utilities (PHE and ULBs in case of Goa and CMWSSB in case of Chennai) are not providing these services and thus not crowding out the private sector.

In the other two case study locations, namely Ujjain and Jabalpur, the discourse as well as action on FSSM is fairly new. Given that the Government of Madhya Pradesh (GoMP) is yet to come up with either a policy or operative guidelines for FSSM, both Ujjain and Jabalpur Municipal Corporations have received little input from the state government in this respect. Further, the idea of PSP in FSSM is an even more unfamiliar territory. The ULBs also lack prior experience of engaging with the private sector in any related sector.

In this context, while both JMC and UMC have made use of the funding available through GoI programmes and schemes (such as JNNURM[53], AMRUT and SCM) for creating infrastructure in the form of FSTPs for treatment of faecal waste, they have not paid much attention to creating an enabling environment to promote or help sustain already existing PSP in FSSM. In fact, in Jabalpur the private cesspool operators who were engaged in emptying/desludging and transportation services have been co-opted by the ULB to work on their behalf. JMC has entered into a contract with these private cesspool operators who are registered as co-operative societies. The contract is one-sided and binds the operators to only undertake trips allotted to them by the ULB. While they are to be paid a fee of INR 1200 per trip, discussion with private operators revealed

[52]Published in the Official Gazette, Series I, No. 18, dated 29 July 2010.

[53]Jawaharlal Nehru National Urban Renewal Mission

that the process of seeking payments is cumbersome and protracted, and often they do not get paid in a timely manner. With the JMC also providing emptying/desludging and transportation services, the private players are in fact being crowded out.

In Jabalpur, the work for construction and O&M of the three FSTPs has been awarded to Meco Technologies Private Limited, a firm based out of Bilaspur in Chhattisgarh. The work order states that the private agency would be responsible for constructing the FSTPs and would undertake O&M of these plants for a five-year period. While the work order outlines the FSTP specifications, field observations at the FSTPs in Jabalpur revealed that the plants do not meet all these specifications. A sizeable proportion (30 per cent) of the items specified has not been adhered to by the private operator, which is compromising the functioning of the FSTPs (refer ANNEX 3). Field visits in Jabalpur also revealed that the staff responsible for O&M of the FSTPS are not well aware of the functioning of the plant. This points to some lapses with respect to oversight from the ULB which needs to be strengthened.

The terms of payment outlined in the work order for construction and O&M of FSTPs in both Ujjain and Jabalpur reflect the bias and mistrust of the ULBs towards the private sector. The private operator is paid for the construction component in tranches,[54] and given the protracted approval and sanctioning processes, payments are hardly made on time. For the O&M component the private operator has to make all payments towards manpower, consumables, chemicals, etc. in advance and is paid at the end of the month on '*successful completion of tasks outlined under O&M*'. Given that the definition of 'successful' operation is neither clearly defined nor well understood by both parties, the approval process is quite subjective.

Water testing at inlet and outlet: In order to meet the overall sector goal of ensuring that there is no environmental pollution (land and water) when the treated faecal sludge is finally disposed, it is crucial to have a rigorous and real-time monitoring system for testing wastewater quality at outlet points. Water quality testing at the inlet point is also crucial to ensure that no industrial wastewater is dumped at the municipal wastewater treatment facilities, whether STPs or FSTPs.

In the co-treatment sites at Tonca (Goa) and Nesapakkam and Perungudi (in Chennai) regular testing of septage at inlet and of treated wastewater at outlet is being undertaken. These treatment sites are equipped with on-campus water testing facilities. Previous research has shown that the results at both inlet and outlet are within the prescribed limits.[55] On the other hand, testing of wastewater at inlet and of treated water at outlet of FSTPs in both Ujjain and Jabalpur are not being undertaken regularly. There are no on-site water testing facilities available. Officials shared that getting the tests done through the State Pollution Control Board (SPCB) is very time-consuming and expensive, and thus they prefer to get the samples tested at private

[54]For the construction of the FSTP, while 25 per cent of the cost (INR 41,49,999) is to be paid on completion of allied civil works, 50 per cent is payable after all mechanical/electrical equipment are delivered at site and the remaining 25 per cent is payable after installation, commissioning and testing.

[55]Gupta. S, Jain, S and Chhabra, S.S., "Draft Guidance Notes on Co-treatment of Septage at Sewage Treatment Plants in India", April 2017.

laboratories. Nevertheless, the reports shared in both cities show that the wastewater at inlet and outlet meets the prescribed standards (ANNEX 4).

Adoption of safe occupational practices and provision of Personal Protective Equipment: Current FSM businesses (both public and private) are failing to achieve public health and labour standards for sanitation workers. The field visits across the four urban centres revealed that the uptake of safe occupational practices and provision/ use of Personal Protective Equipment (PPE) for sanitation workers are low and, in some cases, completely absent. Interactions with sanitation workers revealed that they find the PPE to be restrictive. They also shared that when the gear wears out and has to be replaced there are long delays in getting new gear.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5

RISK IDENTIFICATION AND RISK-SHARING FRAMEWORKS

The four case studies represent different models of FSM provision, which entail varying degrees of risks. A risk matrix modelling the FSM behaviour highlights the prevailing risk factors at three levels, namely households, the Collection and Transportation (C&T) businesses, and the treatment businesses, in both private and public markets. These risks span economic, financial, legal, political and social domains but the stakeholders do not account for all of these risks in decision-making processes. Further, the study also identifies the risk mitigating responses adopted by different stakeholders and how these responses shape strategies across the value chain...

FIGURE 13: RISKS BEING FACED BY HOUSEHOLDS AND BUSINESSES ENGAGED IN C&T AND TREATMENT

CAPTURE > CONTAINMENT > EMPTYING > TRANSPORT > TREATMENT > SAFE REUSE OR DISPOSAL

- **Demand Risk**
  - ~100 million toilets have been built with little knowledge of containment typologies, sizes and desludging requirments.
- **Strategic Risk**
  - Govt. policies regarding sewage are often unformulated or unclear, leading to market uncertaintities about long-term feasibility of FSM concessions.

- **Resource/Input Risk**
  - Market segmentation is often unclear and demand variable.
- **Regulatory and Enforcement Risk**
  - Licensing policies restrict entry into markets.
  - Regulations on dumping increase travel costs.
  - Price cellings reduce market coverage/profit margins.

- **Construction Risk**
- **Resource/Input Risk**
  - Resource inputs may not match design capacity and prevent re-use potential.
- **Design Risk**

DISRUPTIVE TECHNOLOGY RISK

Improved technologies, better market knowledge can significantly impact the FSM value chain in several ways, e.g. in-situ digestion

5.1 ASSESSING THE RISKS FACED BY THE CONSUMERS OF FSM SERVICES – THE DEMAND SIDE RISK

As mentioned earlier the consumers (for the purpose of this study) have been classified into two broad categories – bulk and individual customers.

Though private cesspool operators in both Goa and Chennai reported servicing individual households, the prices they charge them are much higher in comparison to public sector prices charged in Jabalpur and Ujjain. In response to the risk of bearing high desludging costs on a regular basis, individual households have resorted to longer wait times between subsequent desludging by building large septic tanks with a capacity of 15,000 litres and above. Interviews with masons in Goa and Chennai corroborated this finding; it was also revealed that there was a belief that large septic tanks never need to be emptied. However, as a by-product of this mitigation strategy, these systems are often ill-designed, posing environmental and public health hazards as they continue to leak untreated septage into the environment until they are emptied.

On the other hand, bulk customers, including hotels and apartment buildings, are required to install on-site treatment systems. However, the installation and the ongoing maintenance of such systems requires skilled labour and inputs, both of which impose higher costs on the owners as compared to on-site containment systems.

In addition, lax enforcement practices and unclear institutional regimes reduce the incentive to comply with existing legal provisions. These twin considerations lead to a large proportion of bulk customers choosing large, fully lined septic tanks over on-site small-scale sewage treatment plants . While a comprehensive survey of properties is required to assess the actual extent of these practices, over 80 per cent of the bulk establishments visited reported using desludging services.

In addition, septic tanks constructed by bulk customers have no provision for separation of blackwater and greywater, as well as no drains for discharge of overflow. This increases the volume discharged into the septic tank and increases the frequency with which desludging services are required. On the other hand, individual households have septic tanks only for blackwater and have provisions of stormwater drains for discharge of greywater. This, coupled with the large size of septic tanks, increases the time interval between subsequent desludging services required by individual customers. Therefore, it is observed that private C&T businesses service mostly bulk customers. It isn't financially viable for private operators to serve areas dominated by individual households, leaving them to be serviced by public operators.

5.2 ASSESSING THE RISKS FACED BY THE SUPPLIERS OF COLLECTION AND TRANSPORTATION SERVICES (C&T)

5.2.1 Assessing the risks faced by private suppliers

C&T businesses face two major types of risks: demand volatility risks and regulatory risks. Demand volatility risks refer to unpredictable variances in demand that affect revenue and make it harder to plan long-term business investments. Regulatory risk, on the other hand, is a blanket term for different actions that a government might take, ranging from dumping regulations to transport regulations.

i. Demand Volatility Risk

Operators in all four geographies report a degree of demand risk but it is the most pronounced in well-developed, private-sector dominated markets like Goa and Chennai. Much of the demand risk arises from individual households where containment structures vary in size and design and the rates at which these structures fill are also unknown to cesspool operators. With households desludging infrequently, to mitigate the risk of demand volatility and to maintain a steady stream of revenue, cesspool operators focus largely on 'bulk customers' which require desludging more regularly and with a greater degree of certainty. This has resulted in a 'sorting effect', where individual households are served exclusively by the few public operators while private operators focus on higher-margin and more regular bulk customers.

The second facet of demand risk is the lack of clarity around plans for sewerage in these cities. Government officials in all four cities professed planned sewerage as the long-term wastewater management goal despite the slow and halting pace of implementation. Despite the protracted development process alongside continued growth and reliance on OSS systems, local governments have been reluctant to embrace FSM as a viable, long-term alternative solution. Local operators in Goa and Chennai have complained

that there is little communication with the government or responsible parastatals on sewerage or other matters, and that this leads them to underinvest in their business.

ii. Regulatory Risks

The case studies indicate that fuel cost is the largest cost driver (ranging from 35 to 65 per cent) for the C&T businesses. In Goa and Chennai, state-level legislation enforced by local institutions (PHE Department and CMWSSB respectively) led to enforced dumping of faecal sludge at one or more STPs in each location along with a tipping fee. This strategy was chosen to reduce the environmental risks arising from rampant open dumping of faecal sludge and associated citizen complaints. Both these objectives were undoubtedly met. However, in each case, the STPs chosen were at a long distance from the areas served by private operators – at 15-22 km – with an attendant increase in costs and travel time. Both consequences were ultimately passed on to end-users, with operators reporting that desludging prices were increased to account for both increased fuel costs and the new tipping fees.

Further, as the STP in Goa experienced operational issues due to the inflow of faecal sludge and, occasionally, industrial waste, the practice of decanting at multiple SPSs was discontinued and was limited to only one decanting station which was set up just upstream of the Tonca STP. While this strategy was effective in regulating dumping of industrial waste, it increased wait times for operators by over two hours. As a result, operators experienced a 25-50 per cent reduction in daily trips while drivers and labourers had to increase the number of hours worked, without commensurate pay increases.

Without clear communication regarding the prevailing regulations, and ineffective risk-sharing arrangements, businesses choose ad hoc strategies as a response. In Goa, the FSM emptying businesses have responded to increased wait times at the Tonca STP by investing in second-hand fuel tankers of 25 KL or more and using them as mobile septage stations – reducing their tipping fee cost, overall fuel costs and time lost from standing in queues. However, there is little data on whether such infrastructure is qualified to transport wastewater and the broader ramifications thereof. Interviews with Panaji PHE Department officials show that they are aware of this practice and plan to introduce a 'volumetric' tipping fee to discourage such practices. Thus, the sector seems to be stuck in a low-level equilibrium of imperfect, unilaterally determined solutions that undermine the pursuit of broader outcomes like public health, environmental cleanliness and resource recovery.

5.2.2 Assessing the risks faced by the public suppliers

The C&T services are supplied by a mix of public cesspool operators and private operators under contract to the municipality in Jabalpur, while in Ujjain only municipality-owned trucks provide this service. The municipalities face two types of risks while providing collection and transportation services, namely, lack of information about the demand of FSM services and type of containment structures and the burden of non-revenue generating trips.

Often, municipalities do not have adequate knowledge about the extent of demand

of FSM services in their area, as well as the typologies of the existing containment structures. This lack of information makes it difficult for them to assess the frequency with which these structures need to be emptied, and also creates a hindrance in case the municipality decided to implement regulations for scheduled desludging. It also constraints their ability to make informed decisions while developing contracts with private cesspool operators who may be engaged to provide FSM services. However, in some cases, attempts have been made to monitor and regulate the septic tank design and construction. As mentioned earlier, in Goa the PHE department has prescribed a standard design for septic tanks and households are required to seek approval from the department prior to construction. Similarly, in Tamil Nadu, the state government has issued guidelines for the ULBs to evaluate and modify (in case of variation) existing septic tank designs and other storage/treatment systems.

The municipalities have to undertake desludging trips for CTs/PTs, and also clean blocked drains in housing colonies. These trips constitute a significant portion of the total trips for public providers, but do not generate any revenue. This often makes the public provision of these services a loss generating avenue, as observed in Ujjain and Jabalpur, despite per trip costs being 35-65 percent lower in these cities as compared to larger, less-regulated markets like Goa and Chennai. These non-revenue generating trips significantly impact the profitability of the public providers.

5.3 ASSESSING THE RISKS FACED BY THE SUPPLIERS OF TREATMENT SERVICES

Local and state governments, institutions and parastatal bodies collectively constitute public sector stakeholders' and are concerned primarily with maintaining public infrastructure assets (e.g. STPs) and mitigating risks related to public health and the environment.

In Ujjain and Jabalpur, public sector stakeholders lack the existing treatment facilities which larger cities like Goa and Chennai have. In addition to similar public health and environmental risks, public sector stakeholders in Ujjain and Jabalpur confronted a new set of politico-financial risks posed by the annual sanitation evaluation rankings being undertaken by the central government as a part of SBM-U. The 'sanitation' component accounted for 30 per cent and 25 per cent of the 2018 and 2019 rankings, respectively. Out of this, the presence of a treatment facility accounted for 10-15 per cent of the sanitation component, giving municipalities a strong incentive to build a treatment facility. From a risk perspective, if a city chooses to not build a treatment facility, it risks being scored lower on the Swachh Survekshan. For cities with access to AMRUT or other central government funding, this risk is substantially reduced as it can allocate these funds to the construction of these treatment facilities.

Municipalities of both Ujjain and Jabalpur have opted for greenfield investments in FSTPs. However, imperfect information about OSS systems and practices in these cities has meant that the procurement process and estimation of facility capacity were based entirely on the basis of the number of households and public toilet complexes. In Jabalpur, furthermore, an average household desludging interval of three years served

as a planning assumption; recent studies have shown intervals between desludging could be two or three times that number.

As a result of these strategies there has been an overinvestment and creation of excess treatment capacity, with these plants operating at 30-60 per cent of capacity. Thus, an underestimation of demand risk and over-conservative mitigation strategies have solved the challenge of open dumping but at a higher cost than required. It also becomes evident that a strategy predicated on high investment without addressing related issues of upstream demand risk and the complex typology of OSS systems will fail to efficiently manage infrastructure assets as well as meet broader sanitation goals.

Further, interactions with private operators who have been involved in constructing an FSTP and are now operating and maintinaing it revealed funds allocated for construction and O&M of FSTPs are much lower than the requirement for providing adequate services; this in turn has affected the quality of services being provided.

TABLE 10: DETAILS OF RISKS BEING FACED BY HOUSEHOLDS AND BUSINESSES INVOLVED IN C&T AND TREATMENT SERVICES

Demand Side Risk / Households	▪ High lifetime costs for regular desludging ▪ Environment and public health hazards due to ill-designed and poorly maintained on-site systems ▪ Lax enforcement of existing government regulations related to design of on-site systems and their maintenance
Supply-side Risk for Private Suppliers of Collection and Transportation Business	▪ Demand volatility risks ▫ Lack of information on size and design of containment structures ▫ Ambiguity around sewerage plans in the city ▪ Regulatory risks ▫ Introduction of new regulatory initiatives without consultation with cesspool operators ▫ Absence of communication vis-à-vis regulations on pricing, tipping fee, environment etc
Supply-side Risk for Public Suppliers of Collection and Transportation Services	▪ Lack of information about the demand of FSM services and type of containment structures ▪ Non-revenue generating trips
Risks Faced by Suppliers of Treatment Services	▪ Obligation to comply with annual sanitation evaluation rankings (Swachh Survekshan) scoring by the central government, in absence of adequate market information ▪ Inadequate funds made available for construction and O&M of treatment facilities

Thus, while stakeholder strategies can serve narrow and medium-term interests, they also have significant downstream consequences, affecting actors, interests and outcomes across the value chain. The result is a set of makeshift and incomplete solutions that meet some sanitation sector goals in part and others not at all. To meet public health and environmental goals while attracting new technology and business models, stakeholders need to de-risk the value chain through acquiring a sector-wide understanding of risks and develop collaborative strategies to counter them.

6

CONCLUSIONS AND KEY TAKEAWAYS

6.1 INSTITUTIONAL REFORMS FOR FSSM

- **FSSM is being considered only as an interim solution:** Despite the national government's focus on FSSM and the fact that most urban households with IHHLs are connected to OSS systems, local governments continue to remain focused on implementing underground sewerage schemes and enhancing treatment capacities of STPs. At a local level, FSSM is being considered only as an interim solution, if at all. Local/state governments have also not invested in planning how FSSM and sewerage might coexist.
- **There is non-adherence to standards/norms for septic tank design and construction:** Septic tank design and construction mostly do not adhere to the prescribed standards.[56] Households prefer to construct large containment structures in order to delay the need for emptying/desludging. This results in (a) septic tanks not being able to achieve the initial degree of primary on-site treatment and digestion and (b) the standard emptying/desludging timeframe of three years not applying for these large structures.

[56] CPEEHO and the Indian Standards Code 2470 (Part 1, 1985): Section 25.3.1, Modern Building By-laws, Manual on Sewerage and Sewage Treatment (second edition)

- **ULBs are unable to meet the demand for emptying/desludging which is being met by informal private enterprises:** The responsibility for providing septic tank emptying/desludging services rests with ULBs. However, due to many factors (including but not limited to lack of adequate vehicles and staff as well as preoccupation with other municipal functions) they are unable to meet this demand. This has resulted in the mushrooming of small and mid-sized entrepreneurs who provide mechanical emptying/desludging of septic tanks/pits and transport the collected waste away from residential areas.

6.2 PSP IN EMPTYING AND DESLUDGING

- **PSP/engagement models are found to be more robust in cities where government agencies do not over-regulate the sector:** The models of PSP/engagement have emerged in response to the local environment (legal framework, policy and practice) and thus vary considerably across the four case study locations. In Goa the thriving PSP is a result of the fact that apart from providing a decanting (and treatment) facility and fixing a tipping fee, the government agencies (in this case PHE Department and ULBs) have left the remaining parameters (including fee to be charged from consumers and the mechanisms for routing the demand to the private players) to be determined through market mechanisms. In Chennai, while the utility (CMWSSB) requires all private operators to be registered,[57] it has steered clear of over-regulating the sector, thus allowing existing private operators to thrive. In Jabalpur, on the other hand, the JMC's actions in over-regulating the sector (by fixing the fee that private operators can charge consumers,[58] fixing a flat fee with no differential pricing for different categories of consumers, routing all demand through the JMC as well as parallel provision of emptying/desludging services through municipal trucks) have in fact crowded out the private sector. In Ujjain there are no private players and the UMC provides emptying/decanting and transportation services.

- **Demand segmentation – the market is driven by the growth of bulk customers while individual single-family households remain only a peripheral driver:** In Goa and Chennai the emptying market has evolved in response to the growth of bulk customers; demand from individual single-family households remains a peripheral driver of the market. In Goa, the demand is mainly from commercial establishments, primarily hotels that service Goa's large tourism sector, while in Chennai operators primarily serve apartment and multi-family complexes of various sizes. In Jabalpur and Ujjain also, the demand from individual (single-family) households as a percentage of overall market operations is quite low (10 and 5 per cent, respectively). While 'bulk customers' remain a key driver of the market, the demand for FSSM collection and transport services also includes additional components such as desludging services for CTs/PTs and cleaning services for drains and condominial sewers in housing colonies.

[57] Municipal Administration and Water Supply Department, GoTN. 'Operative Guidelines for Septage Management in Urban and Rural Local Bodies'
(http://muzhusugadharam.co.in/wp-content/uploads/2017/07/english-septage-operative-guidelines-tn.pdf)

[58] In Jabalpur the JMC has fixed a standard rate of INR 1500 per trip for all consumers (including households, commercial and institutional).

- **Business operations are more viable and profitable in less regulated markets:** The business modelling exercise carried out to assess the profitability of enterprises engaged in the sanitation emptying market reveals that less regulated markets (including Goa and Chennai) exhibit higher RoI for private operators. Goa exhibits the highest RoI for private operators with 33 per cent profitability from Year 1 and reaching 87 per cent by Year 6. In Chennai, the profitability levels are reasonable at 34 per cent by the end of Year 6. On the other hand, the cesspool operators in Ujjain and Jabalpur are consistently loss making. Though per-trip costs in these two cities are 35-65 per cent lower than larger, less-regulated markets (Goa and Chennai), per-trip revenues are on-average 85 per cent lower. Further, due to the large number of non-revenue trips that private cesspool operators in Ujjain and Jabalpur are forced to make, per-trip earnings are negative.

- **All stakeholders across the FSSM value chain face a set of risks and adopt diverse mitigating strategies:** A variety of risks are faced by households as well as businesses engaged in C&T and Treatment services in both private and public markets. The primary risks being faced by households are those arising out of high lifetime costs of desludging and environmental and public health hazards caused by inadequate design and maintenance of on-site containment systems. Individual households have to pay much higher for desludging services in markets that are serviced by private operators as compared to those serviced by public operators. Further, given the high costs of constructing on-site treatment systems and the lax regulation bulk consumers prefer constructing on-site containment systems in the form of fully lined septic tanks. Given that there is no separate provision for blackwater and grey water these containment systems need frequent desludging services making them the main customers for private operators engaged in provision of C&T services. The private C&T businesses face a set of risks as they lack adequate data about the size and nature of the market (number of containment structures, their sizes and the frequency at which desludging would be required, especially for individual customers). Further, ambiguity about the city's plans for sewerage result in under investments by the private operators. The various actions and decisions which the government may take from time to time without adequate consultation and or communication with the private players are also significant risks for the private operators. The public sector operators in the C&T business have to serve individual households, PTs/ CTs operated by the municipality and other unsewered areas that have no sewerage system and thus operations are not financially viable. While ULBs have tried to maximize their ranking on the Swachh Survekshan by creating dedicated infrastructure for treatment of faecal sludge in the form of FSTPs through private providers, the costs allocated for construction as well as O&M are so low that they are acting as barriers in the provision of quality services.

6.3 TREATMENT

- **Co-treatment of septage at existing FSTPs:** The main enabling factor for initiating co-treatment has been the presence of spare treatment capacities in existing STPs (in both Goa and Chennai as well as other cities across India which have opted for

co-treatment). While there are capital costs involved in setting up of a decanting station, these are not prohibitive. The findings from both Goa and Chennai show that there are no significant costs incurred for tweaking the treatment process post addition of septage to sewage inflows nor are there any significant increases in the overall O&M costs of the plant.

- **Setting up of dedicated decentralized FSTPs:** In Jabalpur and Ujjain the treatment of faecal sludge is being carried out through dedicated FSTPs.[59] Both cities have used funds available under GoI schemes related to the creation of urban sanitation infrastructure (including AMRUT and SCM) and have selected private agencies to undertake construction and O&M through a competitive bidding process. However, a lack of oversight by the local government has meant that some of the design specifications outlined in the work order have not been fully adhered to during construction and there are some gaps in the O&M of these plants. The result is that the overall sector goal, which is to ensure that there is no environmental pollution due to discharge of untreated faecal sludge and septage, remains unmet.

6.4 RECOMMENDATIONS

- Over-regulation of the sector is likely to negatively impact the operations and profitability of private operators. The local/city government, thus, should aim at ensuring that the larger sector goals are achieved, i.e., all urban households with IHHLs connected to septic tanks and other OSS systems have access to safe emptying/desludging services, and faecal sludge collected is safely transported and treated prior to its disposal in the environment in order to ensure there is no environmental pollution.
- If public sector and private sector interventions in emptying/desludging are to coexist, there is a need to clearly outline separate markets and to ensure revenue-generating opportunities are reserved for private actors.
- There should be a dedicated FSM cell that monitors FSSM and private sector interventions at the local level. There is also a need to establish, at city or state level, clear policies regarding the governing of FSM as also to outline model contracts/ tenders that provide clarity to existing/potential businesses on the growth potential of the sector and impending sewerage plans.
- There should be incentives to comply with standards without increasing costs for businesses.
- A comprehensive risk identification exercise should be undertaken for all stakeholders.
- A database of OSSs present in a city should be created. ULBs must develop and maintain a database of the size, type of construction and present condition of septic tanks and other OSS systems.

[59] In Jabalpur there are three FSTPs (capacity of 50 KLD each) with a combined capacity of 150 KLD. In Ujjain there is only one FSTP with a capacity of 50 KLD.


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ANNEXURES

Annex 1: Swachh Survekshan – Parameters Pertaining to FSSM (2018 and 2019)

In Swachh Survekshan 2018 there were 11 parameters under 'sanitation' of which two, namely 3.3 and 3.4, pertain to FSSM.[60] In Swachh Survekshan 2019 the definition of the category 'sanitation' was expanded to include 'sustainable sanitation'. Of the seven parameters under the category of sustainable sanitation, 3.1 and 3.2 pertain to FSSM.[61]

Parameters	Justification
Swachh Survekshan 2018	
3.3. Are desludging operators registered and being monitored by the city	This indicator will help ascertain the number of septic tank cleaner/operators in the city and whether they are registered or not. These numbers can help extrapolate whether the city has an adequate number of operators to meet the demand (based on the number of households not connected to sewerage and dependent on OSS systems).
3.4 Does the city have liquid waste processing infrastructure (FSTP or STP with co-treatment facility)	This indicator will help assess the city's infrastructure towards liquid waste management.
Swachh Sarvekshan 2019	
3.1 What percentage of households/ commercial establishments/ CTs/PTs; are connected to a closed system such as sewerage, septic tank + soak pit, twin pit system etc. (no open system/connection/ flow/discharge)	This indicator will ascertain whether the city has adequate coverage of sewerage network or septic tanks.
3.2 What percentage of faecal sludge generated from households/commercial establishments/ CTs/PTs; is treated at FSTP/ STP - Scientific processing of faecal sludge	This indicator will ascertain whether the city has adequate processing facilities for faecal sludge.

[60] Swachh Survekshan Toolkit, 2018 (http://swachhsurvekshan2018.org/Images/Swachh%20Survekshan%202018%20Toolkit%20-%20English.pdf), accessed on 20.04.2019.

[61] Swachh Survekshan Toolkit, 2019 (https://swachhsurvekshan2019.org/Images/Survekshan%20Survey%202019%20Toolkit.pdf), accessed on 20.04.2019.

Annex 2: Operative Guidelines for Septage Management for Urban and Rural Bodies Issued by the Government of Tamil Nadu [62]

Parameter	Details
Design and construction of septic tanks	Evaluate existing septic tank designs and other storage/ treatment systems and modify (in case of variation) based on the suggested design.
	Issue notice to owners of septic tanks that do not meet the standard septic tank design under Tamil Nadu Public Health Act, 1939.
	Convert insanitary latrines into sanitary latrines.
Pumping and desludging	Conduct periodic and routine desludging.
	Local bodies to ensure proper collection (transportation) system, and treatment of septage at the nearest STP and safe disposal.
Septage transportation	Local body clusters have been identified for treatment of collected septage at earmarked STP locations. All septage transportation vehicles should be directed to transport septage to their designated STP.
	Only certified and licensed septage transporters to desludge and transport waste to the designated STP
	Septage transportation vehicle operators involved in the process of collection, treatment and disposal of sewage should be well trained and equipped with protective safety gear, uniforms, tools and proper vacuum trucks, to ensure safe handling of sewage.
Treatment andfinal disposal	Design of decanting facility:The decanting facility should be designed based on expected volumes of septage generated in local body clusters, with adequate capacity for the next five years based on the urbanization trend in the cluster.
	Quality check: Input quality of the collected septage should be tested at the decanting facility for presence of any metal or traces of industrial waste.
	Operational details: The septage receiving facility should be operational during working hours only and a responsible person should be appointed in the facility to ensure that no commercial or industrial waste is unloaded through these facilities.

[62] Source: Municipal Administration and Water Supply Department, Government of Tamil Nadu. 'Operative Guidelines for Septage Management in Urban and Rural Local Bodies' (http://muzhusugadharam.co.in/wp-content/uploads/2017/07/english-septage-operative-guidelines-tn.pdf)

Parameter	Details
IEC for municipal staff, households and private operators	Staff should be well-trained in safe septage management and its best practices. The residents must be sensitized regarding the health hazards associated with improper collection and treatment of waste, and the ill-effects of sewage discharge into fresh water/storm water drains. Private Operators and Transporters should be well trained in safe collection and transportation of sewage including vehicle design, process of desludging, safety gears and safe disposal at the nearest STP.
Fees/charges for desludging, transportation and treatment	Fees for desludgingareto be collected from residents by the certified/licensed tanker operators.
	Transport charges should be determined based on market rates.
	Treatment charges: For treatment, the current rate of INR 150-200 can be charged for 9000 litres of waste collected.
Management Information System (MIS)	Information related to septage generation from residents and commercial establishments needs to be collected by the local bodies. Household level details of insanitary latrines, identification of septic tank location, operator in-charge for each location, vehicle details, name and location of STP earmarked for disposal of septage, and decant facility details should be duly collected by all local bodies.

Annex 3: Comparison of Specifications for FSTPs as per Work Order Issued by JMC and the Findings from Field Research

Requirements as per Work Order	Whether Fulfilled *(as per Field Research)*
Screen chamber	N
Oil and grease tank	N
Equalization tank	N
Raw sewage pumping system	Y
Aeration tank	Y
Secondary settler tank	Y
Treated sewage tank	Y
Backwash water tank	Not clear
MGF	Y
On-line coagulation	Not clear
Activated carbon filter	Not clear
Polishing filtration system	Y
Chlorination system	N
Biosludge handling	Y
Dewatering system	N
Treated water pumping system	Y
Control panel for semi-automatic operation	Y
24-hours operation	N
Total area to not exceed 50 sq metres	N

Buffer tank level controller	N
Treated sewage tank level controller	N
Raw sewage pump submersible	Y
Biosludge recycling and dewatering system	N
Power consumption less than 15 hP	Not clear
Noise level less than 75 db at 1m from STP	Not clear
Malodour control in STP vicinity	Y, no discernible odour
RCC tank of 50 cubic metres	Y

Annex 4: Test Results of Raw andTreated Water at Jabalpur and Ujjain

Test results of raw and treated water at Garha, Aadhartal and Poliapathar FSTPs in Jabalpur (23 August 2018)

Parameters	Standards as per Work Order	Garha		Aadhartal		Poliapathar	
		Raw Water	Treated Water	Raw water	Treated Water	Raw Water	Treated Water
PH	5.5-9.0	7.78	7.27	7.73	7.28	7.81	7.33
BOD	<20 mg/l	16,263	8.15	16,045	9.26	15,061	9.26
COD	< 50 mg/l	28,425	41.83	28,034	41.37	27,256	42.67
TSS	<30 mg/l	26,074	16.24	26,012	14.12	25,863	15.28
Oil and grease	<10 mg/l	475	7.3	457	7.7	468	6.4

Test results of raw and treated water at Sadawal FSTP in Ujjain (14 December 2018)

Parameters	Design Standard of Treated Water[63]	Raw Water	Treated Water
PH	6.5 to 9.5	7.74	7.36
BOD	<10 mg/l	1490	9
COD	<50 mg/l	5195	32.2
TSS	<150 mg/l	990	20
Oil and grease	<10 mg/l	380	6

[63] As per DD Builders' technical specification document.

Scaling City Institutions for India: Sanitation

Sanitation programme at the Centre for Policy Research (CPR) is a multi-disciplinary research, outreach and policy support initiative. The programme seeks to improve the understanding of the reasons for poor sanitation, and to examine how these might be related to technology and service delivery models, institutions, governance and financial issues, and socio-economic dimensions. Based on research findings, it seeks to support national, state and city authorities develop policies and programmes for intervention with the goal of increasing access to inclusive, safe and sustainable sanitation. Initiated in 2013, the programme is primarily funded by the Bill and Melinda Gates Foundation (BMGF).

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