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Reimagining Sanitation Services

With Digital Public Infrastructure

A Strategy Note

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EXECUTIVE SUMMARY

India's Swachh Bharat Mission has been the centerpiece of government programs in the last decade, spending over USD 29 billion (₹2.4 lakh crores) on accelerating sanitation outcomes by eradicating open defecation.

To meet international sanitation commitments (like Sustainable Development Goals), recover economic losses due to inadequate sanitation (USD 105 billion or ₹8.7 lakh crores in 2015, amounting to 5.2% of the country's GDP then)[1] and to make decisive progress in sanitation, the Government of India (GOI) has launched many important sanitation programs and policies including the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), the Jal Jeevan Mission (JJM), the National Mission for Clean Ganga (NMCG), the Solid Waste Management (SWM) Rules, the Liquid Waste Management (LWM) Rules, the Plastic Waste Management (PWM) Rules, etc. The rights and interests of those who work in sanitation have also gained attention in the last few years, and the comprehensive and well-resourced NAMASTE (National Action for Mechanised Sanitation Ecosystem) scheme for sanitation worker well-being and the Emergency Response Sanitation Unit (ERSU) guidelines for working in hazardous environments have also been released.

India's sanitation sector is at an inflection point with International commitments, National intent and State mandates driving a step-change in service delivery outcomes. But sanitation remains a complex problem to solve — the domain is marked by rapid changes in the problem space, multi-actor involvement, and a lack of reliable data and transparency within various waste streams or in their management. Sanitation needs and challenges vary based on a number of factors, including geography, level of urbanization and industrialisation, socio-economic context etc.; while some common trends can be observed, effective service delivery still requires empowerment of field workers through adaptation of solutions to local needs.

Digital Public Infrastructures (DPIs) are well-suited to cater to problems of this nature and scale, particularly in low-capacity environments. When it comes to leveraging DPIs, India is ahead of the curve. We've used digital platforms to solve multiple problems including social security access (Aadhar), financial inclusion (UPI), education (DIKSHA), healthcare (ABDM) and urban governance (UPYOG). This document envisions a National Sanitation Platform to deliver safe and efficient sanitation services across waste streams at speed, scale and substantially lower costs compared to other tech-enabled alternatives. A shared national platform makes digital transformation of sanitation accessible to all relevant governments/ agencies by enabling economies of scale.

DPIs are governed at three-levels: institutional governance for the establishment, operations and maintenance of the DPI; programmatic governance to ensure that on-ground benefits are realized; and platform governance to ensure that specifications

1 *Poor sanitation cost India 5.2 percent of its GDP, Down to Earth, Sept 2016*

and standards act as guardrails and guidelines for the sanitation ecosystem to build and evolve new solutions and offerings.

The architecture of the platform consists of three key layers:

Core Data Infrastructure Layer: The sanitation domain needs consistent, reliable and accessible data as a "shared source of truth" across multiple stakeholders — this will enhance service delivery, coordination and administration. The core data layer is well-suited to solve this problem as it validates and stores data securely. The layer is made up of data registries and configurable master data that have relevance across government departments and can be accessed through APIs. To ensure data integrity and transparency, the layer includes a non-repudiable log of access or changes to data.

Core Services Layer: To streamline the process of building solutions for state and local governments, the core services layer provides context-neutral and reusable functional services (like payments, billing, search features, etc.) that serve as fundamental building blocks — since these can be reused to build solutions across multiple domains, including sanitation, they lower the barrier to access this solution. Players who use the building blocks to create new services and features can also contribute their solutions back to the platform for others to reuse, and reduce redundant efforts and associated costs.

Sanitation Solutions Layer: This layer houses sanitation-specific solutions required to implement large-scale sanitation programs, and integrates with applicable core services and data registries. When many components of the application are already available, it reduces cost, time and effort required to build and deploy new sanitation applications/ solutions. These services are configurable and also reusable across multiple sanitation domains like Faecal Sludge and Septage Management (FSSM), Solid Waste Management (SWM), Biomedical Waste Management (BWM), etc. The extensibility of the DPI allows rapid scale-up of sanitation services — not just across geographies, but also across waste streams.

To enable States to leverage the platform and accelerate participation, the DPI will also provide reference applications for specific waste streams, e.g. FSSM and SWM — these applications will enable coordination within a waste stream, and generate data and value chain visibility. As more States develop and deploy their own solutions based on these reference applications, more collective value is created through data generation and enhancement of existing features, which can all be contributed back to the shared digital infrastructure.

A National Sanitation DPI can unlock and accelerate innovation in the sanitation sector across the country. Beyond the digitalization of Sanitation service delivery across waste streams, a National Sanitation platform can also enable integration of sanitation services with overlapping municipal services like Property Tax, Water and Sewerage Fees, Building Plan Approval, Grievance Redressal, etc., leading to efficient service delivery through seamless flow of verified data. The DPI can reduce redundancies, enable efficiency through integrated service delivery, and has transformative benefits such as:

Improved and inclusive access for citizens: Digitizing sanitation solutions will enable citizens to access and track services with ease, and create a digital log of any disputes raised during service delivery. With assisted service delivery models (like employing digitally-literate service intermediaries), citizens with lesser digital access/ skills can have better access to services and overcome existing socio-economic barriers like gender, geography, etc. This will enable all citizens to have equal access to services.

Ease of working for service providers: The automation of back-end operational tasks opens up the capacity of bandwidth-strapped field-level service providers. The transparency, and associated accountability, enabled by digitisation will create greater coordination among value chain actors to deliver efficient services.

Data-driven governance and performance management: Value chain visibility will enable a clear view of operational and financial bottlenecks to achieve sanitation outcomes and benefits. Administrators will have access to reliable real-time analytics, enabling greater administrative control and local government accountability, to access performance metrics, allocate resources and effectively deal with planning challenges.

Evidence-based policymaking: Post facto survey data comes with associated costs and a significant time lag. The DPI generates real-time transactional data and on-demand insights which enables continuous monitoring and better planning, paving the way for timely service reforms. Further, real-time data generated by the platform can further enable monitoring of reforms, in addition to any State or National policy, to ensure that desired outcomes are achieved.

Creating new markets: The DPI will enable interaction and coordination between industry and government, supporting an ever-evolving service delivery landscape, and paving the way for creation of end-product markets driving financial sustainability and profitability for all players.

Enabling a circular economy: By providing real-time data on where and how much of different waste products are generated, recycling and upcycling organizations will be able to understand market opportunities. This will enable new players to enter the fray, leading to the creation and expansion of circular economy markets.

Enhancing ability to respond to emerging needs: The sanitation sector needs to respond to evolving trends and threats — like service access in times of natural disasters, new models of service delivery, public health concerns, etc. This becomes easier due to the DPI's building block approach, allowing new solutions and features to be built and deployed at cost and scale.

The range of benefits unlocked at each part of the value chain and for each player in the ecosystem through the DPI can enable a step-change in sanitation outcomes. This resultant shift in system equilibrium could be the robust overhaul the sector needs to ensure that there are zero deaths, diseases and environmental contamination as a result of ineffective sanitation.

Chapter 01

BACKGROUND AND INDIA'S SANITATION JOURNEY

4.5
Billion people

Lack Safely Managed Sanitation Services

Across the world, 4.5 billion people continue to live without access to safely managed sanitation services[2] — this is more than half the global population.[3] Taking cognizance of this reality, international initiatives have been urging global economies to place greater emphasis on water and sanitation. The Sustainable Development Goals (SDGs), set up in 2015, called attention to this through SDG 6: Clean Water and Sanitation for all. The importance of SDG 6 is emphasized by how it affects other goals,[4] creating repercussions in overall socio-economic progress and well-being.

Figure 1: The importance of SDG 6 is emphasized because it affects other goals

Aligned with global efforts, India focused its attention on Sanitation and entered into Mission mode to ensure sanitation, hygiene and the eradication of Open Defecation through its flagship sanitation program — the Swachh Bharat Mission (SBM). The mission, envisioned as a *Jan Andolan* (people's movement), was considered a success with the construction of over 10.9 crore new rural household toilets,[5] and most parts of the country achieving ODF (Open Defecation Free) status.[6]

2 The Global Sanitation Crisis, The World Bank, Jul 2020
3 Our growing population, United Nations
4 India's achievement in SDG 6 in the 2030 Agenda, BMC Public Health, 2022
5 Toilets Built Under Swachh Bharat Mission, Press Information Bureau, Feb 2022
6 India achieves over one lakh ODF Plus villages, Press Information Bureau, Aug 2022

In 2015, a further fillip to Sanitation interventions in the country came with the launch of the Atal Mission for Renewal and Urban Transformation (AMRUT) by the Ministry of Housing and Urban Affairs (MoHUA), wherein the provision of sewerage facilities and septage management was a key priority. In 2019, the Jal Jeevan Mission was launched by the Ministry of Jal Shakti to ensure functional water connections to all households, while the National Mission for Clean Ganga had constructed nearly 100 Sewage Treatment Plants (STPs), with more underway.[7]

In 2021, India's flagship sanitation program was launched in its second phase (SBM 2.0) with 2.5x funding to address the downstream concerns of SBM's toilet building campaign. USD 17 billion (₹1.41 lakhs crore) was allocated in the budget to achieve ODF+ status (by ensuring functional and well-maintained facilities with working water supply), ODF++ status (by ensuring safe management of septage and sewage), and Water+ status (no wastewater is released into the environment without adequate treatment).

Additionally, rules for Solid Waste Management, Plastic Waste Management, e-Waste Management, etc., were announced by the Ministry of Environment, Forests and Climate Change (MoEF&CC), creating an enabling environment for holistic Sanitation by identifying different waste streams and the prerequisites for their safe handling and management.

For the people who work across these waste value chains,[8] MoHUA and MoSJE (Ministry of Social Justice and Empowerment) jointly launched the comprehensive NAMASTE (National Action for Mechanised Sanitation Ecosystem) scheme in 2022. The scheme ensures overall sanitation worker well-being through mechanization, skilling, enabling alternate livelihood opportunities, etc.

This scheme was preceded by MoHUA's Emergency Response Sanitation Unit (ERSU) advisory, which takes cognizance of the reality that 5 million sanitation workers come in contact with faecal matter, and over 2 million of them are employed in high-risk situations,[9] and provides directives for the State to ensure safeguards for sanitation workers who clean manholes and sewers.[10]

Technology has also been used as a lever to catalyze innovations in sanitation under SBM — though Swachh Survekshan, a ranking exercise to foster competition between cities to meet various waste management parameters; the Swachhata app for citizens to demand better sanitation services from local governments; SBM toilet locator on Google Maps[11] to locate and provide feedback on public toilets (30,000 toilets from 500+ cities are live on Google Maps); the My Toilet Facility app designed to enhance efficiency for the caretakers of community/ public toilets; and an e-learning portal for Urban Local Body (ULB) employees to learn about innovative and sustainable sanitation solutions in the marketplace. However, despite investment in technology to realize sanitation goals, these systems are designed as stand-alone solutions, each meeting a specific programmatic need. They are not interoperable-by-design, limiting the possibilities of deriving integrated data insights, increasing efficiency, and reducing costs.

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7 *National Mission for Clean Ganga, At a Glance, Sept 2020*

8 *A business or process model that describes the entire chain of activities — including collection, transport, processing, treatment, disposal/ reuse — required to provide waste management services*

9 *The Nine Kinds of Manual Scavenging in India, The Wire, Nov 2018*

10 *Explained: Why emergency response units are needed to ensure safety of sanitation workers, The Indian Express, Sept 2023*

11 *Locate Public Toilets on Google Maps MoHUA partners with Google to launch #LooReview Campaign, Press Information Bureau, Sept 2018*

Chapter
02

SANITATION NOW — THE CHALLENGES AHEAD

India's Sanitation service delivery requires a robust overhaul to make sure that there are zero deaths, diseases, and environmental contamination resulting from unsafe sanitation practices. Complex problems like sanitation — that comprise multiple waste streams, various policies and governing institutions, and ever-evolving requirements — can not be solved by any one actor.

The sector requires the collaboration of actors across the public, private, and social sectors, so that knowledge, skills, and resources can be pooled, to enable transformation at scale. This is a monumental task, requiring the alignment and coordination of multiple stakeholders and standardization of practices across multiple waste streams.

For this, it is important to ensure that standards, policies, and rules exist, and there is necessary access and visibility to ensure suitable behavior of all actors across value chains. These standards need to consider that each waste stream involves various business models, market uncertainties and treatment technologies.

Given India's federal structure, States have the discretion to integrate and adapt to National policies. As a State subject,[12] sanitation realities, complexities and solutions differ across States, and this is further contextualized at the local government level. Hence, any holistic approach needs to be built with State and ULB autonomy at its core.

12 *National urban Sanitation Policy, Ministry of Urban Development, Government of India, 2008*

Governance Challenges in Sanitation Service Delivery

Effective and customized sanitation service delivery at the local government level requires an understanding of the administrative challenges that lead to suboptimal outcomes. Given the various touch points in the waste management value chain, lack of systemic data clouds visibility, making it challenging for administrators to identify failures, risks and opportunities in sanitation service delivery. Additional **State Capacity** constraints can be in terms of budgets, skilled human resources, and access to relevant technologies.

This compounds State challenges in solving existing exclusion concerns in public service delivery, and ensuring **access and inclusion** of all recipients. Untreated waste has negative impacts on the environment and on public health, potentially affecting all residents of a given area, making complete and inclusive sanitation coverage a crucial local government priority.

It is also essential to note that Sanitation strategy and provision needs to **respond rapidly to emerging threats and needs.** If unprepared, progress can swiftly be set back during times of crisis — like COVID-19 and extreme weather events — and compound existing service delivery challenges, access barriers, and risks.

The Multiple Waste Streams of Sanitation

Waste value chain models provide a lucid frame to understand the ideal flow of waste. While the model is abstracted to be widely applicable, each value chain comprises different stakeholders and business models. Sanitation/ waste management value chains can be broadly described as consisting of five stages: containment/ segregation, emptying/ collection, transport, treatment, and reuse/ disposal. At each stage, various measures can be taken to ensure safety and transparency.

Lack of coordination between value chain stakeholders and lack of visibility to ensure standardized practices in each stage of the value chain result in sub-optimal sanitation outcomes. Additionally, friction between stakeholders, and unviability of existing and emerging business models undermine the effectiveness of existing or proposed waste management approaches.

The table below provides an overview of the similarities in value chains and differences in each stage across three waste streams — Faecal Sludge and Septage Management (FSSM), Solid Waste Management (SWM) and Liquid Waste Management (LWM).

Stage	Challenges in FSSM	Challenges in SWM	Challenges in LWM
Containment / Segregation	— Citizens build large septic tanks or ones which are not lined at the bottom to limit the frequency of desludging. — Septic tanks are often not built according to design norms, due to lack of awareness among contractors. When masons who construct the tanks oversize them or avoid lining them at the bottom to reduce the frequency of desludging, it causes overflows into connected open drains, causing a major health and environment hazard.	— Citizens do not segregate waste at the source. — Non-segregation of household waste adds to the burden of local bodies, resulting in a large proportion of waste ending up in landfills. — Waste segregation is largely undertaken by the informal sector, and only high value plastics or recyclable materials are recovered.	— Nearly 70% of Indian households are not connected to sewer networks. — Segregating blackwater and greywater at source requires additional infrastructural investments at the household level.

Emptying / Collection	— Desludging at regular intervals is essential. However, without appropriate information about the capacity of a tank, it is hard to gauge how frequently desludging services need to be scheduled. — Citizens rely on private desludging operators; service delivery is not reliable, and they cannot track their request. — Due to India's pervasive model of on-demand desludging, it is often the case that tanks overflow or systems clog before the service is requested. This can cause a health hazard for front line service providers, as well as environmental & public health consequences for the area and residents at large. — Sanitation workers are often unaware of safety procedures and do not use safety equipment while working, which is a safety violation and a human rights concern. — There are still many cases of illegal manual scavenging reported in the country.	— Many waste collecting vehicles are not equipped to collect segregated waste, meaning that they mix the waste even if it's segregated at source. —The rapid growth of cities places increasing strain on waste collection services. Many housing areas often experience irregular waste collection and resort to dumping waste in nearby vacant plots and open spaces.	— Traditionally, for cities with no sewered networks, greywater is let out into open drains, which eventually gets contaminated by black water released from insanitary containment structures.
Transport	— There are many private service providers who operate cesspool vehicles, and these players are not incentivised to follow safety standards and regulations. — After desludging, the untreated fecal sludge is often dumped in remote locations, in water bodies, open lands, or directly in agricultural fields.	— If treatment centers are far, waste transporters may be disincentivized from spending the increased transportation costs, resulting in illegal dumping of waste.	— For cities with sewered networks, the pipes are not monitored for possible leakages / obstructions, which can lead to overflow and contamination of surrounding water bodies. — For non-sewered cities, there is no visibility of the location of drains or the volume of liquid waste being discharged. — Information on the nearest treatment plant is lacking, as is information about the level of contamination of nearby water bodies, which results in illegal dumping of liquid waste into open water bodies and drains.

Treatment	— Most small-medium cities and towns lack adequate treatment infrastructure, and designated sites for sewage/ septage treatment and disposal. This contributes to illegal dumping. — Big cities have more treatment infrastructure, but incoming desludging load can be unreliable and unpredictable. This means that plant capacity can be underutilized. In some cases, it can also mean system shocks due to lack of information about effluent composition, which can lead to plant failure in the long-term. —We do not have adequate measures to ensure that sludge is appropriately treated before it is released into the environment.	— The calorific value of the waste that determines whether it is of a quality that a waste-to-energy facility can use largely depends upon the composition and moisture content of waste; we do not have adequate measures to ensure that the calorific value is maintained at a certain level.	— There is no State-level visibility of the functioning of treatment plants. — Standards for treatment are also being defined: they may vary from city-to-city depending on proximity to water bodies. — Cities with no sewered networks may not have treatment plants with adequate capacity to treat incoming waste.
Reuse/ disposal	— There is a lot of wasted economic potential in treated sludge: it can be used as manure and biofuel. Treated wastewater can also be used in gardening, car washing, etc. However, social stigma prevents this practice. — There is no mechanism to ensure that treated waste is disposed of safely.	— There are insufficient waste to value markets due to lack of visibility on demand and supply of waste products	— There is no market for reuse of treated water. There needs to be visibility on users and the volume of treated water used. — Stringent quality of treatment needs to be followed by the treatment plants. Currently this visibility of treatment quality does not exist.

India's Sanitation Systems: Impact and Priorities

Across these waste streams, the effects of unsafe and inadequate sanitation have repercussions on public health, environment, economy and social progress.

Cost to economy: India's economic losses due to inadequate sanitation amounted to USD 105 billion or ₹8.7 lakh crores, according to a 2015 study — this is 5.2% of the country's GDP and almost half of all global losses (cost to global economy was estimated at USD 219 billion of ₹18.2 lakh crores).[13]

Environmental costs: Unsafe waste management has contributed to illegal dumping of sewage, silt, and garbage into rivers and lakes, resulting in 80% of India's water resources becoming severely polluted. Open defecation, poor sanitation, and polluted[14] natural resources increase the disease burden of the country.

13 *Poor sanitation cost India 5.2 percent of its GDP, Down to Earth, Sept 2016*
14 *How Water Pollution in India Kills Millions, Borgen Magazine, Jul 2020*

Figure 2: Sanitation Impact Priorities

Disease burden: Diarrhea, a preventable disease that is closely related to unsanitary practices, kills 3 lakh children every year[15] and contributes to the stunted growth of 4 crore children.[16] In 2017, the prevalence of WASH-related diseases was estimated to be 5.7% of all doctor visits and 6.9% of all hospital admissions — with estimated average expenditure of USD 8.5 (or ₹703) per doctor visit and USD 117 (or ₹9656) for every hospital admission. [17]

Exacerbating vulnerabilities: The economic impacts of unsafe sanitation create a vicious cycle, as disease burden is more pronounced in vulnerable communities, with more than one-third of the lowest-income urban households lacking access to safe sanitation facilities.[18] This disrupts growth and development by compounding existing vulnerabilities — for example, lack of adequate sanitation facilities in schools burden the girl child disproportionately, resulting in 23% of girls dropping out of school on reaching puberty, limiting their potential as individuals and future workers, due to institutional inability to manage menstrual hygiene. [19]Similarly, low-income households — who are more likely to live in areas exposed to untreated waste — are also likely to struggle the most with out-of-pocket (OOP) expenses on healthcare.

Low State Capacity: The access barriers to adequate sanitation are compounded by state capacity gaps that affect service delivery. These are reflected in the form of inadequate resources, funds, skills, and information that are required to provide and monitor effective and inclusive delivery of sanitation services.

Human rights concerns: Sanitation services are currently centered around unregulated manual work, placing a disproportionate burden on sanitation workers, who are often trapped by multi-generational socio-economic constraints. Manual scavenging is still a reality in India, and — despite existing policies focused on their safety — a sanitation worker dies every five days. The magnitude of this problem is also underestimated, given the lack of data.[20]

15 *Diarrheal diseases among children in India: Current scenario and future perspectives, National Library of Medicine, 2015*
16 *Stop stunting, UNICEF*
17 *Burden of water, sanitation and hygiene related diseases in India: prevalence, health care cost and effect of community level factors, Science Direct, 2021*
18 *Urban sanitation in India: key shifts in the national policy frame, Sage Journals, Jun 2015*
19 *About 23 per cent girls drop out of school on reaching puberty, Down to Earth, Jan 2018*
20 *One manual scavenging death every five days: Official data, The Indian Express, Sept 2023*

Chapter 03

A NATIONAL PLATFORM FOR SANITATION SERVICE DELIVERY

The sanitation sector requires coordination at a national scale, while making space for regional variations in service delivery. Also, as an evolving problem space seated at the crucial intersection of public health and environmental concerns, the sector requires the ability to develop and deploy solutions to meet existing and emerging sanitation demands quickly. Given the nature and scale of the problem, Digital Public Infrastructures (DPIs) are best suited to cater to the needs of Sanitation Service Delivery and enable a step-change in outcomes.

DPIs enable the effective provisioning of essential social functions and services like civil registration, ID and authentication, payments, and data exchange. India is a global trend-setter in the use of DPIs given the scale achieved — in the number of people this architecture serves, and across the number of solutions it provides.

We've used digital platforms to solve multiple problems including social access (Aadhar), financial inclusion (UPI), education (DIKSHA), healthcare (ABDM) and urban governance (UPYOG). These platforms have created reusable and extensible digital components which can be leveraged by solution architects across the public, private and social sectors.

India's Sanitation sector is well positioned to build on these platforms, and leverage learnings to transform service delivery in sanitation markets. The National Sanitation Stack is envisioned as a digital public infrastructure for the sanitation sector. It is designed to transform India's sanitation sector, help unlock the latent potential of India's waste-to-value market, and distribute the ability to solve. To do this, the DPI needs to adhere to certain principles to enable ecosystem actors to develop sanitation solutions.

Guiding Principles of a DPI

Adherence to the design principles and standards ensures increased access and lowers barriers to participation. Therefore, the approach allows all actors across the ecosystem

to collaborate and solve sanitation challenges at scale and with speed, while ensuring the quality of outcomes.

1. Ecosystem Driven

The digital infrastructure will foster a vibrant ecosystem of sanitation actors and respond to their needs by enabling effective collaboration for the purpose of devising solutions that are relevant to the contexts of each State and local government.

2. Interoperability through Open APIs and Open Standards

Interoperability is essential for a DPI to be able to support the diversity and complexity of the sanitation sector. The DPI must be built using open standards and avoid dependence on specific platforms or software frameworks that become a barrier to the participation of any actor in the ecosystem. In addition, the components of the platform would be loosely coupled using open interfaces (APIs). Adoption of open and vendor-neutral APIs and open standards and, wherever appropriate, choosing open source frameworks and components over proprietary ones, will help achieve the goal of interoperability.

3. Inclusive

The design is aimed at ensuring that all segments of citizens can benefit from the DPI. The DPI should be able to configure, extend or customize applications to cater to their specific needs. In addition, it can be leveraged across multiple channels — both digital and physical to engage and serve citizens effectively.

4. Minimalistic

The goal of the DPI is to enable relevant solutions; hence it is important that it remains minimal and allows innovative solutions to emerge rather than forcing a particular type of solution. It may provide reference applications to seed the imagination of the ecosystem, but should remain minimalistic to allow actors to respond to context and complexity.

5. Privacy and Security by Design

Managing security and privacy of data is crucial to building and maintaining trust between ecosystem participants and thus will be a critical design principle. All data access must be through API calls to ensure appropriate security controls. The DPI will provide standards and certification for data privacy and security. Direct access to data will be prohibited and use of APIs will be mandated. The DPI will ensure privacy, data encryption and data integrity, and will disseminate data only to authenticated and authorized stakeholders (both internal and external) through data fiduciaries.

6. Unbundling

Platforms achieve scale and flexibility by unbundling complex challenges into micro solutions and services, and subsequently allowing their re-bundling in specific contexts. These layers rise from context-neutral bottom layers to more context-sensitive ones — similar to LEGO building blocks. Unbundling promotes reusability, lowers the barrier for new solutions and enhances participation by abstracting complexity under simple interfaces.

7. Designing for Evolvability and Scale

The DPI will need to keep pace with India's sanitation challenges as they evolve over the years. It will have an architecture that can easily accommodate new capabilities as the ecosystem evolves and to incorporate new technologies as they emerge. The DPI will be able to scale horizontally to hundreds of millions of users in the sanitation ecosystem and to handle trillions of data records. All components, including computer, network and storage resources, must be capable of scaling horizontally. Being cloud-ready and using commodity hardware will ensure that capital investments on the DPI will be minimal.

This will also give a choice of infrastructure to the actors and users and enable systems to evolve heterogeneously.

8. Transparency and Accountability through Data

The verified registry of all the organizations/ agencies and the non-repudiable transaction trails shall lead to higher trust and stronger accountability. The DPI will be data-driven and will use data generated through transactions for reporting and analysis. Public Open Data shall be made available via APIs for transparency. The access to open data will ensure high-quality analytics, accurate fraud detection, shorter cycles for system improvement and, most importantly, high responsiveness to user needs.

9. Non-Repudiable

The DPI would enable the verifiability of data and its provenance and thereby ensure trust and accountability within the ecosystem. All data would be non-repudiable and verifiable in order to energize the ecosystem for collaboration and interaction between actors.

10. Domain Modeling

Since the DPI must balance between abstraction, for wider adaptability, and context-specific solutions, the data specifications would remain generic without making concrete assumptions about the purpose for which the data is used. The data specifications would be extensible, allowing programs to model their own domain by adding new data attributes on top of available specifications.

11. Federated Architecture

To resolve for scale and ensure agency, the ability to solve must be distributed, empowering stakeholders to overcome the challenges they face. Hence the DPI will have a federated architecture enabling actors to retain agency and choice in solutions.

12. Ensuring extensibility through the use of layered design

The design of the DPO will be modular, with clear separation of data storage, software services and APIs. Components will be minimalistic, independently replaceable and extensible. This will allow different components to be loosely coupled when building applications, thereby enabling application diversity. Different users will be able to customize and create contextual solutions to serve their specific purpose.

13. Multi-Channel Access

With the rapid growth of net connectivity and the variety of electronic devices available in the market, it is important that the end user's access points and access interfaces are kept in mind while enabling access channels — Citizen Service Centres, PCs, Tablets, Smartphones, local kiosks and doorstep delivery — and ensuring user choice to enable rapid adoption and ease of operation by the end users. The platform needs to be agnostic to channel of access and also enable offline access. This will enable cities to effectively respond to the needs of all citizens including digitally excluded sections of the society.

The Sanitation Stack Infrastructure

As illustrated above (Chapter 2), while Sanitation requirements and solutions differ across local governments, sanitation waste streams — FSM, SWM, LWM, etc. — have similarities in value chain (starting from generation/ containment, to collection, transport, treatment, and disposal/ reuse). These similarities allow for us to abstract and digitize various components of the service value chain, with the possibility of encoding standards, and enabling data and visibility into sanitation services.

Given the requirements and constraints of the Indian Sanitation Sector, a National Sanitation Platforms will enable:

1. Coordination — by providing shared data registries
2. Ease of solution design, customisation, and deployment — by providing shared services, including both relatively context-agnostic services (e.g. workflow, billing, etc.) and more sanitation-specific ones (e.g. treatment quality monitoring)
3. Ease of reimagination and catalysis — by providing reference applications

Standards and Specifications: The DPI can be seen as a manifestation in software (code) of standards and specifications, which act as guardrails and guidelines for the ecosystem, as different actors build solutions across time, geographies, and waste streams. This enables flexibility and choice to ecosystem actors, while maintaining effective coordination through a common vocabulary across various areas.

Since the standards and specifications are aligned to the design principles of the platform (mentioned above), including openness, minimalism, unbundling, and extensibility, they pave the way for both increased interoperability between solutions and systems (which can enable coordination between sanitation service providers and adjacent local government services), and modularity and flexibility (which can enable state and local governments to start up sanitation service delivery programs at speed, scale, and low cost, as well as to respond swiftly to emerging needs).

Additionally, the use of open standards reduces the barriers to participation for ecosystem actors, and eliminates the problem of vendor lock-ins — unlike proprietary software where users become dependent on vendors for products and enhancements owing to the substantial cost of switching to another vendor, an open-source infrastructure allows for ease of building and integration across services.

The use of federated architecture with multi-tenancy addresses concerns around digital sovereignty and control over data in federal systems. India, composed of different States with varying levels of resource availability and tech-readiness, will benefit from this as it will allow the proliferation of sanitation solutions using a common framework while placing agency and control in the hands of local governments.

These standards and specifications guide all data registries and services that are built on the platform, creating a coordinated base to create and deploy solutions. The DPI is made up of three layers — comprising reusable digital components — that act as building blocks for solutions:

1. Core Data Infrastructure layer: The sanitation sector lacks consistent, reliable, and regularly-updated data. Sanitation services span waste streams and governing institutions, and sanitation services hinge on information from adjacent agencies — for example, property data, building plan data, public grievances data, etc. — to help plan and prioritize sanitation services. Shared data will not only enable inter-governmental coordination for service delivery and governance, but will also enable the creation and expansion of markets by equipping private sector players with data related to waste market opportunities. However, lack of reliable and easily-accessible data is a core problem in governance. Each organization tends to maintain its own copy of data, with limited data-sharing across ecosystem actors. If one organization updates some data, this updated data may not reflect in any other organization's records or systems. This, in turn, makes it difficult to get a holistic view of the on-ground reality of the sanitation value chains.

This challenge is solved by the Core Data Infrastructure Layer of the DPI, consisting of data registries and configurable master data, which has relevance across government departments — subject to authorisation, these can be accessed through APIs. This way, multiple organizations/ agencies can access these data registries, which serve as a "single source of truth". Based on the level of authorisation, multiple agencies may read, search, update, and conduct various forms of analysis on the data in these registries. A competent authority can be designated with the responsibility for verifying specific data points, and verified data can be considered to be of higher reliability.

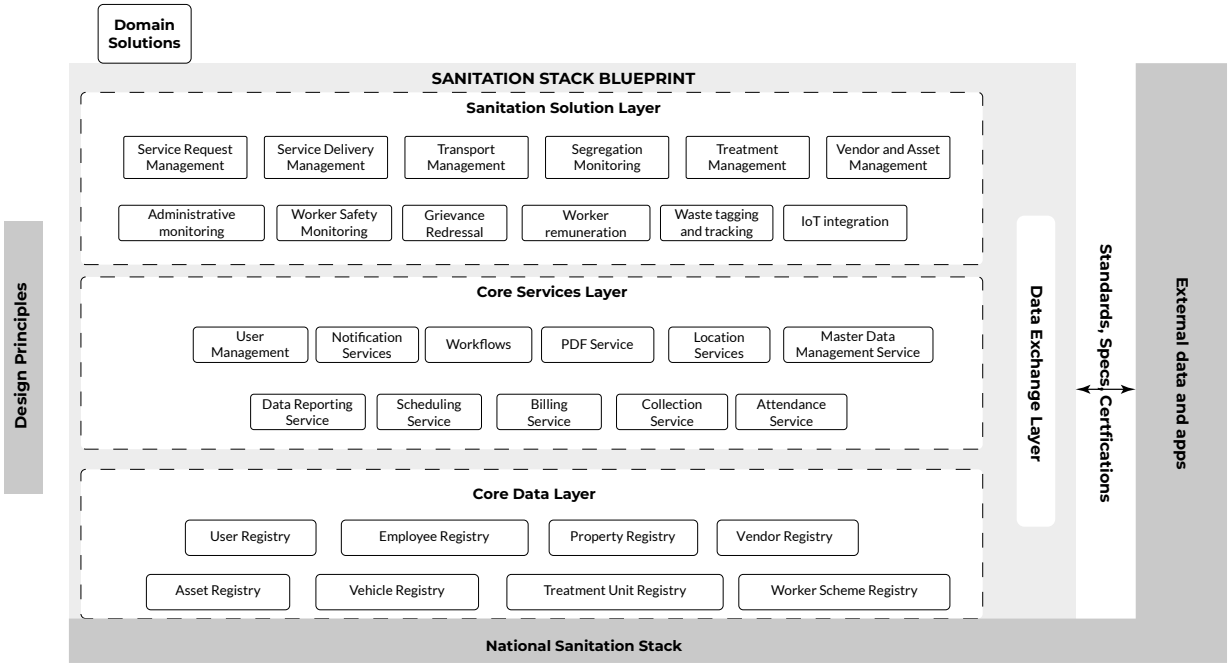


Figure 3: The layers of the National Sanitation Stack — Standards and Specifications run parallel to the stack and work as guardrails for all solutions built on the DPI

As the registries are created using common standards (data models, ontologies, taxonomies), the recorded data will be clearly-defined and commonly understood. Following the principles of minimalism and extensibility, the data models can include a minimal number of mandatory fields, while leaving organizations/ agencies the flexibility of including additional fields that they may find relevant or useful for their purposes.

When one entity creates a new record or updates an existing record, the new or updated record is visible to all other consumers of the registry. The change in question can be approved or verified by the authority holding the information, pending which it will be identified as draft or unverified. The registry's audit log, which is non-repudiable, will also show who made and/ or approved any such creation/ update/ deletion, providing an incontrovertible record of changes to the data.

2. Core Service Layer: Sanitation solutions need to account for variations in context and needs, and consider the resource constraints of smaller local government bodies. India has over 4000 small cities and towns that are challenged with middling or low state capacity, and struggle to meet their development needs.

The digital infrastructure provides context-neutral functional services which can be leveraged to build solutions. New applications and features can be composed with minimal time, cost and effort. The availability of these reusable services can significantly reduce the cost of adopting digital sanitation solutions for the long tail of small cities, by lowering the barrier to develop and deploy such services.

These reusable functional services like payments, notifications, location tracking, search functionality, etc., act as fundamental building blocks, which can be reused to build solutions across multiple domains. For example, user management, data reporting, search, payments, attendance, etc., are all capabilities needed for municipal service delivery and governance; all of these will likewise find use in any sanitation service delivery or waste management solution.

As states or cities adopt or develop solutions on the national sanitation platform, every new application built can use some elements from the existing services. The platform (and hence, any solution that is built on it) can also interact and integrate with third-party

services (like a revenue tracking system) through open APIs.

This building block approach to building new solutions not only reduces cost and effort, but also enhances the functionality of existing solutions — different stakeholders can contribute features and solutions back to the platform. This means that code, features, applications, etc., developed by third-parties can be easily integrated to enhance existing functionalities or add new ones, and new features can be developed collaboratively by stakeholders interested in different facets of the same problem.

3. Sanitation Solutions Layer: While sanitation service delivery might be able to leverage many of the common services in the core service layer, there are also aspects of waste management that can be abstracted, drawing from our understanding of the waste value chain. These services — vehicle tracking, effluent quality monitoring, etc. — may have limited use in other forms of service delivery, but are common aspects of an end-to-end sanitation management solution. These services are required to implement large-scale sanitation programs, again integrating with services from the core data and services layers as applicable. These services are configurable and reusable across multiple sanitation domains like FSM, SWM, BWM, etc.

Reference Applications: To enable State and local governments to leverage the DPI and build on it, reference applications will be provided. Reference applications help programs get started, operate with minimal effort and address the most common use-cases. As functionally complete modules, they can also act as a base to enhance and evolve solutions.

Reference applications also serve as a starting point to demonstrate to developers how the various components in the core services, core data, and sanitation solution layers can be leveraged to address the needs of a specific waste stream.

For example, FSSM, which is fast growing as an essential alternative to networked sewerage, requires a property registry, Desludging Operator (DSO) vehicle registry and treatment plant registry, which can be populated in the core data layer of the Sanitation platform. Core services, like user management, payment, billing, etc., and sanitation

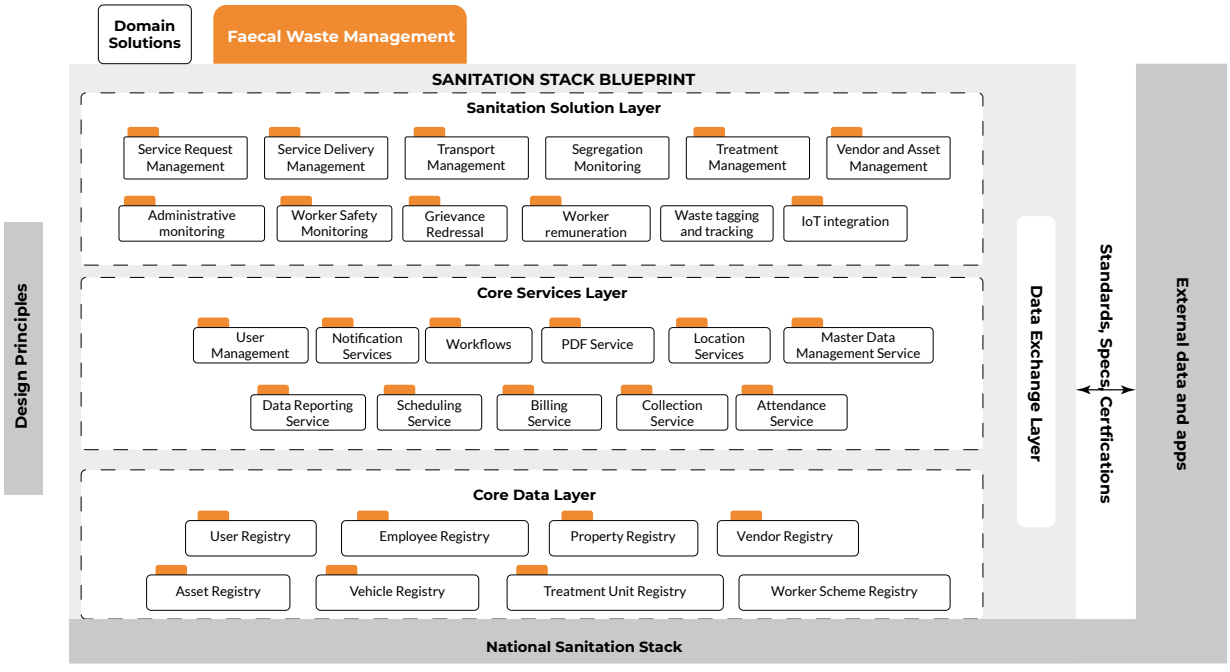


Figure 4: The FSSM solution across DPI layers — Relevant data registries and core services are leveraged to compose a FSM solution with context-specific requirements

services, like service delivery, transport management, treatment management, etc., can be used to compose a FSSM application that digitizes service delivery.

An application to digitize UWM can also reuse the citizen and treatment plant registries, and can leverage core services like user management, billing, GPS tracking, treatment management, etc. to compose a new solution. The UWM application can use the same building blocks from the sanitation stack as the FSSM application, enabling the creation of quick and cost-effective solutions.

The Solution in Action — The Odisha Case Study

In late 2021, the State of Odisha operationalised the National Faecal Sludge and Septage Management (FSSM) Policy (introduced in 2017), setting up close to 100 Faecal Sludge Treatment Plants (FSTPs). The State, however, had very limited visibility on how many FSSM services were requested across the State, the quality of service delivery, and the utilization of the treatment infrastructure (which cost nearly 300 crores in investment). [21]

This was of importance to Odisha because, as per the 2011 census, the State was one of the poorest performers in urban sanitation in the country — 33% of urban households lacked toilets and practiced open defecation; septage treatment plants didn't exist, and only 2% of the sludge generated was being treated; cesspool vehicle operators / DSOs were few; and manual scavenging was prevalent, with workers subject to discrimination and exclusions.

Odisha has made many strides to turn around its urban and sanitation narrative with definitive action and innovative solutions (see Annexure 1). One of these was a DPI — called SUJOG, built on the DPG DIGIT — to digitalise delivery of urban services like property tax, building plan approval, public grievance redressal, etc.

The DPI extended its services to the sanitation sector by creating sanitation-specific services (using the sanitation solution layer) such as service request management, transport management, treatment management, etc., to digitalise FSSM operations (see Annexure 2 for more information on the waste stream). This FSSM application has been able to provide data and visibility to track service requests and understand the service delivery value chain, paving the way for process enhancement in FSSM (see Annexure 3 to understand qualitative impact of SUJOG-FSSM).

Benefits Realized by Odisha

As on date, SUJOG-FSSM has been rolled out to 69 ULBs. Each ULB has 2 employees using the platform — one at the ULB office (responsible for collecting and managing requests) and another at the FSTP (responsible for logging in vehicles, be it associated with an application or independently).

Total No. of ULBs	Total No. of Personnel using SUJOG-FSSM	Total citizen requests raised on SUJOG-FSSM	Expected Revenue Generated (INR)
69	138	7500+	140 Lakh+

Data from November, 2022

Capacity building: Leveraging a train-the-trainer approach, master trainers from the Odisha Urban Academy (OUA) were trained so that they could further train end-users at the ULB-level. Thus far, over 166 end-users across 69 ULBs have been skilled in the use of the digital platforms.

21 *Faecal Sludge and Septage Management in Urban Areas — Services & Business Models, NFSSM Alliance and NITI Aayog, Jan 2021*

Planning service delivery: Having a cohesive view of property types within the boundaries of a ULB can help the local government plan for incoming volume of sludge and schedule desludging

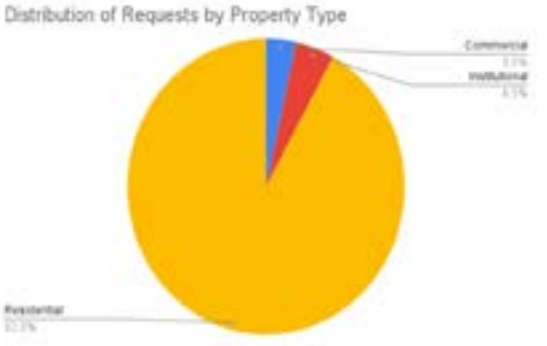
Monitoring and accountability: The platform enables multi-stakeholder interaction, between citizens, ULB FSSM executives, cesspool operators, and FSTP operators. A citizen can raise a desludging request, or have a ULB employee raise it on their behalf, and track the status of service delivery. The cesspool operator provides the service, and the FSTP operator is responsible for closing the request once the septage is safely disposed of at the FSTP. This visibility into the value chain enables monitoring of and accountability within the FSSM value chain.

Administrative visibility of on-ground reality: As adoption increases, so does data and visibility into realities on the ground. Data from the platform helps drive insights on many aspects of FSSM service delivery, with process and policy suggestions to enhance outcomes. For example, data from the platform shows that private desludging vehicles, which aren't registered with the ULB, deposit sludge at the FSTP. This shows that there are some private vehicles operating in Odisha, which aren't empaneled by the State.

Infrastructure optimisation: Odisha is implementing an urban-rural service convergence model, and working to optimize the capacity of the FSTP plants in the State. Since all relevant data is already available on the platform — Data on available capacity vs. utilized capacity, compared against no. of households tagged to the FSTP and the no. of vehicles that perform desludging activities — it is possible to automate analysis on the gaps that need to be bridged to optimize FSTP capacity.

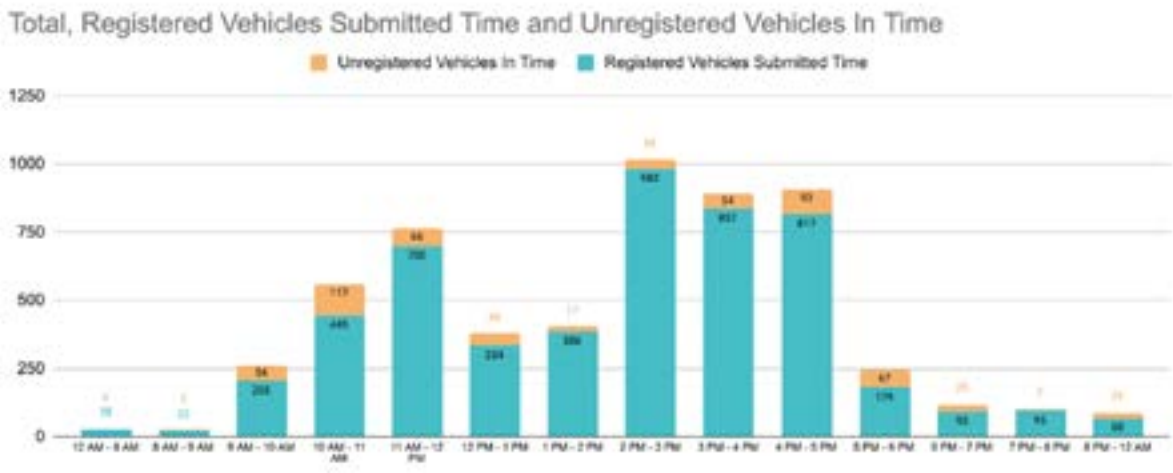
Total No. of FSTPs	Total Trips with sludge disposed at FSTP	Total Septage disposed at FSTP (Litre)
69	14500+	400 Lakh+

Data from November, 2022



Sanitation worker safety: Odisha is invested in the well-being of its frontline sanitation workers, and to this end, has launched the Garima scheme to provide worker IDs to sanitation workers and adopted the ERSU (emergency response sanitation unit) advisory to ensure safety of workers who enter septic tanks and sewers. Owing to the ease of building and integrating features on SUJOG, these process flows will soon be digitized for automated tracking.

SUJOG-FSSM has enabled Odisha to achieve a step-change in service delivery. Since the shared infrastructure has already been adopted, the State can also digitalise and enhance service delivery processes and outcomes across waste streams at cost and speed. The benefits of this approach to service delivery and governance can be felt across the ecosystem.


Total, Registered Vehicles Submitted Time and Unregistered Vehicles In Time
Unregistered Vehicles In Time
Registered Vehicles Submitted Time
1250
1000
750
500
250
0

Chapter 04

THE BENEFITS OF A NATIONAL SANITATION PLATFORM

The National Sanitation Stack will encode standards digitally and ensure value chain transparency to address systemic challenges in the sanitation sector, including data paucity, operational inefficiencies, information asymmetry, and capacity constraints. Additionally, when ecosystem actors are enabled to develop contextual solutions, they will be able to accelerate the proliferation of sanitation innovations.

The design of the platform is geared towards resolving key challenges, needs, and pain points for all key stakeholders: citizens, frontline workers (in this context, sanitation workers), back office employees (e.g. in the ULB office, for the Technical Support Unit (TSU), the Program Management Unit (PMU), etc.), vendors and service providers to the government (e.g. desludging vehicle providers or operators, treatment plant operators, etc.), and administrators at multiple levels/ tiers of government.

Benefits to value-chain stakeholders	
Citizen 	- The citizen is able to have multi-channel access to safe and trackable service delivery. This leads to accountable and transparent services and seamless grievance redressal. - They can receive push notifications — with reminders for when their septic tank is due for de-sludging or with information on how to accurately segregate solid waste — to create behavioral nudges that contribute to healthier habitats. - Overall improvements in waste management and reduction in illegal dumping will mean that everyone lives in a cleaner and healthier neighborhood, leading to public health gains (e.g. reduction in water-borne diseases).

Sanitation Worker 	- The sanitation workers are skilled in safe sanitation practices, standards and tools. - Monitored service delivery will lead to optimisation of performance and create safe working conditions with transparency ensuring compliance in safety practices. - Enumeration of sanitation workers will enable delivery of targeted benefits and welfare schemes for workers and their families (e.g. health checkups, insurance, social security, scholarships for children,etc.)
ULB Employee 	- The ULB employee is able to create a single back-end registry of all incoming service requests. They are able to collect and maintain relevant citizen information to deliver efficient services. - The ULB employee is able to do remote tracking of value chain stakeholder — waste-transporters can be tracked in real-time to ensure that there is no illegal dumping of collected waste; and they are able to ensure that quality of waste treatment meets standards by validating automated records without being at the waste treatment plant.
Waste management vendors 	- Waste Management vendors are able to assign tools and services that best suit the citizen who has raised the request by referring to relevant information that would affect service delivery — like property information. The ability to do this would make the process time and cost-effective. - Increasing the viability of waste management services will enable more private players to enter the fray, limit illegal dumping and eradicate opportunities for illegal manual scavenging.
Treatment plant / center operator 	- The plant operator will be able to validate that there is no discrepancy in volume between the waste collected at the households and disposed at the plant, ensuring that no waste drops off the value chain without treatment. - The plant operator is able to ensure that the treated (liquid) waste meets appropriate standards by validating it against lab reports, and that solid waste is appropriately reused and recycled. - Operational efficiency and capacity utilization of plants can be monitored - Treatment plants can be plugged into waste-to-value markets, making it easier for buyers of processed and tested waste to discover and buy from them, contributing to financial sustainability of treatment plants.
ULB Administrator 	- The ULB administrator has access to automated and on-demand analytics to monitor service delivery outcomes in real-time - Access and Inclusion in service provision can be ensured - The ULB administrator is able to identify and resolve any operational bottlenecks; financial transparency enables planning of resources and funds; and ensure that citizens receive safe and satisfactory sanitation services

By allowing actors along the value chain to generate and feed relevant data into the system, the National Sanitation Stack contributes to the larger Public-Private-Social sector ecosystem around sanitation. In the long term, data generated through the platform will enable better operational and financial planning, ensuring sustainability and effectiveness of service delivery.

A National Sanitation Stack will provide the Union government visibility on the health and potential of ULBs to deliver sanitation services. The data can help stakeholders understand the reasons for service delivery bottlenecks and provide essential support to enhance performance.

Decision-makers at each administrative level (National, State, Local government) can be equipped with relevant and regularly updated data analytics to enable effective performance management, decision-making, and process reforms. This can help manage resources, and to effectively expand state capacity by channeling limited resources and capacities to their most effective uses.

Benefits to the Public-Private-Social ecosystem

Government

- Rapidly scalable, context-specific, cost-effective digital solutions to drive safe sanitation
- Improved sanitation coverage through the building-block approach, leading to accelerated achievement of SDGs (e.g. SDG 6)
- Ability to create data-driven policies for sanitation
- Ability to monitor, audit, and improve sanitation performance, practices, and standards
- Drive transparency and accountability within the market for sanitation outcomes
- Adopting open-source technologies and preventing vendor lock-in

Market Players

- Large-scale waste management companies can expand their sphere of operations to provide more holistic solutions with close feedback from the ecosystem and the platform.
- Construction companies (that build STPs/ FSTPs/ Landfills) will have a better understanding of waste volumes that require processing
- Waste solution provides will have better visibility of demand and supply opportunities in the ecosystem to capture value from waste, which will also enable new players to enter the fray
- System integrators will have the business opportunity to implement the public digital infrastructure in multiple state-wide implementations.

Academia

- Digitization will create data, process flows, and standards that will become the subject of research and analysis to create new knowledge, technologies and recommendations.
- Knowledge dissemination: the learning from research can contribute to improving policy and standards, creating a feedback loop of do-learn-do to drive impact

Civil society organizations (CSOs)

- Thanks to value chain visibility, CSOs will be equipped with crucial data-driven insights to enable better planning and implementation of sanitation programs
- Evidence-based insights will support policy advocacy, process reforms and program re-design to achieve desired outcomes; these measures can further be monitored on the platform

Apart from the benefits to value chain stakeholders and the sanitation ecosys Apart from the benefits to value chain stakeholders and the sanitation ecosys tem, the value proposition of a shared digital infrastructure is in how it shifts system equilibrium by catalyzing transformative benefits for everyone involved. Over a period of time, these benefits will lead to a robust overhaul of the Sanitation sectors — by creating value chain visibility, improving citizen services, enabling markets, etc. — allowing the sector to ensure zero deaths, disease, and environmental contamination resulting from unsafe sanitation practices.

Systemic Shifts in Sanitation Service Delivery

Effective resource planning: Over time, data accruing from digitalisation will help identify

operational bottlenecks and enable resource planning — this will help provide sustainable and reliable sanitation services. The financial health of ULBs can also be enhanced, as increased visibility into transactions aids financial planning and fund management. Automation and data-insights will enable ease of working and decision making for bandwidth-strapped local government employees.

Empowering service intermediaries: Women from self-help groups are often engaged as service intermediaries in sanitation. Equipping them with digital tools and skills will contribute to their overall professional development, and visibility into the value of their services will also enhance their involvement in ensuring sanitation outcomes.

Inter-departmental coordination: In the long term, Sanitation — as a domain that overlaps with other municipal services — can be streamlined through inter-departmental data-sharing and integration. For example: waste segregation requirements can be mandated and verified while applying for building licenses; or septic tank construction standards can be encoded while registering a property. This digital governance solution can break data silos while ensuring data integrity to provide integrated public services. This will lead to ease of working, streamline coordination of actions, reduce duplication of efforts and, and enable greater efficiency in local government operations.

Enabling State Capacity: Adopting a digital solution and enabling automation of back-end tasks will quickly translate to efficiency gains for all value-chain actors, allowing them to focus on more qualitative requirements of their role — this is particularly of value in resource-constrained government agencies. These efficiency gains will lead to an expansion in State Capacity, allowing governments to shift the needle to focus on more qualitative outcomes.

Ability to respond to emerging needs: The rights and safety of sanitation workers has been receiving renewed National attention in the last few years with the announcement of the Emergency Response Sanitation Unit (ERSU) guidelines and the National Action for

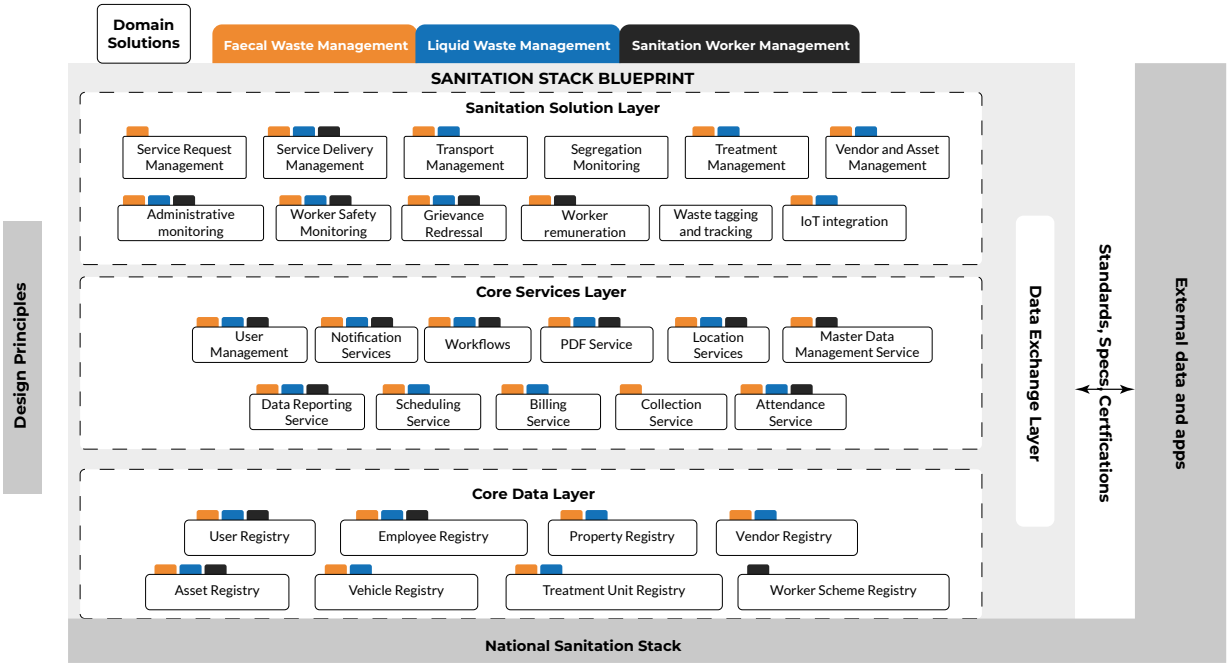


Figure 5: The extensibility of the Sanitation stack — the reusable components of the stack can be leveraged to build new features and solutions

Mechanised Sanitation Ecosystem (NAMASTE) scheme. Leveraging the digital components available on the platform, new digital workflows to ensure sanitation worker well-being can be quickly built and deployed, thanks to the modular nature of the DPI. This ability of the DPI to respond to emerging needs can also be leveraged in times of natural disasters like floods and disease outbreaks, and new policy implementation like the urban-rural service delivery convergence.

Distributive Justice in Service Delivery: The visibility and data-driven insights generated by the DPI will give the State visibility of service coverage, and a channel for enacting any corrective measures to ensure that unserved and underserved populations receive the distributional benefits of sanitation service delivery.

Markets for technology and innovation: Data from the DPI will enable the creation and expansion of markets by clearly identifying demand and supply opportunities, and paving the way for the commodification of new and innovative tech. For example, Internet of Things (IoT) technologies are nascent, and not yet largely adopted, as they are not yet cost-effective at scale. A unified view of sanitation solution opportunities will bring in more players to develop innovative and cost-effective solutions, leveraging existing building blocks and capabilities of the platform to address some of the pieces necessary to make IoT-based monitoring more practical and viable.

Extensibility of solutions: With many components of the application already available, it reduces the cost, time and effort required to build and deploy a new application. The extensibility of the platform allows rapid scale-up of sanitation services — not just across geographies, but also across waste streams.

Chapter 05

REIMAGINING MULTIPLE WASTE STREAMS ON THE SANITATION STACK

The sanitation platform can be used to govern and deliver safe and effective sanitation services, across all levels of government. The benefits of the platform for citizen service delivery, ecosystem players, and policy reforms will also scale and compound as the DPI is scaled across waste streams to create a cohesive National Sanitation Platform.

The DPI can create exponential value in the long term by creating an integrated administrative workbench for local government employees, and enabling interdepartmental coordination among municipal services providers. This enables seamless flow of necessary information to provide efficient public services through an integrated service delivery architecture. Services can also be extended to new areas, as the building block approach allows for solutions to be composed quickly and cost effectively. Below are a few potential use cases of how a DPI can be leveraged across the sanitation domain:

State Y in India wants to formalize biomedical waste management and prevent illegal dumping of potentially infectious waste. Ahead of the next COVID-19 booster drive, the State wants to leverage a DPI to meet this goal. What is the potential opportunity?

Given that vaccinations in India are booked and recorded by COWIN as part of the COVID-19 vaccination drive, it is possible to retrieve the data from the COWIN system, using open APIs, to compute the quantum of syringe, vaccination vials, gloves, etc. that are generated at a healthcare facility/ ULB/ State level. This visibility allows us to plan and allocate operational resources and execute biomedical waste management to establish a chain of custody.

India has 400 million informal laborers, including sanitation workers. There are many schemes to support their well-being and progress, but there is no unified view of their socio-economic progress as they are usually paid in cash. How can we ensure that those who are employed in public service delivery receive adequate compensation on time using a DPI?

Sanitation service intermediaries will be tracked by the system when their work value chains are digitalised. The core data layer hosts an employee registry and a worker

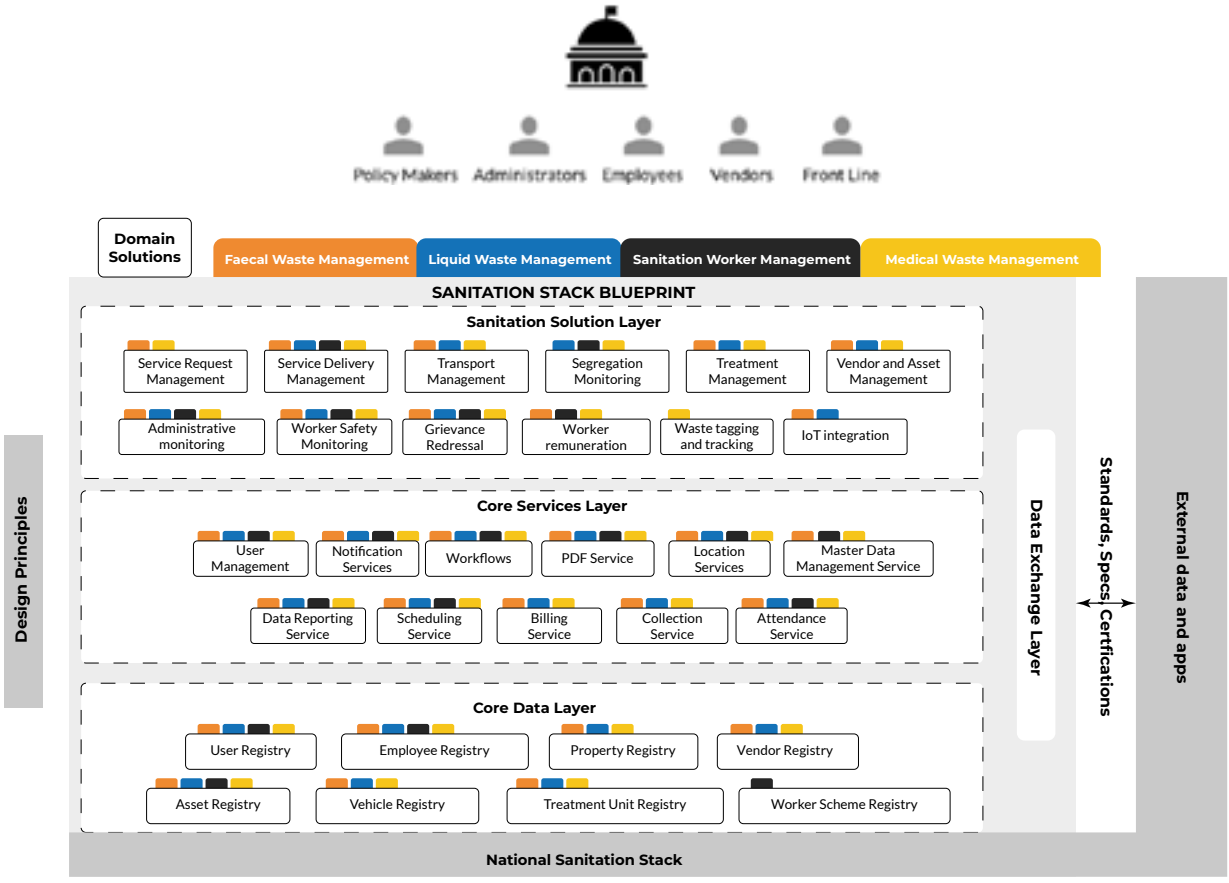


Figure 6: The National Sanitation Platform can provide a unified administrative interface to govern service delivery across waste streams

scheme registry which can be used with the attendance service and the worker remuneration service to map worker identity to payments and benefits.

A Smart Payments system, linking service contracts to payments, can validate attendance and hours logged in, and automate timely payments. The system also has the capacity to register sanitation workers against their IDs to ensure that they and their families receive government benefits available to them.

A grievance redressal service can also allow for workers to raise disputes and resolve any discrepancies using the same application — history of complaints will log time taken to resolve concerns. This approach makes it possible to enable digital skilling and ensure worker dignity in sanitation intermediary service provision.

State X wants to digitize Solid Waste Management to ensure that waste is appropriately segregated in every household, and regularly collected by waste workers. How can the State leverage a DPI to enable compliance?

The core data layer of a DPI hosts property data, which can be tagged against a QR code assigned to each household. This way, we can ensure that waste from each property is collected everyday and checked against the QR code. With the use of QR codes, if the waste collected from a household is not appropriately segregated, the waste worker can escalate the issue and behavior change can be instigated through negative incentives like fines and penalties.

MoHUA and MoSJE released the Emergency Response Sanitation Unit (ERSU) advisory in 2019 and many states are working to operationalise this protocol. ERSU calls for periodic training of sanitation workers to ensure that no one without adequate knowledge of safe sanitation management practices is employed in delivering services. How can this be ensured?

A DPI can be leveraged by mapping employee data against training services completed and preventing sanitation workers without necessary training to be assigned services within the system. Further, by linking sanitation worker training to the number of services delivered, we are able to analyze how much the training contributes to enabling efficiency in safe service delivery.

India wants to move towards a circular waste management economy. How can a DPI be leveraged to achieve this outcome?

A DPI can enable interaction between industry and government, supporting an ever-evolving service delivery landscape. It can pave the way for the creation of end-product markets by discovering demand and supply markets, and ensuring quality of outputs. Data from the platform also enables visibility to identify opportunities to optimize operations. This paves the way for profitability and encourages more players to enter the market contributing to market expansion. This increases competition and drives innovation.

One of the challenges in providing seamless FSSM service delivery is lack of information about septic tanks — like size, volume and access. How can a DPI be used to bridge this information gap?

By encoding building standards for septic tanks, it is possible to enforce compliance by verifying septic tank dimensions and construction standards while providing building plan approvals. For existing constructions, property data can be leveraged to access information on the size, volume and accessibility of the septic tank. Further GIS data can be used to understand barriers to street access for the vacuum trucks that are used in desludging services. Finally, this information, once accessed, can be stored as part of the property data and can be retrieved to provide efficient services when desludging services are next requested.

Chapter
06

INSTITUTIONALIZING A NATIONAL SANITATION PLATFORM

For the long-term sustainability and success of the sanitation platform, it is essential that ecosystem actors like GoI, State governments, local governments, and sanitation ecosystem players act together. GoI will create the National Sanitation Stack as a Digital Public Good that is available to States and local governments, who can then configure, customize and extend the features of the platform as per their needs.

To this end, it is essential to institutionalize the shared digital infrastructure in a suitable public institution which has the mandate and the capabilities to make it available at a national scale. For this, the following is necessary:

Operationalisation of the National Sanitation Stack

By creating policy support and allocating funds, GoI will focus on developing the sanitation stack, and making it available for ecosystem actors to adopt and deploy. This will be done by focusing on two tracks:

Technology: Develop the Sanitation Stack and make it available to state and local governments for them to leverage. The reference applications that will be available on the stack will enable the establishment and implementation of sanitation solutions in a phased manner. As the ecosystem adopts and further builds/builds on these applications, more applications will become available, making it possible to meet a wider range of existing and emerging needs effectively by leveraging the stack.

Ecosystem: Help early adopters of the sanitation stack prepare for deployment by readying their existing systems and processes for rapid implementation of key programs, driving capacity building for ecosystem actors, and developing a digital roadmap for sanitation programs.

Institutionalization of the National Sanitation Stack

A given DPI or platform can be said to be institutionalized at the national level once the following elements have been put in place:

- a nodal ministry or agency at the GoI level, which owns, governs, and serves as a champion for the platform – typically by creating a national mission or scheme that provides a policy mandate for the platform;

- an anchor institution either in a ministry or other GoI-affiliated entity, which serves as the custodian of the national platform, and provides the ongoing operational leadership for the mission;

- sufficient and suitably-skilled human resources in the anchor institution, covering both programmatic and technical capabilities;

- suitable funding for both the anchor institution and state or local governments wishing to adopt the platform – this may take the form of allocating new funding or allowing the use of funds allocated under various schemes and missions for implementation of the national sanitation stack;

- enabling policy reforms or changes, as needed, to accelerate adoption of the national sanitation stack.

- engaging with the ecosystem to understand their needs and introduce new enablers and accelerators to address these

For instance, the National Urban Digital Mission was launched in 2021 by MoHUA and the Ministry of Electronics and Information Technology (MEITy).

An anchor institution was created in the form of the Centre for Digital Governance (CDG) at the National Institute of Urban Affairs (NIUA), which brought on board a team with both programmatic and technical skills to manage the platforms created under the National Urban Innovation Stack (NUIS), engage with state governments, and provide overall program governance.

CDG has further brought out a series of enabling knowledge assets, such as the NUIS Digital Blueprint, Technical Implementation Guidelines, and Program Implementation Guidelines. A number of implementation service providers have been empaneled by CDG – simplifying the process of procuring such services for state governments – and a series of training and certification programs are being conducted to ensure that skills and capabilities to deploy, customize, and build on the platform are available throughout the ecosystem.

As with NUDM, institutionalizing the Sanitation Stack also requires the commitment to evolve the stack to meet the emerging needs of the ecosystem actors. The Sanitation Stack will need to be housed in a suitable institution which will drive adoption and usage of the stack. The anchor institution will further guide the evolution of the stack, by identifying key needs of different sanitation waste streams and actors and catalyzing solutions for them.

In driving governance and evolution of the stack, the anchor institution will work with the ecosystem to define standards and specifications to inform the future roadmap for development, deployment and dissemination of the stack. It will design an inclusive governance structure for the stack, to enable the platform and the ecosystem to address sanitation challenges while remaining in compliance with the standards, specification, guidelines, and design principles governing the platform.

Catalyzing Adoption of the National Sanitation Stack

In order to drive sanitation transformation across the country, the sanitation stack, once offered by GoI (through the anchor institution), needs to be adopted by States and Local Governments.

An enabling policy environment and necessary resource allocations to enable state-level adoption of the platform will be ensured — Government Missions like SBM Urban, SBM Gramin, JJM and AMRUT will earmark resources that States can use to implement the National Sanitation Stack. Additionally, relevant reporting metrics for the management and monitoring of ongoing projects under these missions will be incorporated within a year of the stack being launched.
This will also encourage local governments to use the platform, and nudge all value chain players to transact on the platform through behavior change communications.

The transformative benefits of the platform can be realized when ecosystem players innovate and build new solutions/ features on the platform, and contribute the new solutions/ features back to the platform for others to use. Data from the DPI can be further utilized by CSOs and research organizations to study trends, design new solutions, etc.

ANNEXURES

Annexure

01

THE ODISHA LANDSCAPE

The State of Odisha, with a population of 4.1 crores (41 million), is one of the least urbanized States in the country, with 83% of the population living in rural areas. Poverty, vulnerability, and exclusions have been consistent challenges in urban Odisha, with over 22% of the urban population living in slums without any security of tenure, and over 28% living in poverty, a lower per capita income than the national average, and shortages / access challenges with respect to housing, water, and sanitation.[22]

There have been significant developments in the overall economy, as well as in the urban sector in Odisha, driven by proactive and inclusive policies and initiatives taken by the State Government. The foundation of the change process is the 5T principles of Transparency, Technology, Teamwork, Time, and Transformation (5T) adopted by the State to improve the quality of governance and services in the urban areas.

To operationalise the 5T principles, the State Government, which has enjoyed political stability for two decades, has launched several programmes in recent years like the JAGA mission for slum development, MUKTA for wage employment, UIDSSMT for urban infrastructure development, Mission SHAKTI for women's economic development and the 'Mission Drink From Tap' for urban water supply, while also implementing National schemes like AMRUT (water supply and sewage), PMAY (urban housing) and the SMART Cities initiative (Bhubaneswar and Rourkela).

Odisha is ahead of the curve in adopting digital technologies to offer public services. One example is the 'Odisha One' portal, an integrated service delivery platform for Government-to-Citizen services at the Gram Panchayat level. Another example is SUJOG, a transformative digital platform for urban service delivery, which enhances transparency and access for citizens, automates back-office processes for ULBs, and facilitates integration between departments by enabling secure information flow.

22 *Census of India, 2011*

Annexure 02

THE CONTEXT FOR FSSM

For most Indian households that use a toilet, the waste flushed down does not connect to a sewer system. Centralized sewer systems require vast underground pipelines, pumping stations and treatment plants, which are expensive to build and operate effectively. As a result, 47% of Indian households use septic tanks or soak pits, which are known as on-site sanitation (OSS) systems. It is important to formalize the management of OSS systems, particularly in the 7000+ small towns that do not currently have central sewer systems and are unlikely to be covered by one in the near future. Lack of safe and transparent management of OSS systems results in in 52.2 billion liters of raw sewage going out into the environment every day,[23] compounding environmental and public health concerns, and increasing associated economic costs.

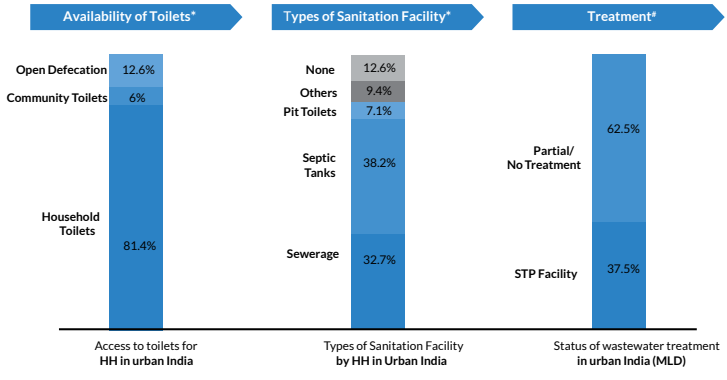


Figure 8: Status of Sanitation in India[24]

23 National Inventory of Sewage Treatment Plants, Centre Pollution Control Board, March 2021

24 Faecal Sludge and Septage Management Policy, Ministry of Urban Development, Government of India, Feb 2017

Underscored by this reality, MOHUA released the Faecal Sludge and Septage Management (FSSM) policy in 2017.

The FSSM value chain

OSS systems accumulate and store faecal matter over 3-5 years, as opposed to sewer systems, which allow the continuous transport of faecal matter with used water. Once the OSS storage is full, the waste is emptied and transported to the treatment plant through vacuum trucks. The end-to-end value chain of safe storage, collection, transport, treatment, and reuse or disposal of faecal matter is called Fecal Sludge and Septage management (FSSM).

The Faecal Sludge and Septage Management ecosystem is made of highly interdependent parts, with the value chain requiring multiple touch points. While the linear value chain gives a lucid frame to understand the ideal flow of faecal sludge, there are various points of friction between stakeholders that currently undermine the effectiveness of the sanitation value chain. This means that there are different actors at each stage of the value chain whose behaviors and business models affect how subsequent stages function.

For instance, if a citizen is unable to provide adequate information about how to access

their septic tank, the additional time, effort, and equipment required to enable access will add to the cost burden of the desludging operator (DSO). If the DSO is unable to derive a profit from their service, it disincentives them from ensuring the waste is treated appropriately, and incentivises them to illegally dump the sludge — particularly because most treatment plants are located in city outskirts. The incentives, awareness levels, and information available for every actor who participates in the value chain is crucial, as this tends to have a cascading effect — not just on the sanitation value chain, but on the environment and public health. It is essential for actors in this value chain to have more information and visibility on the consequences of their actions. This will help identify viable service models and essential infrastructure to optimize service delivery.

Why FSSM?

Under SBM, GOI's flagship Sanitation mission, over 10 crore household toilets were built from 2014-2019, requiring OSS solutions for many, particularly in the 7000+ small towns that do not currently have central sewer systems and are unlikely to be covered by one in the near future. Acknowledging that SBM's end goal could not be achieved without the safe management of faecal sludge and septage, India implemented the FSSM Policy in 2017. [25]

25 *Faecal Sludge and Septage Management Policy, Ministry of Urban Development, Government of India, Feb 2017*

Figure 7: The Faecal Sludge and Septage Management (FSSM) value chain[26]

FSSM has emerged as a necessary and viable population-scale alternative to the networked sewer.

1. Cost-effective: FSSM systems are 10 times cheaper than sewer management systems.[27] Given the fiscal opportunities for sanitation (details below), FSSM becomes an affordable solution to deliver safe and equitable sanitation for all

.

2. Coverage and scale: With less than one-third of urban toilets connected to sewer systems, strengthening FSSM service delivery will maximize citizen impact.

Sanitation System in city/town	Applicability of FSSM
Complete sewer coverage with adequate STP capacity	FSSM required only in growth areas
Partial sewer coverage with adequate STP capacity	FSSM to complement sewerage with co-treatment and FSTPs
No sewer coverage	FSSM with stand-alone or clustered FSTPs

Figure 8: FSSM compliments existing sanitation infrastructure to rapidly solve human waste disposal concerns[28]

3. Policy tail-winds: Since the launch of the Swachh Bharat Mission, GOI has shown consistent commitment towards Sanitation. 2014 SBM's toilet-building drive was primarily geared towards eradicating open defecation; it also introduced service level benchmarks, e-learning platforms for municipal functionaries, and fostered competition among cities through the Swachh Survekshan.

In phase II (SBM 2.0), launched in 2021, the mission emphasizes that it is not only important to achieve ODF status but also work towards ODF+ (sustaining ODF behaviours and maintaining safe facilities) and ODF++ (ensure that collected waste is safely managed and treated). The 2017 FSSM Policy further highlights that this can only be achieved by emphasizing attention on OSS containment systems.

26 *Toolbox by FSMA*
27 *Toilet Ke Baad Kya?, NFSSM Alliance, 2018*
28 *Faecal Sludge and Septage Management in Urban Areas – Services & Business Models, NFSSM Alliance and NITI Aayog, Jan 2021*

Co-treatment in existing STPs-69	Co-treatment in existing STPs 50	Co-treatment in existing STPs 2	Co-treatment in existing/proposed STPs 28	Co-treatment in existing STPs In Hyderabad (12 No.s)
Independent FSTPs (co-located at SWM plant) 327 All towns covered	Independent FSTPs 59 Population covered 2.5 Cr (75% urban pop;600 towns)	Independent FSTPs 97 Cities covered ALL	Independent FSTPs 77 All towns covered	Independent FSTPs 71 (PPP-HAM)+70 (EPC) All towns covered
Total investment 45 Cr	Total investment 200 Cr	Total investment 298 Cr	Total investment 259 Cr	Total investment 250+ Cr

Co-treatment is the disposal of Faecal Sludge at existing Sewage Treatment Plants with some excess capacity for treatment along with the incoming sewage. It utilizes existing capacity and is hence cost effective and fast.

UP also has undertaken Co-treatment* and FSTP implementation in 50+ towns

Source: NFSSM Alliance analysis

Figure 9: States that have rolled out FSSM with modest capital outlays

4. State-level intent: International approaches to Sanitation — like City-Wide Inclusive Sanitation (CWIS) — have urged the country to look beyond infrastructure-creation and focus on tailored, innovative solutions that ensure inclusive service delivery. Since 2018, over 19 States and UTs have adopted FSSM policies, committing to build over 700 FSTPs — 220 are under construction, with 150 operational plants. These states include Maharashtra, Odisha, Rajasthan, Tamil Nadu, Gujarat, Jharkhand, Andhra Pradesh, and Himachal Pradesh.[29]

5. Market growth: The Toilet Coalition Board estimated that the sanitation economy's market opportunity will stand at USD 97 billion (or ₹ 7.9 lakh crores) in 2021, with the potential to grow to USD 148 billion (or ₹12 lakh crore by 2030.[30] This number includes estimates only for the first part of the FSSM value chain — provision, operations and maintenance of toilets. Citizen-facing services like construction and emptying of OSS systems is still fulfilled by the informal sector in many parts of the country, and holds great market potential if formalized. The role of these businesses and the viability of their business models will be critical to the delivery of safely managed sanitation services in the future.

6. Nascent field: FSSM is a nascent field in the sanitation sector, limiting complications from legacy systems. The technologies and business models used in the sector are still being debated, offering opportunities to evaluate various solutions' long-term sustainability and ability to adapt to evolving needs. The learnings and winning solutions from FSSM have the potential to influence and remedy challenges in other sanitation areas like SWM and UWM.

29 *Faecal Sludge and Septage Management in Urban Areas — Services & Business Models, NFSSM Alliance and NITI Aayog, Jan 2021*

30 *Sanitation economy markets: India, Toilet Board Coalition, Nov 2020*

Annexure 03

Annexure

STORIES OF CHANGE — HAPPY TO HELP!

Thanks to SUJOG, a digital infrastructure deployed to digitize FSSM service delivery in Odisha, ULB employees find ease and efficiency in providing services to citizens.

Biswakalyani Ranjit was drowning in paperwork for over a year, while working as the Technical Resource Person (TRP) at the Khordha Municipality in Odisha. She had to sort through the multiple registries that were maintained to log citizen service requests, and they didn't always have access to the information they required to provide seamless service delivery. "We were manually calculating the daily, weekly and monthly analysis reports from the hand-written register using excel sheets," she says, sounding exhausted at the thought of it.

But now, thanks to Odisha's decision to deploy a Digital Public Infrastructure (DPI) for FSSM service delivery in the State, ULB workers have started finding happiness in the ease of working due to automation. "Now that we are using SUJOG, we know where everything is logged, maintained and we can track it! There is accessibility to the number of requests raised by citizens, the number of trips taken by the Desludging operator, the volume of septage collected, etc. All this can be tracked through the platform dashboard, which is helpful for all officials, particularly the ULB head," says Biswakalyani. Overall State-wide performance is visualized from the dashboard which has pie charts, graphs, etc., enabling easy analysis and decision-making.

Her sentiments are echoed by Dimple Mahanand, who has been working as a TRP in the Sundergarh Municipality for almost a year. "When I joined the ULB, we were maintaining manual registries to transact services. After the launch of SUJOG-FSSM, we are using the platform to log requests, assign vehicles and track the vehicle at the FSTP. This makes it easy for both the ULB and the FSTP personnel to track the status of each desludging request," says Dimple.

"The Vehicle Log feature on the platform is helpful to get details of the sludge disposed of at the FSTP by cesspool vehicles which are not empanelled at the ULB; this helps in empanelling them at a later stage," says Subhasinee Sahoo, TRP, Talcher Municipality, adding, "The simplest things matter the most and SUJOG-FSSM is simple to use."

The ULB service providers are also encouraged by the value they are adding to citizens. "Earlier citizens would have to visit the ULB to raise a desludging request. Now there is a provision for them to raise the request from their mobile phone — this makes it easy for many more people to access these services, and also track the status of service delivery," says Subhasinee.

Debanjana Dey, TRP, Balasore Municipality, agrees: "Earlier it was mostly men who came to the ULB counters to raise desludging requests; but now, women can also take the lead on making these household decisions by using the platform." After two years of working as a TRP, Debanjana is excited to see the changes brought on by the use of a digital platform. Since gender is also captured on the platform, she's glad to know that gender diversity can also be tracked on the platform.

"This is important because all ULB officials can see the trend of requests, trips, etc. across the week and the month by using the dashboard. Transparency has increased as visibility for all — from the citizen to the ULB — is enabled through the platform," says Debanjana.

The ULB workers engaged in providing desludging services in Odisha are glad for the value the digital platform is providing to service delivery — their work has become more efficient, monitoring and decision-making has become automated, and they are most pleased to know that the citizens are well-served!

About eGov

eGovernments Foundation is a not-for-profit organisation that works to partner with local governments, market actors and civil service organisations to leverage the transformative power of technology to enhance Citizen Service Delivery.

Over the past two decades, eGovernments Foundation(eGov)'s work can be seen in more than 2,500 towns and cities across 8 countries, having built a robust digitally-enabled ecosystem, positively impacting the lives of over 260 million citizens across the world.

eGov partners with Civil Societies, the Government bodies and the Markets to catalyse the ecosystem to develop solutions that bring about population-scale transformations and enhances Citizen Service Delivery.

At the heart of population-scale transformation is eGov's DIGIT platform, a digital public good, designed for the ecosystem to co-create diverse solutions to resolve citizen-centric challenges with speed and at scale.

eGov is steadfast in its journey of catalysing the achievement of Sustainable Development Goals(SDG), and has till date facilitated the delivery of over 1.1 billion public services.

The organisation's vision is to bring about transparent, equitable and accessible services to all of humanity.

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