Climate Resilient **SWM Services** **For Small And Medium Towns** Of Gujarat

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CWAS CENTER FOR WATER AND SANITATION

CRDF CEPT UNIVERSITY

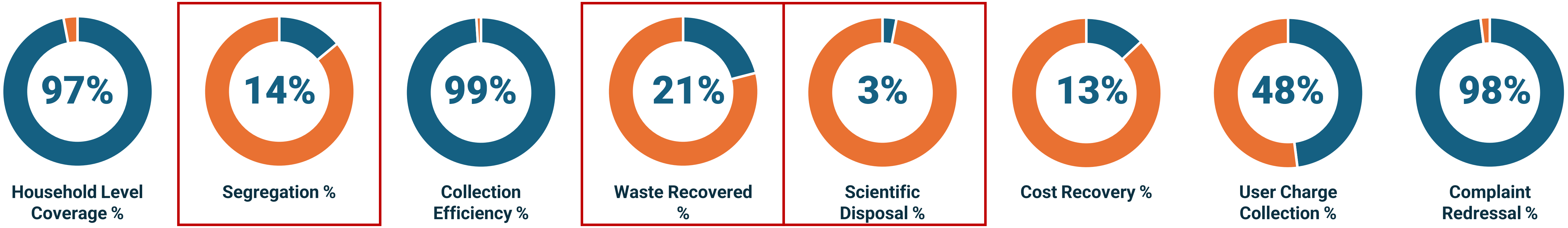
Why Climate Resilience in **SWM Services for Small and Medium Towns**

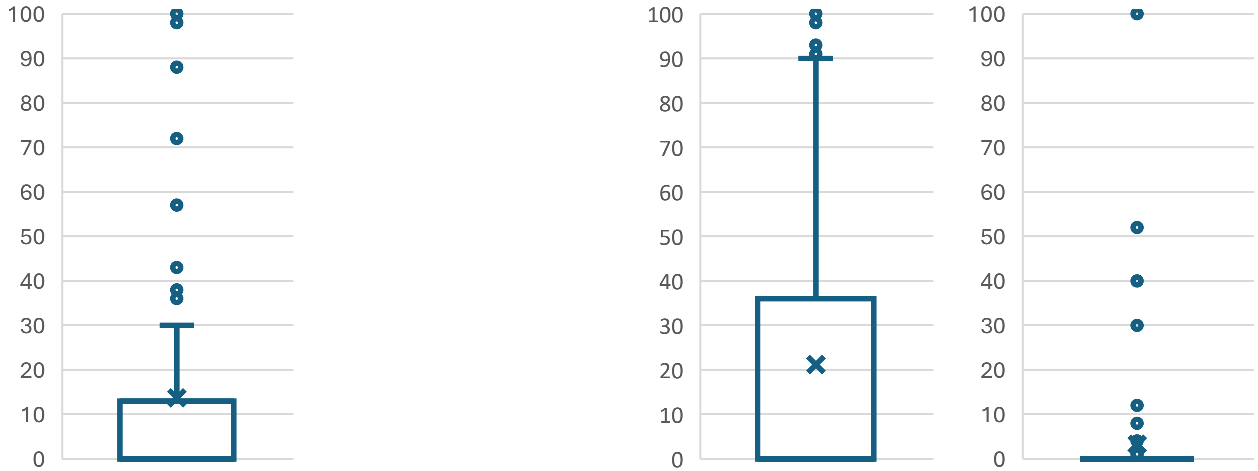
In close collaboration with the **Viega Foundation, the Center for Water and Sanitation (CWAS)** is leading a pioneering project near Ahmedabad, Gujarat. In the face of accelerating urbanisation and the growing impacts of climate change, **small towns** in the region must enhance their **solid waste management systems.** This initiative focuses on equipping these towns with **climate resilient, future-ready infrastructure and sustainable practices to address emerging environmental and urban challenges effectively.**

Source: Viega. (n.d.). Viega Foundation. Viega Group.

Why Climate Resilience in **SWM Services for Small and Medium Towns**

Analyzing Service Level Benchmarks Performance in Solid Waste Management of all the Class B and Class C towns of Gujarat, 2020-21





With just 14% segregation, waste stays mixed, limiting recovery to 21%. ULBs lack the capacity to process it, and only 3% is scientifically disposed—most ends up in open dumps. This leads to high risk of environmental degradation, contamination, emissions, and public health threats.

Source: Ministry of Housing and Urban Affairs. (n.d.). Service level benchmarking dashboard. City Finance.

Why Climate Resilience in **SWM Services for Small and Medium Towns**

Hypothesis

Lack Of Infrastructure

Small and medium cities lack formal processing and disposal infrastructure, hindering climate action prioritization

Opportunities for Sustainable Development

Despite challenges, small and medium cities have the opportunity to leapfrog traditional development pathways and prioritize sustainable infrastructure

Need for Integrated Planning

To be climate-adaptive, small and medium cities must integrate climate considerations into infrastructure development and planning itself for easy adoption.

Source: CWAS | Times of India. (2024, April 4). Challenges faced by civic bodies in solid waste management.

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Opportunity

Nirmal Gujarat Abhiyan 2.0

- **Launched**: January 2024
- **Total Budget**: **₹2,500 crore**
- **Objective**: To build upon the original 2007 Nirmal Gujarat campaign, aiming to improve sanitation, **waste management, and urban infrastructure in alignment with the Swachh Bharat Mission (Urban)**

> Nirmal Gujarat 2.0 programme under the urban development department (UDD) is aiming for **'zero-dumpsite' nagarpalikas**. We are not planning to establish any more dumpsites for the 157 nagarpalikas. Instead, **we will put in place a processing or material retrieval plant for wet and dry waste for each nagarpalika.**
>
> **- Official, Urban Development Department, Gujarat**

Source: CWAS | Times of India. (2024, April 4). Challenges faced by civic bodies in solid waste management.

SWM Focus of **Nirmal Gujarat 2.0**

Feature	Nirmal Gujarat	Nirmal Gujarat 2.0
Primary Focus	Both rural and urban sanitation, with strong initial focus on making rural areas ODF.	Primarily urban cleanliness and strengthening Swachh Bharat Mission (Urban).
Geographic Scope Emphasis	Initially broader, covering both rural and urban areas.	More specifically targets urban local bodies and urban areas.
Key Strategies	Community engagement, demand generation for toilets, integration with TSC.	**Financial incentives for ULBs based on tax collection, infrastructure development, beautification, public awareness campaigns.**
Financial Incentives	Existed, but initial focus was more on behavioral change and community ownership.	**Strong emphasis on performance-based incentive grants and matching grants for ULBs based on sanitation tax collection.**
Infrastructure Focus	Less explicit focus on urban infrastructure development.	Specific objectives for developing entry roads, iconic roads, and cleaning radii in urban areas.
Aesthetics Focus	Less explicit focus on urban beautification.	**Explicit objective of beautifying Garbage Vulnerable Points (GVPs).**
Competition Among Cities	Not a primary feature.	Introduction of the "Maru Shaher, Swachh Shaher" quarterly competition.
Recognition of Workers	Less specific focus on recognizing sanitation workers.	Explicit aim to provide financial incentives and recognition to the best sanitation workers in urban areas.
Government Cleanliness	Less explicit focus on cleanliness within government bodies.	Inclusion of an annual cleanliness calendar and activities in government administrative departments.
Alignment with National Programs	Worked with Total Sanitation Campaign (TSC).	Explicitly aims to strengthen the Swachh Bharat Mission (Urban).
Overarching Goal	Achieve total sanitation across Gujarat.	Position Gujarat as a leading state in urban cleanliness nationwide.

Source: Times of India. (2024, April 4). Challenges faced by civic bodies in solid waste management.

AIM:

To assess and suggest strategies to improve solid waste management service through climate action in small and medium towns of Gujarat

Aim & Objectives

AIM:

To assess and suggest strategies solid waste management service through climate action in small and medium towns of Gujarat

OBJECTIVES:

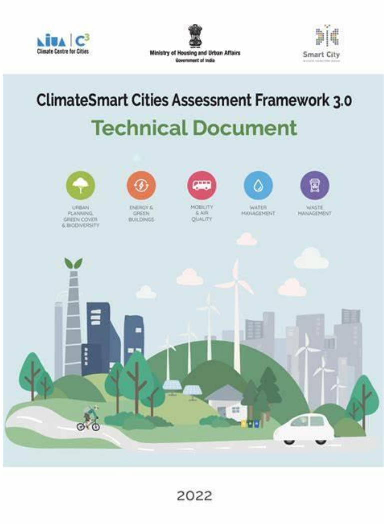
- To assess solid waste management value chain of small and medium towns in Gujarat through assessment of its municipal waste.
- To assess whether the solid waste management process is climate friendly, and systems are resilient in the case city/town.
- To propose suitable recommendations in addressing the issues.

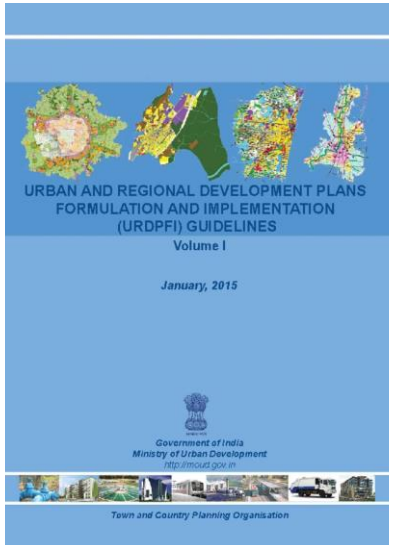
Source:

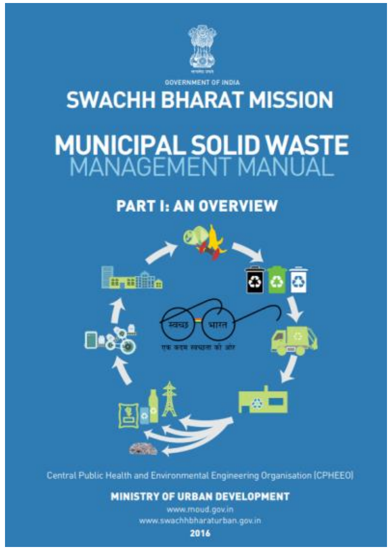
Methodology

Literature

- NIUA: climate smart city assessment framework
- CURB: Climate action for URBan sustainability
- Swatch Bharat Mission (Municipal solid waste management manual)
- URDPFI: sustainability guidelines
- Waste-wise cities







Source: Key Informant Interview, Official from Viramgam ULB

Methodology

Literature

- NIUA: climate smart city assessment framework
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- URDPFI: sustainability guidelines
- Waste-wise cities

Site visit

- **10+ FDGs** to understand quality of SWM services provided by ULBs.

Stakeholder Interviews-

- Chief officer (Mansa, Viramgam)
- SI (Mansa, Viramgam)
- Private contractor
- Local recyclers
- Scrab Dealers





Source: Key Informant Interview, Official from Viramgam ULB

Methodology

Waste composition activity

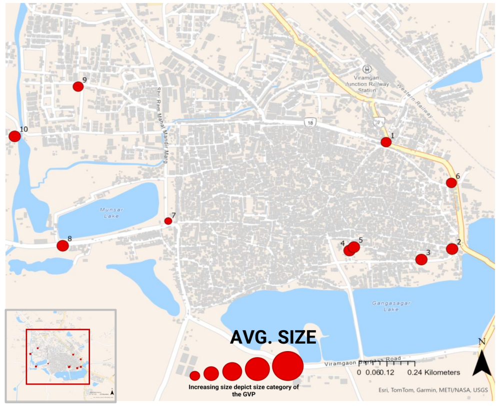
Quartering Cone Method Process in Viramgam

Whole Sample Segregation in Viramgam

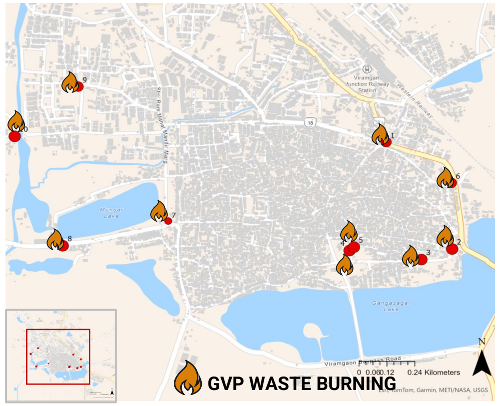
Methodology

GVP analysis

Identifying and Mapping the Major 10 GVPs



(GVPs) Size-wise Division of Scale & Identify the Pattern in Locations of GVPs



Sign of Waste Getting Burned / Incinerated

Calculation of emissions in collection, processing and disposal

Collection

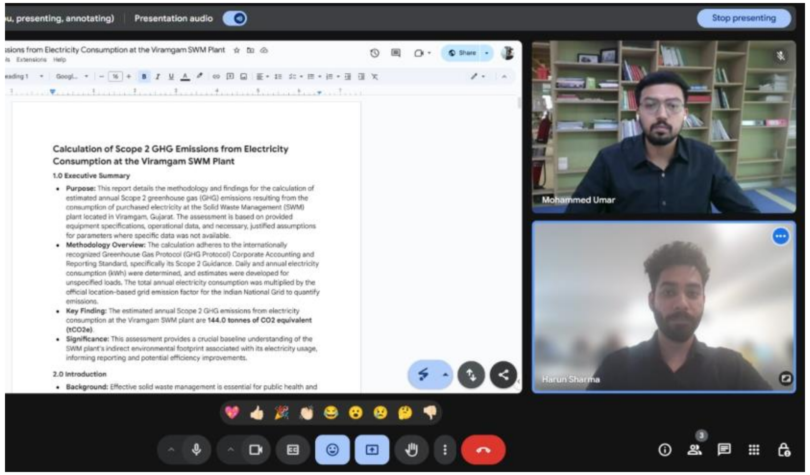
Greenhouse Gas (GHG) emissions from the Solid Waste Management vehicle fleets in Viramgam and Mansa, Quantifying daily and annual **Scope 1 GHG** emissions based on operational data received by ULB and D2D contractors based **on IPCC Tier 1 methodology**.

Recovery and Processing

Estimated annual **Scope 2 greenhouse gas** (GHG) emissions resulting from the **consumption of purchased electricity** at the Solid Waste Management (SWM) plant located in Viramgam, Gujarat

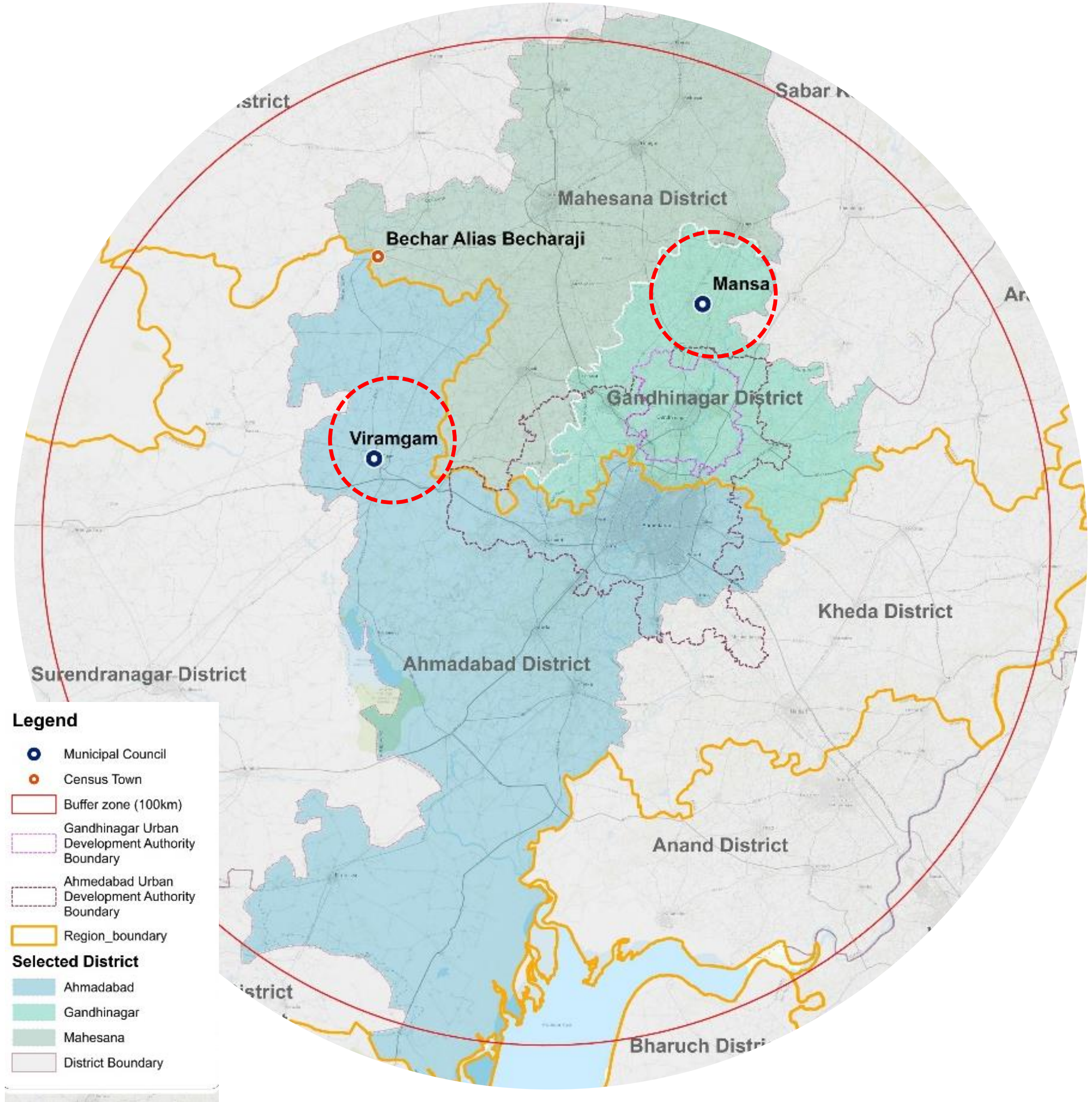
Disposal

Emissions were estimated using waste composition data from a sample survey, applying **IPCC 2006 Tier 1 methods** with 2019 refinements, and 100-year GWP values from IPCC AR6 for CO_2 equivalence.



Discussion with expert- sector expert (Innovation and Research) - GBCI

DRP Case Cities



Source: cwas,crdf

Viramgam and **Mansa** were selected as the part of this Viega and Cwas collaboration project.

Category	**Shortlisted Cities**	**Representative Cities/Towns**	**Scalability**
50,000-1,00,000 **(medium)**	Viramgam **(Class B)**	Representative of **31 Class B Councils** in Gujarat	Demonstrates scalability due to its varied urban character
20,000-50,000 **(small)**	Mansa **(Class C)**	Representative of **60 Class C Councils** in Gujarat	Demonstrates scalability due to its good practices and adaptability to innovative approaches

Case Cities **Overview**

Viramgam

Population (2023) **:** 69,212

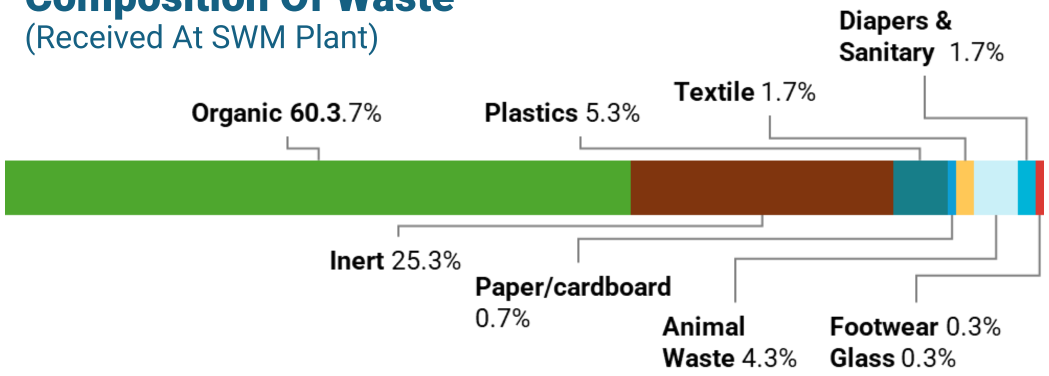
Area (2023) **:** 99.54 SqKm

Total HH : 22,752

20.76 TPD

Per capita waste generation : **300 gm** *

Composition Of Waste
(Received At SWM Plant)



Source: pas.org.in | Primary Survey

* Calculated as per SBM urban 2.0 guidelines

Case Cities **Overview**

Mansa

Population (2023) **:** 41,968

Area (2023) **:** 27.33 SqKm

Total HH : 13,100

12.59 TPD

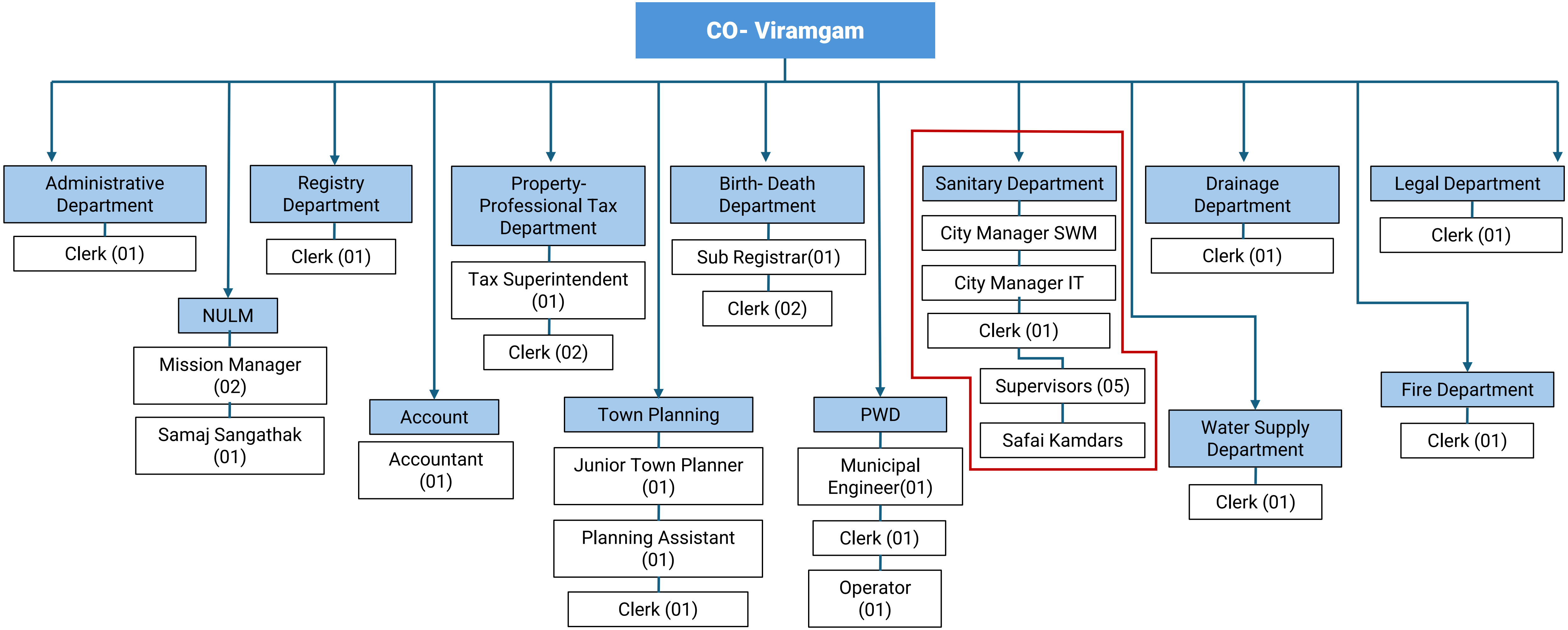
Per capita waste generation : **300 gm** *

SWM Plant Under Construction
(Waste Disposed in Open Dumpsite)

Source: pas.org.in | Primary Survey

* Calculated as per SBM urban 2.0 guidelines

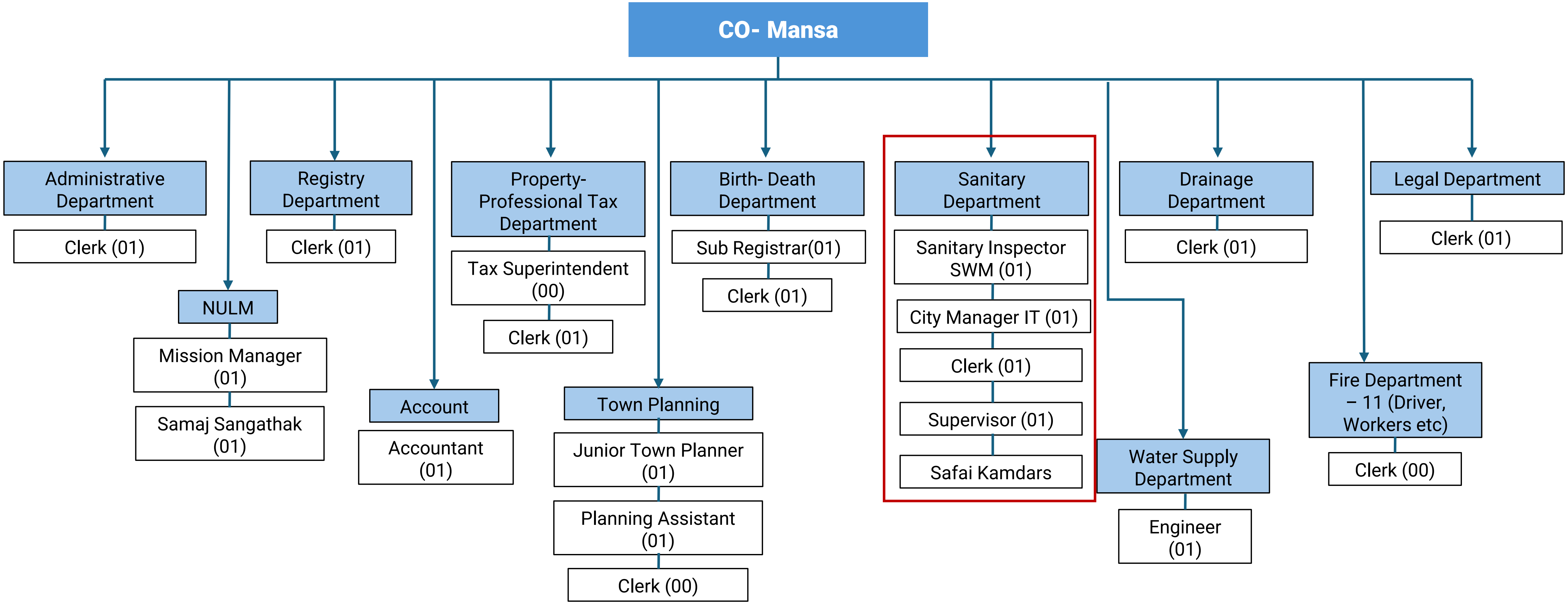
Institutional Framework of ULB: Viramgam



Lack of a S.I. for Solid waste management to streamline coordination, improve efficiency and communication across stakeholders

Source: Key Informant Interview, Official from Viramgam ULB

Institutional Framework of ULB : MANSA

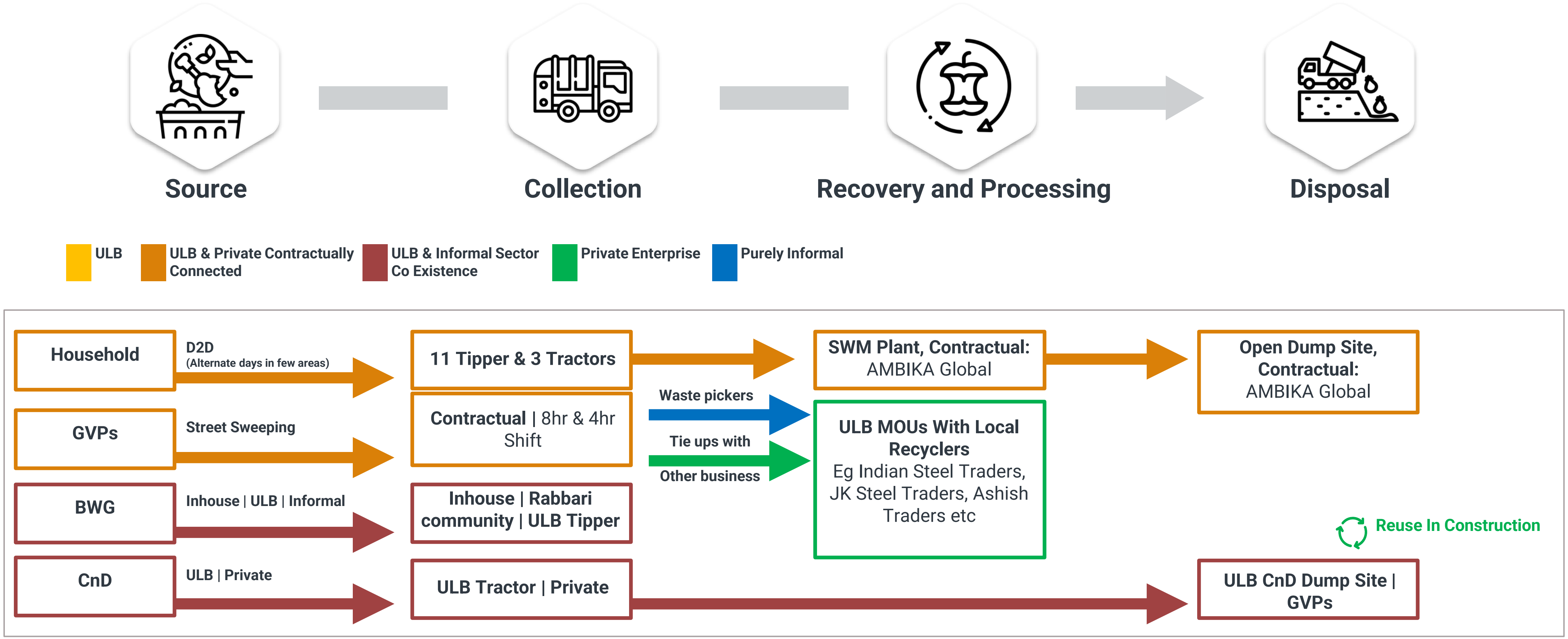


There is a noticeable shortage of staff at the ward level, where increased engagement is most needed

Source: Key Informant Interview, Official from Mansa ULB

Roles of Stakeholders In SWM Service Chain

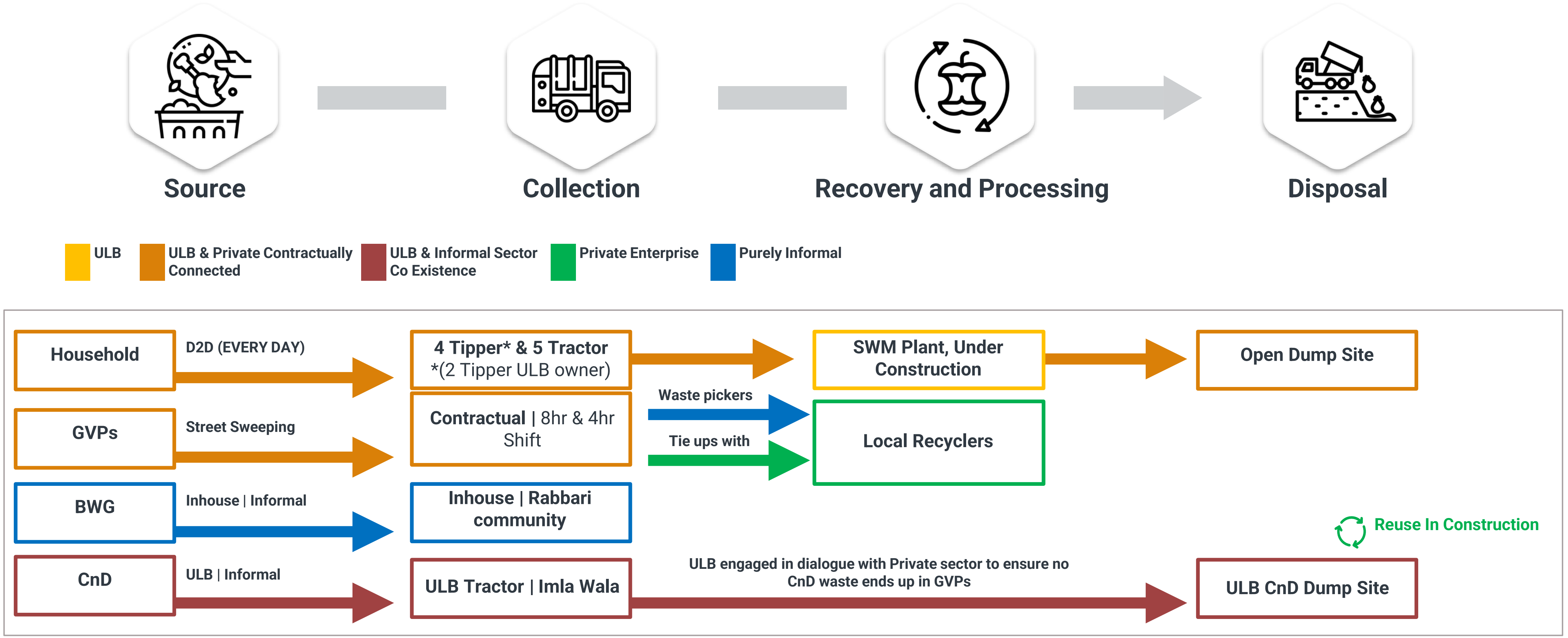
Viramgam



Source: Key Informant Interview, Official from Viramgam ULB

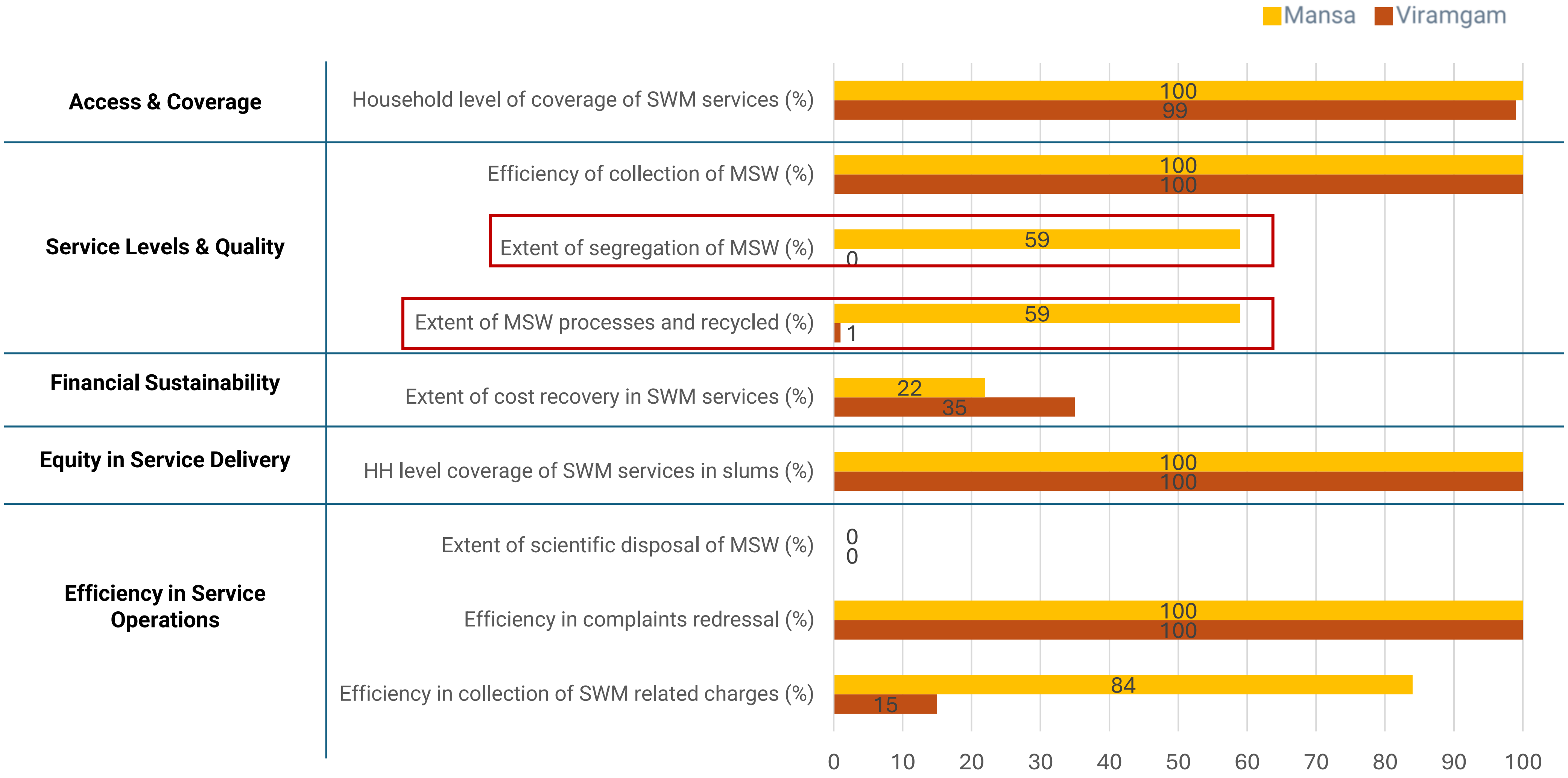
Roles of Stakeholders In SWM Service Chain

Mansa



Source: Key Informant Interview, Official from Viramgam ULB

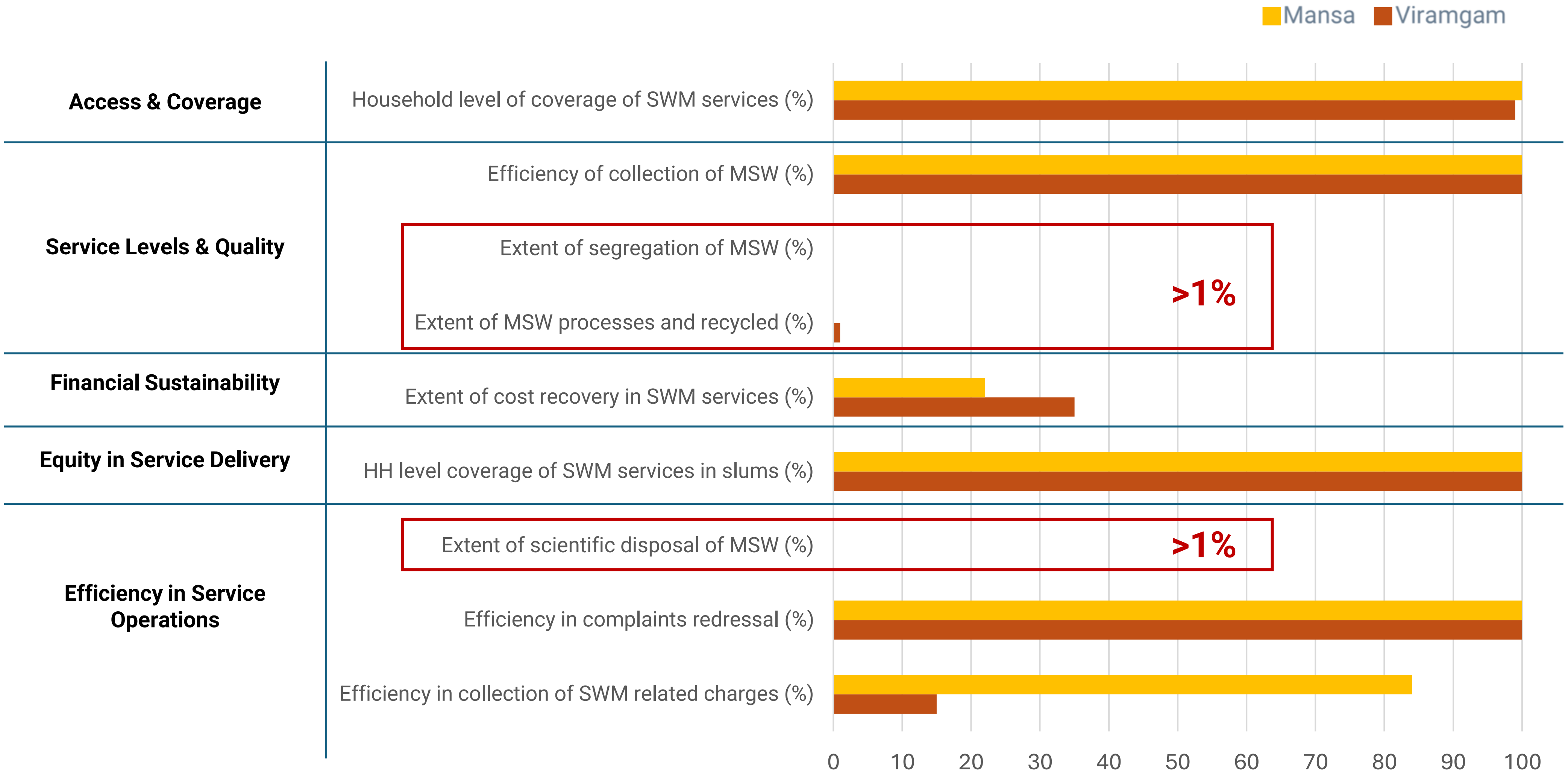
Current Scenario SLB Performance



Mansa reports 59% in both segregation and processing of waste but upon closer inspection it turned out to be less than 1 % in both the parameters

Source: Pass.org.in

Current Scenario SLB Performance

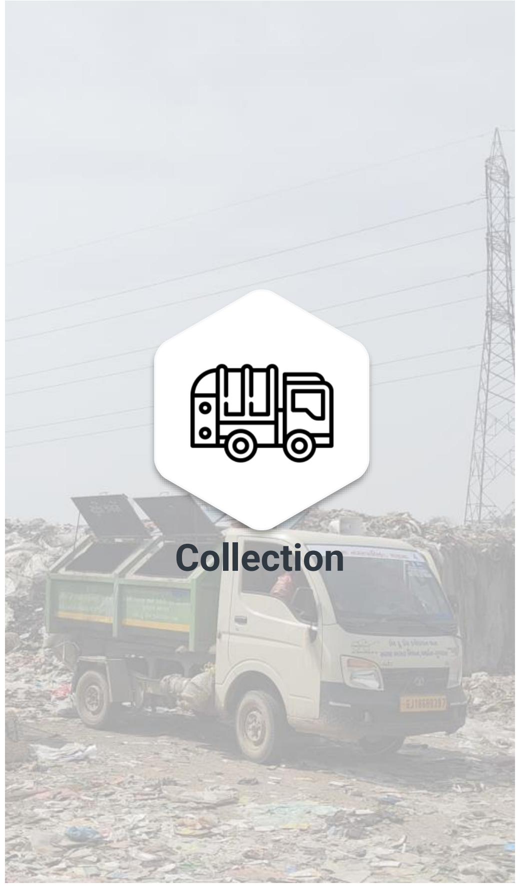


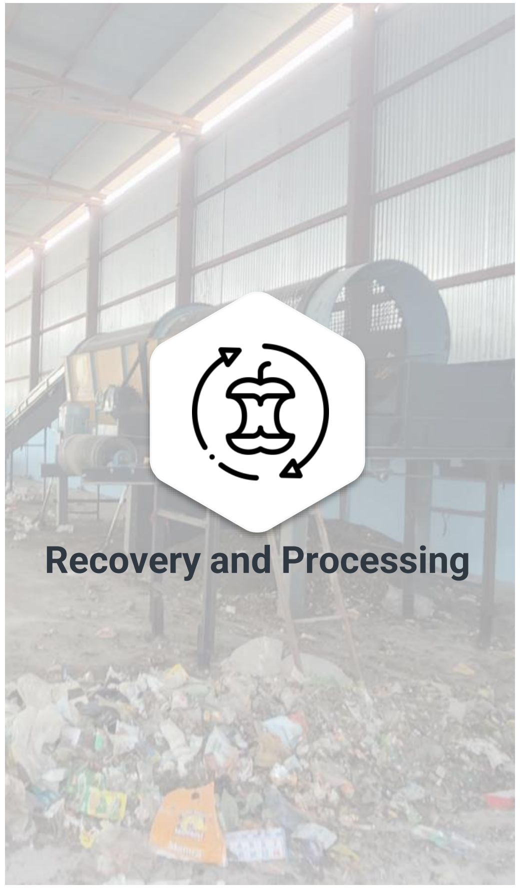
waste is neither segregated at the source nor adequately processed or recycled. Additionally, the absence of scientific landfills for safe disposal further leaves scope environmental degradation and increases the risk of emissions.

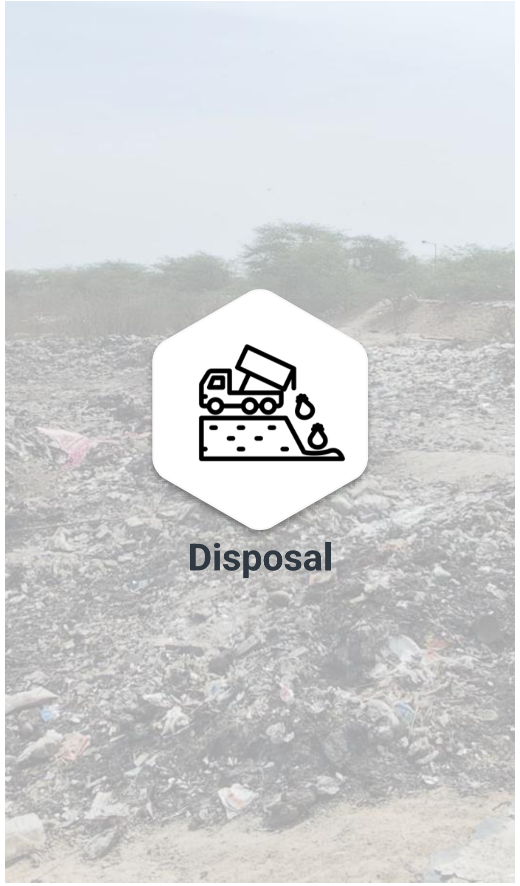
Source: Pass.org.in

SWM Value Chain Analysis

Analyzing the solid waste management service value chain to identify entry points for climate action and strengthen the resilience of processes at each stage of service value chain







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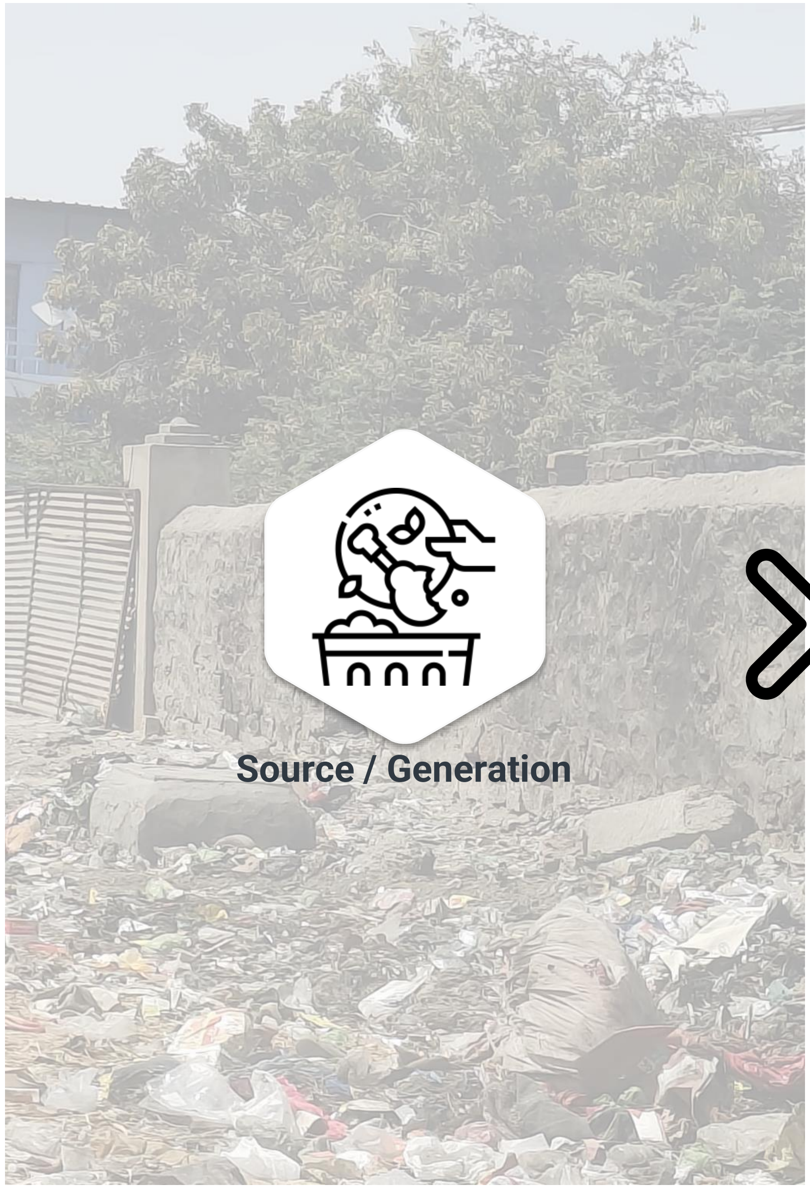
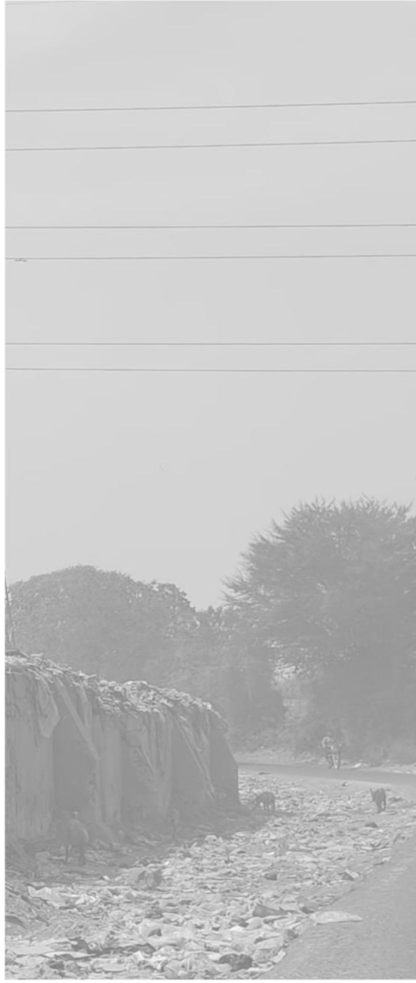


Source / Generation

Collection



SWM Value Chain Analysis

Source → Collection → Recovery and Processing → Disposal

Viramgam

Source: Primary Survey | Key Informant Interviews

Street Sweeping

Workforce

Sweeper-to-road length ratio	2.3

Source: Pass.org, Know your city

- **25** permanent safai kamdars
- **61** daily wage workers (8hr shifts)
- **51** part-time safai kamdars (4hr shifts)

05 Supervisors

Challenges

Household	ULB	Worker
GVPs near residential areas are oversized and unmanaged, attracting cattle, spreading odour, and posing health risks. Frequent burning adds to GHG emissions and air pollution.	No formal contracts result in frequent absenteeism among part-time and daily wage workers, causing staff shortages. GVPs formation potential risk to ULB ratings.	Inefficient collection leads to large waste accumulation points. Informal hiring creates uncertainty in scope of work and responsibilities.

SWM Value Chain Analysis

Source → Collection → Recovery and Processing → Disposal

Mansa

Street Sweeping

Workforce

Sweeper-to-road length ratio	1.1

Source: Pass.org, Know your city

45 permanent safai kamdars (8hr shifts)

51 part-time safai kamdars (4hr shifts)

01 Supervisors

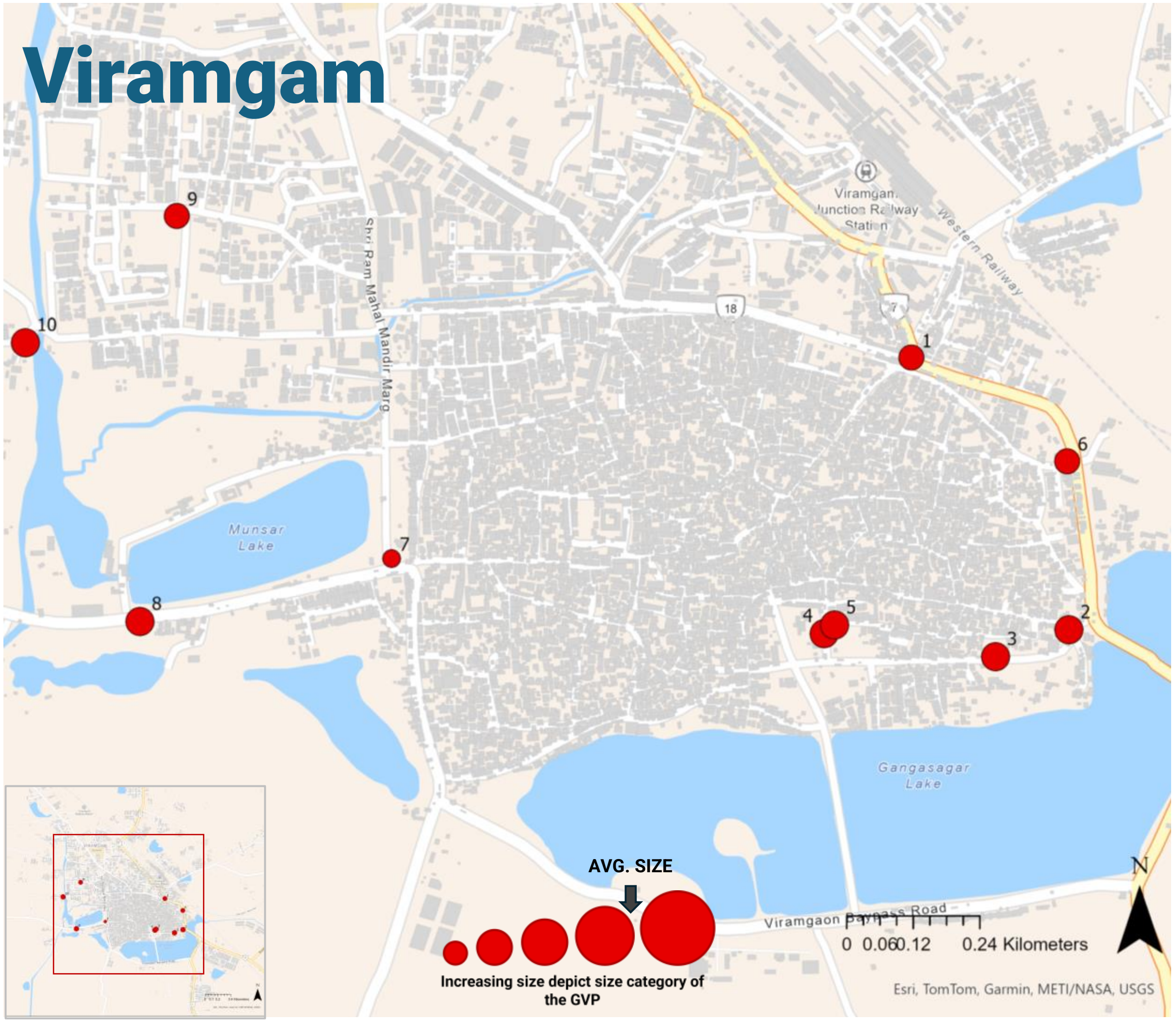
Challenges

Household	ULB	Worker
Community bin usage leads to GVP formation, attracting cattle, emitting odour, and posing health risks	Lack of staff to manage and monitor street sweeping leads to overburdening of those overseeing the service.	Inefficient collection leads to large waste accumulation points.

Source:

GVP Analysis

Source → Collection → Recovery and Processing → Disposal

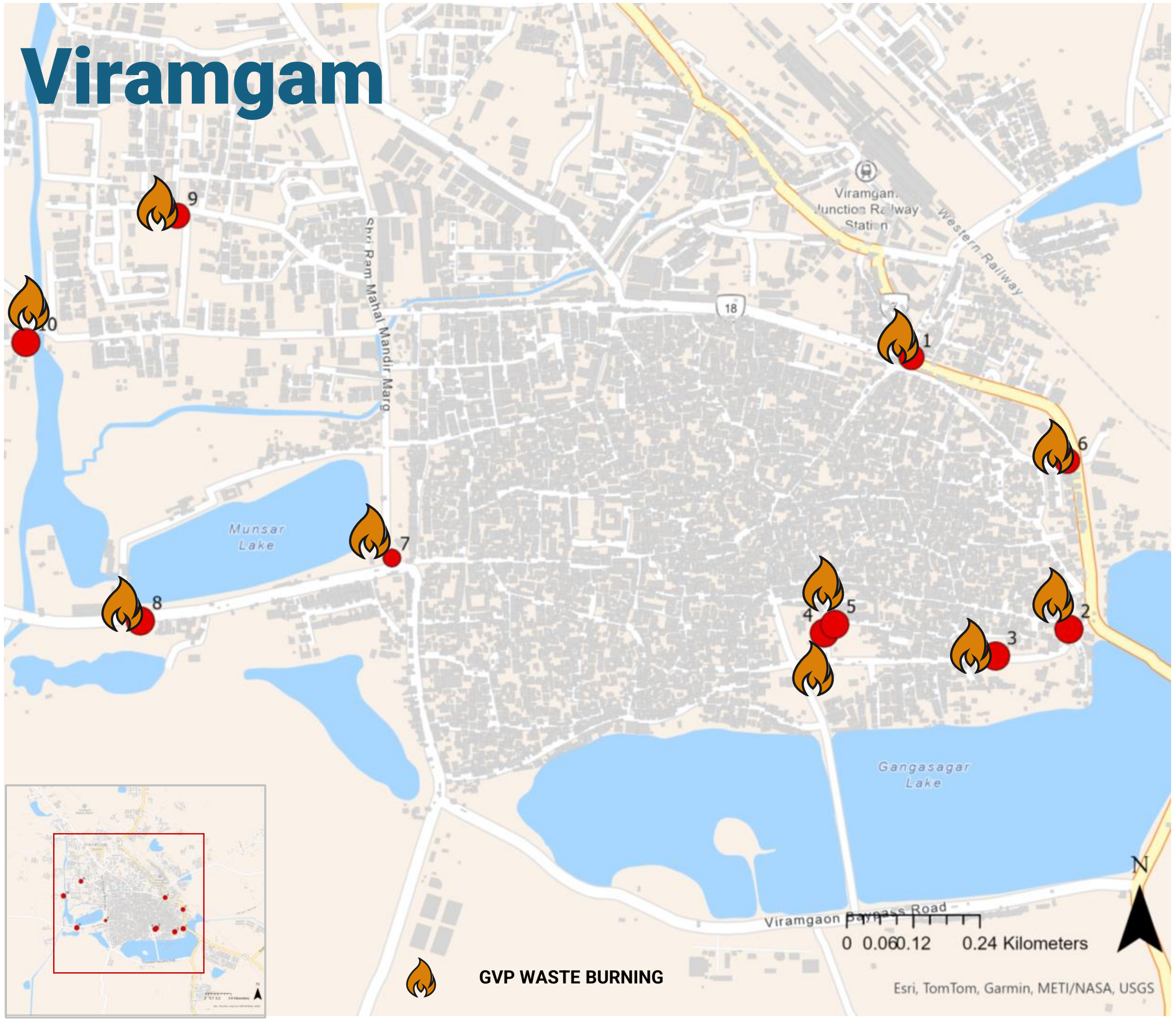


The GVPs observed across Viramgam were generally large in size. They were **predominantly found around vacant plots, boundary walls, and public spaces. A significant concentration of CnC GVPs was located near the water body.** Additionally, there was a notable presence of cattle on the streets surrounding these GVPs.

Source: Primary Survey

GVP Analysis

Source
Collection
Recovery and Processing
Disposal

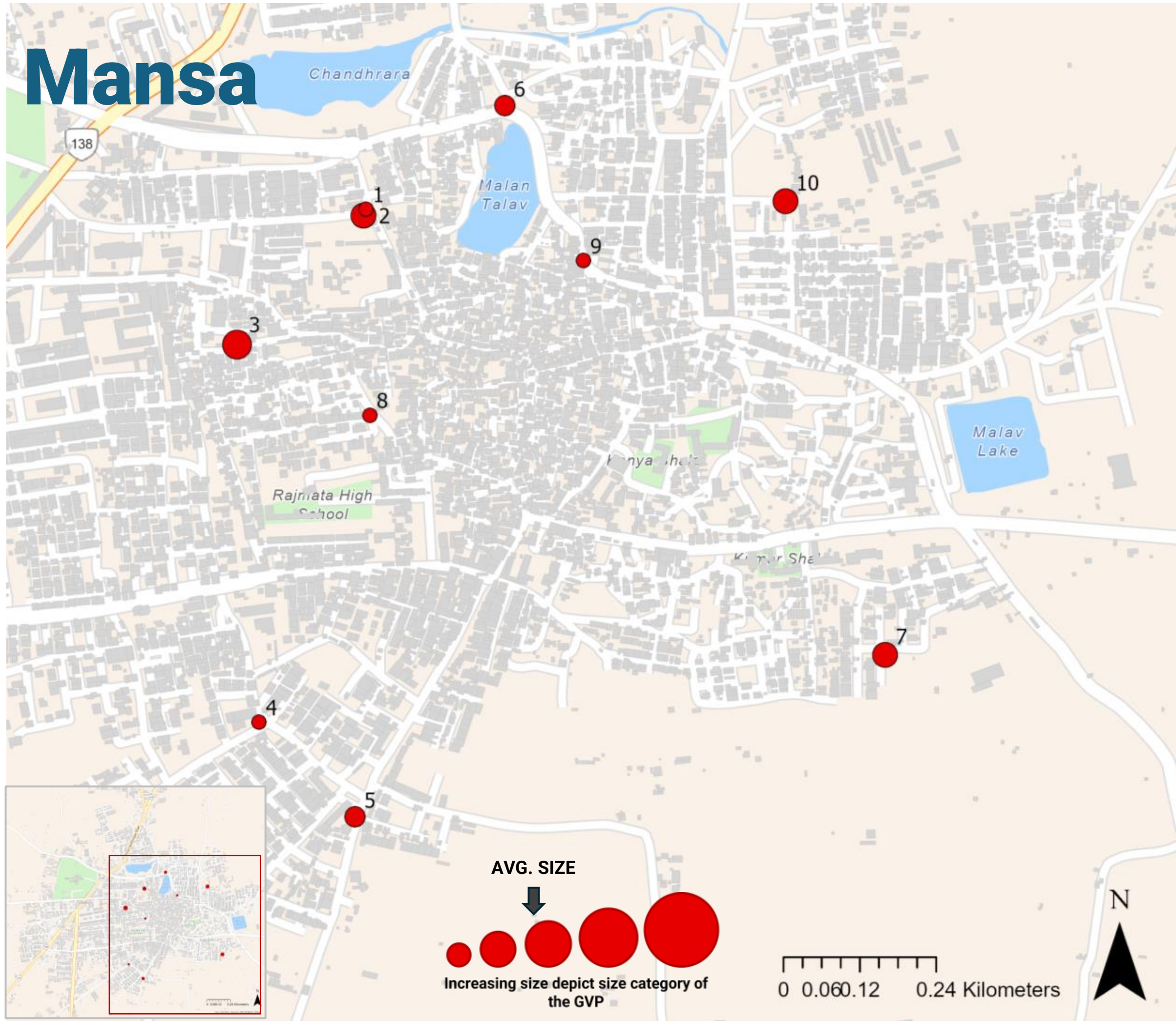


All **10 out of 10 GVPs showed signs of burning**, with some actively smoldering at the time of observation. Burning GVP waste appeared to be routine, almost ritualistic.

Source: Primary Survey

GVP Analysis

Source → Collection → Recovery and Processing → Disposal

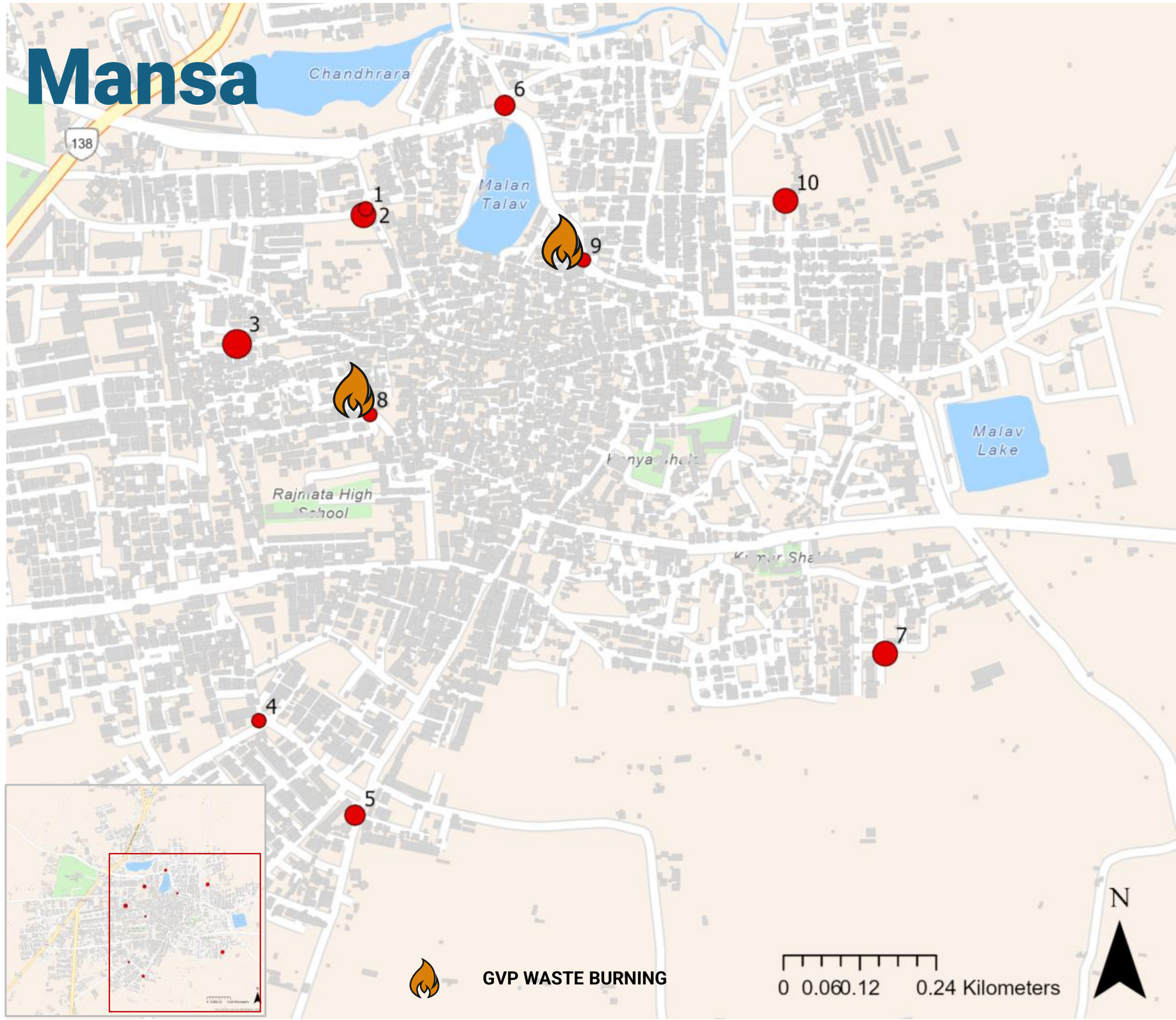


The average size of GVPs observed in Mansa was significantly smaller compared to those found in Viramgam. The highest concentration of GVPs in Mansa was **found near community bin locations situated outside residential localities.** Additionally, there was a notable presence of cattle on the streets surrounding these GVPs.

Source: Primary Survey

GVP Analysis

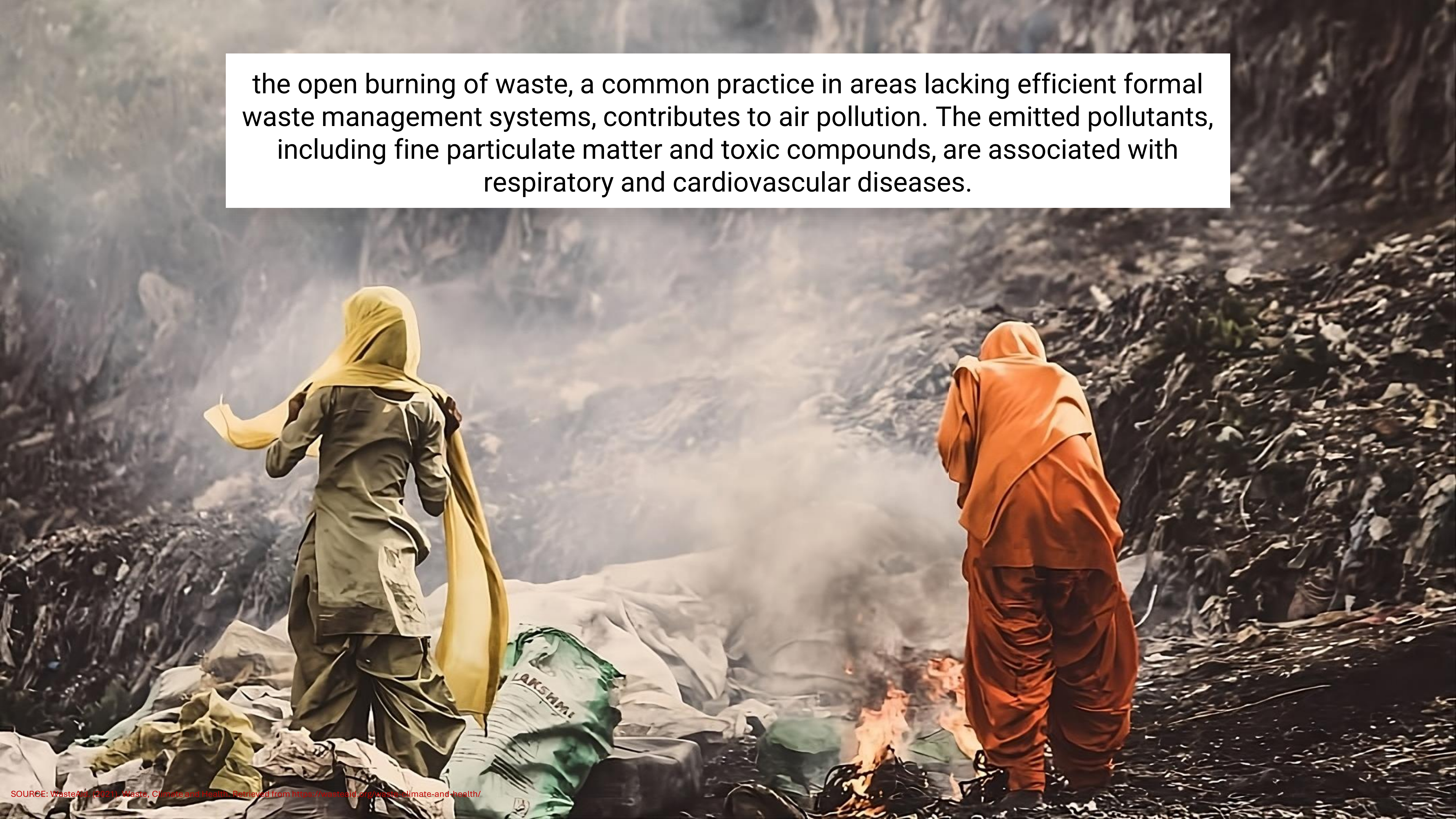
Source → Collection → Recovery and Processing → Disposal



Only **2 out of 10** GVPs showed evidence of waste burning, which primarily consisted of dry leaves.

Source: Primary Survey

the open burning of waste, a common practice in areas lacking efficient formal waste management systems, contributes to air pollution. The emitted pollutants, including fine particulate matter and toxic compounds, are associated with respiratory and cardiovascular diseases.



SOURCE: WasteAid. (2021). Waste, Climate and Health. Retrieved from https://wasteaid.org/waste-climate-and-health/

2,70,000

premature deaths each year worldwide

SOURCE: WasteAid. (2021). Waste, Climate and Health. Retrieved from https://wasteaid.org/waste-climate-and-health/

Collection Scenario

Viramgam

Collection service delivery: CONTRACTUAL

Payment Based On: The contractor responsible for picking up waste is paid according to the properties it covers in a month.

Monitoring: The contractor's pay is cut according to the complaints received for no show for collecting waste. The complaint can only be registered via call or in person visit to municipality.

Collection Vehicle Fleet:

Tipper Van: 11

Owned by ULB: **8**

Majorly used for D2D services

Tractors: 7

For D2D: 3

For Street Sweeping waste: 4

Challenges:

Household

Irregular waste collection forces citizens to dump in community bins or GVPs. Lack of incentives, monitoring, and sustained IEC campaigns hinders household-level waste segregation.

ULB

While the contract mandates segregated waste collection, enforcement is ineffective due to challenges in securing and retaining reliable D2D service providers. This impacts SWM plant efficiency and threatens operational viability.

Contractor

Households do not practice segregation, making collection-stage segregation unfeasible. Inadequate tipper vans lead to poor coverage and GVP formation, necessitating collection by tractors and driving up operational costs.

Source: Primary Survey | Key Informant Interviews | Viramgam Nagarpalika

Collection Scenario

Source → Collection → Recovery and Processing → Disposal

Mansa

Collection service delivery: CONTRACTUAL

Payment Based On: The contractor responsible for picking up waste is paid according to the properties it covers in a month. **INR 33/- per property**

Monitoring: The contractor's pay is cut according to the complaints received for no show for collecting waste. The complaint can only be registered via call or in person visit to municipality.

Collection Vehicle Fleet:

Tipper Van: 4

Owned by ULB: **2** (ULB charges **INR 7,500/-** per Tipper van as rent)

Majorly used for D2D services

Tractors: 5

Owned by Contractor

Majorly used to collect waste from BWGs and GVPs

Challenges:

Household

Many areas rely on community bin collection via tractors, which attracts cattle and creates hygiene risks. Absence of targeted, long-term IEC campaigns hampers household-level segregation.

ULB

Contracts mandate wet waste segregation for vermicomposting, but enforcement is weak due to difficulties in securing reliable D2D contractors. Non-functional compost pits and absence of an SWM plant leave little motivation to focus on segregation.

Contractor

Households do not segregate waste, rendering collection-stage segregation unfeasible. Community bins necessitate high-emission, fuel-intensive tractors, and without an operational SWM plant or vermicompost pits, waste is sent directly to dump sites.

Source: Primary Survey | Key Informant Interviews | Viramgam Nagarpalika

Emissions in Collection Services

Source | Collection | Recovery and Processing | Disposal

Greenhouse Gas (GHG) emissions from the Solid Waste Management vehicle fleets in Viramgam and Mansa, Quantifying daily and annual Scope 1 GHG emissions based on operational data received by ULB and D2D contractors based on IPCC Tier 1 methodology.

Viramgam

The daily diesel consumption for SWM collection operations in Viramgam remains 161 Liters/day

- **Tipper Vans** 66 L/day
- **Tractors** 70 L/day
- **JCB** 25 L/day

Total Annual GHG Emissions: **168.30 tonnes CO2e/year**

Mansa

The daily diesel consumption for SWM collection operations in Viramgam remains 55 Liters/day

- **Tipper Vans** 20 L/day
- **Tractors** 35 L/day

Total Annual GHG Emissions: **57.69 tonnes CO2e/year**

Source: Primary Survey | Viramgam Nagar Palika | Mansa Nagar Palika | D2D Contractors in both the case cities

IEC Initiative

Source → Collection → Recovery and Processing → Disposal

Viramgam

Source: https://static.toiimg.com/thumb/msid-96265060,imgsize-139258,width-400,height-225,resizemode-72/96265060.jpg

Viramgam has adopted similar IEC strategies as Mansa, including a recent 3-month collaboration with **SHGs to accompany collection vehicles and promote segregation awareness.** While the intent was commendable, **lack of follow-up monitoring and impact assessment** has resulted in well-intentioned efforts **failing to achieve lasting outcomes**.

Mansa

The primary focus of Mansa ULB is on conducting **training workshops for sanitation workers, promoting school and home composting, and organizing zero-waste events.** Efforts to engage local residents in community education were also observed, helping build a connection with citizens. While the approach emphasizes reducing waste at the source—which is commendable, **there is little emphasis on waste segregation.** Moreover, there is **no mechanism in place to track the progress or impact of these IEC activities.**

Inclusive and collaborative IEC initiatives are a step in the right direction, but a short-term outlook limits their effectiveness. Sustained impact requires follow-up and monitoring mechanisms across the waste value chain.

Source: Viramgam Nagar palika | Mansa Nagar Palika

Issues Identified

Source → Collection → Recovery and Processing → Disposal

Inefficient Collection Service

The inefficiencies in D2D service provided is causing massive GVP problems in Viramgam where D2D service is provided on alternate days. Odd timings of D2D in Mansa is leading to the issue of GVPs around Community bins.

Presence of Community Garbage Bins

Use of Community bins in Mansa are the major cause of GVPs forming in Mansa. In viramgam these bins are removed but those areas are still working with the same purpose.

Lack of monitoring hence no accountability

There is a significant lack in monitoring of people as well as the contractors. E.g. Tipper vans are paid just by the properties covered. There is no way to determine and quantify the quality of service delivered.

Inefficient Street Sweeping Service

Viramgam's street-sweeping system employs both 8-hour and 4-hour contract shifts, but the shorter shifts face chronic understaffing and poorly defined responsibilities. This undermines efficiency and accountability in maintaining cleanliness.

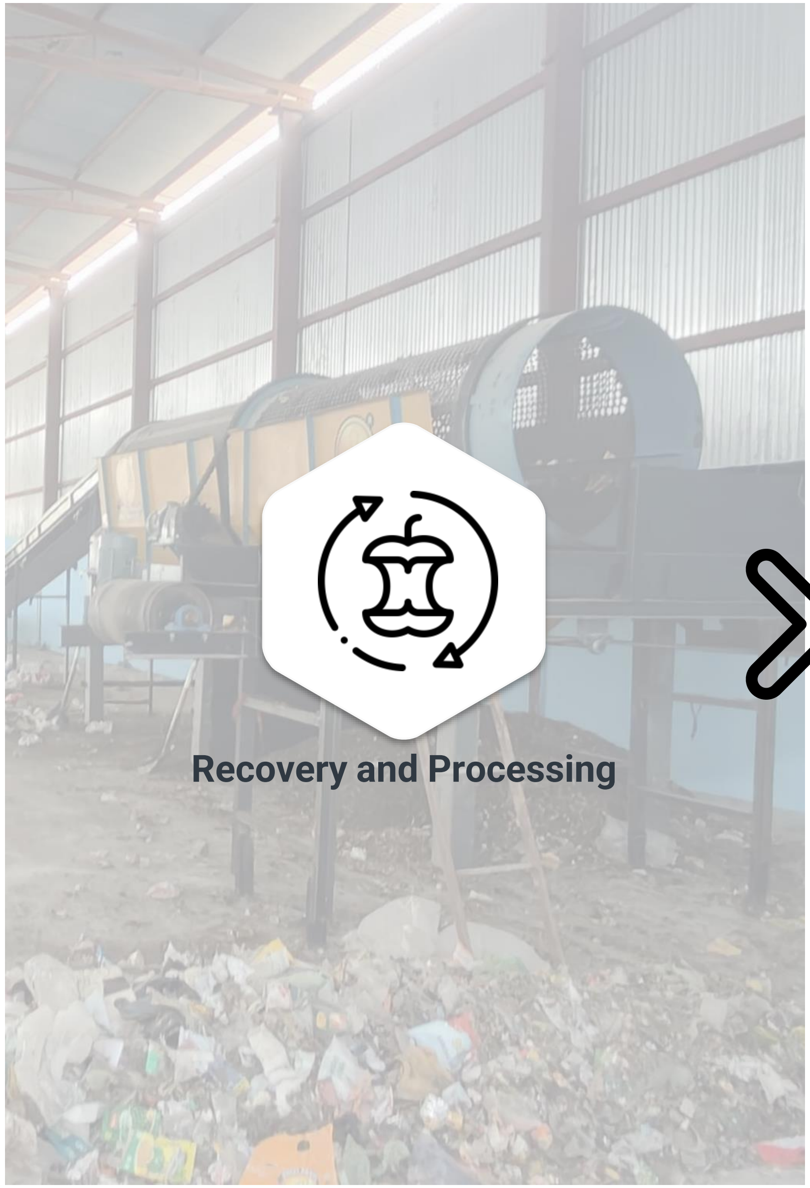
Waste Collection Point

These GVPs in Mansa and Viramgam are generally formed by street sweepers and Wheelbarrow operators as these are collection points for bigger vehicles like tipper vans to further take it forward.

Ineffective IEC initiatives

short-term outlook on IEC limits their effectiveness. Sustained impact requires follow-up and monitoring mechanisms across the waste value chain, which is currently missing.

Source: Primary Survey | Google Street View



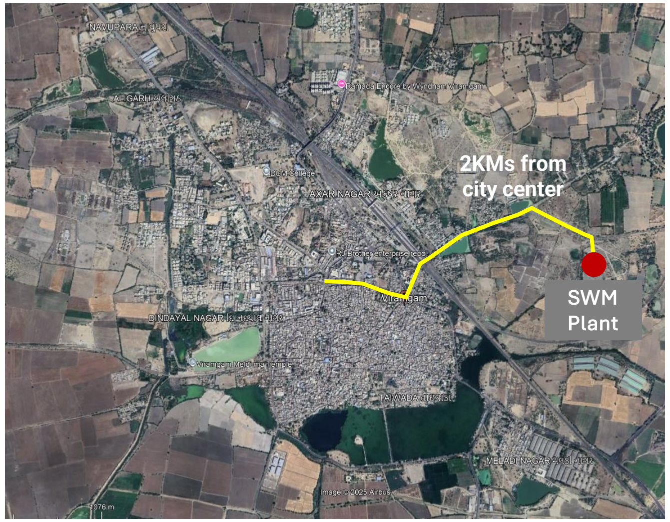
Recovery and Processing

Disposal

Current Scenario In Processing

Source → Collection → **Recovery and Processing** → **Disposal**

Viramgam



22 TPD
SWM Plant Capacity

13 TPD
Waste Received in Plant

Operated By: **Ambika Group** (Contracted)

SWM Plant

Vermi Compost Pits

Open Dumpsite

Source: Primary Survey | Viramgam Nagar Palika

Processing Technologies: **Viramgam**

Source | Collection | **Recovery and Processing** | **Disposal**

Sorting of Waste

Secondary Segregation: Trommel Machine

Wet Waste Processing: 13 TPD Cap.

1. **Bio Gas Digester**
2. **Organic Waste Composter**
3. **Vermi Composting Pits**

Dry Waste Processing: 9 TPD Cap.

1. **Shredder**
2. **Washer**
3. **Crushing unit**
4. **Plastic Bailing Machine**

Source:

Key challenges in processing

Unsegregated Waste Disrupting Trommel Operations

Unsegregated waste containing wet fractions cannot be fed into the trommel machine due to the risk of clogging the sieves. Consequently, contractors leave the waste outside the facility to dry, resulting in foul odour, vector breeding, delayed processing, and increased methane and leachate-related emissions.

Infrastructure Gaps Undermining Wet Waste Management

Investments in wet waste processing have become redundant, as machines remain non-operational due to unsegregated waste. Equipment like the mechanized composting unit and bio-methanation plant are underutilized due to the absence of essential supporting infrastructure.

Climate Unsuitability for Vermicomposting

Viramgam's average maximum temperature is around 35°C, often exceeding 40°C in few months, well above the optimal 30°C required for vermicomposting. This makes the infrastructure ineffective, rendering past investments largely redundant.

Operational Risks Due to Grid Dependency

The plant has faced frequent power outages, disrupting processing operations and causing waste to accumulate on-site. This attracts cattle feeding on organic waste and poses hygiene risks, ultimately threatening the sustainability of plant operations.

Source: Primary Survey

Emissions in Processing due to electricity consumption

Equipment Item / Load Category	Power Rating (KW)	Op. Hours/Day (Ideal Scenario)	Daily kWh	Assumed Op. Days/Year	Estimated Annual kWh
Single-shaft hopper-fed cutter	3.0	4	12.00	365	4,380
Rotary drum film washer	3.0	4	12.00	365	4,380
Plastic Bailing Machine	3.0	4	12.00	365	4,380
Rotary trommel screen	3.0	4	12.00	365	4,380
Heavy Duty Shredder	10.0	4	40.00	365	14,600
Crushing Unit	3.0	4	12.00	365	4,380
Conveyer belt	3.0	6	18.00	365	6,570
Trommel machine with conveyer belt setup	13.0	6	78.00	365	28,470
Organic waste composter (3 units)	13.5 (Total)	24	324.00	365	118,260
Subtotal - Listed Equipment	**N/A**	**N/A**	**520.00**	**365**	**189,800**
Weighbridge (Assumed)	0.1 (Assumed)	4	0.40	365	146
Auxiliary Loads (Assumed 0.3 KW for 8 hrs)	0.3 (Assumed)	8	2.40	365	876
Total Estimated Plant Consumption	**N/A**	**N/A**	**542.80**	**365**	**198,122**

Estimated annual Scope 2 greenhouse gas (GHG) emissions resulting from the consumption of purchased electricity at the Solid Waste Management (SWM) plant located in Viramgam, Gujarat

Annual Estimated Plant Electricity Consumption **198,122 kWh/year**

Used an official grid emission factor for the Indian National Grid (FY 2023-24): 0.727 kg CO2e/kWh

Annual Scope 2 GHG Emissions **144.0 t CO2e**

Current Scenario In Disposal

Source | Collection | Recovery and Processing | Disposal

Viramgam

Mansa

Source: Primary Survey

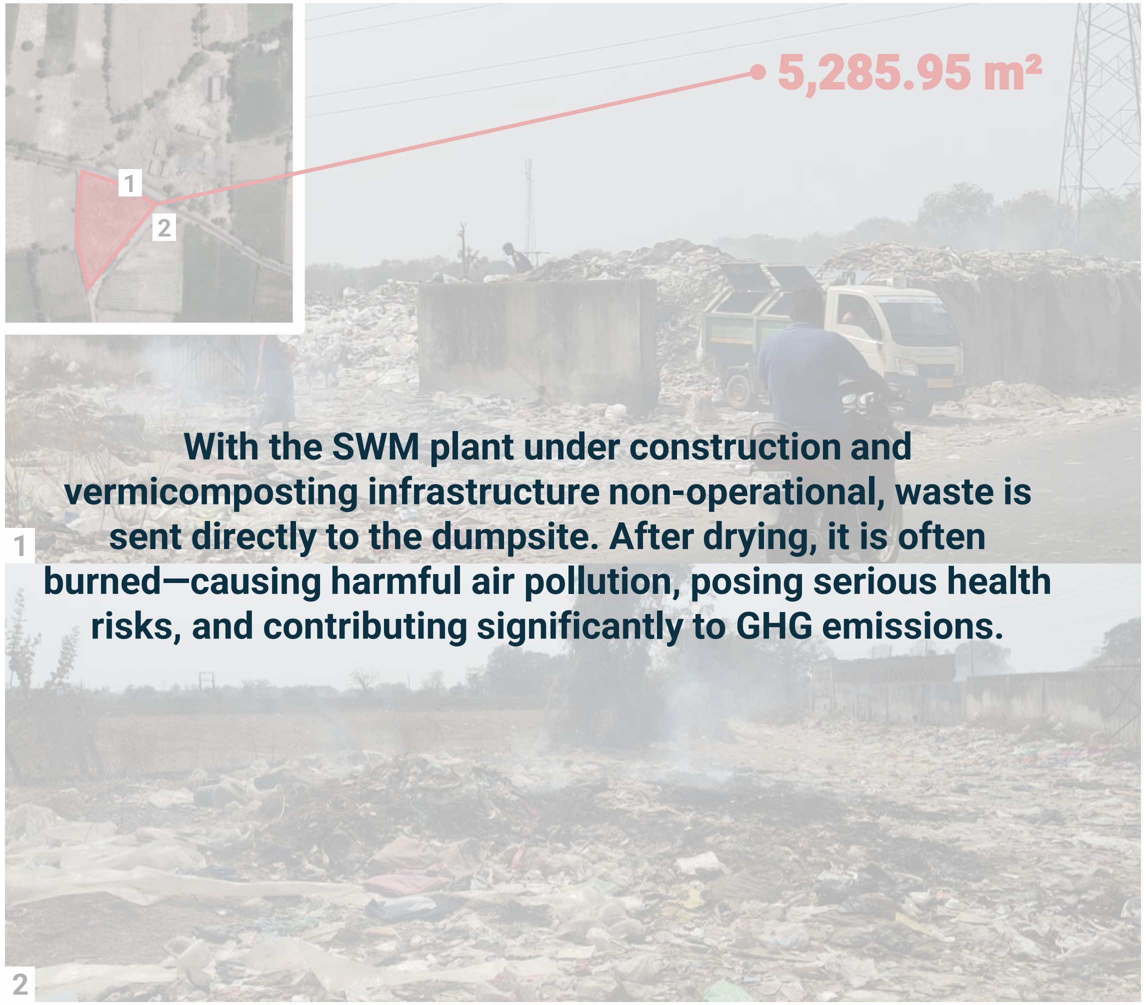
Current Scenario In Disposal

Source → Collection → Recovery and Processing → **Disposal**

Viramgam

Viramgam stores incoming waste in the open to dry before trommel processing. Partially decomposed waste is sent to a secondary dumpsite, while unrecovered waste is dumped nearby and often burned, posing serious health risks and significantly contributing to GHG emissions.

Mansa



With the SWM plant under construction and vermicomposting infrastructure non-operational, waste is sent directly to the dumpsite. After drying, it is often burned—causing harmful air pollution, posing serious health risks, and contributing significantly to GHG emissions.

Source: Primary Survey

Emissions In Disposal

Viramgam

Methodology Basis:

- IPCC 2006 Guidelines (Tier 1 approach) with 2019 Refinements.
- IPCC Sixth Assessment Report (AR6) 100-year GWPs.

Estimated Annual GHG Emissions — **842.46 t CO2e**

Source: Primary Survey

Problem Tree and Theme of Recommendations

Effect

- Increased GHG Emissions (from burning, fleet, dumpsites)
- Environmental Degradation (soil/water contamination, GVPs)
- Poor Public Service Delivery & Citizen Dissatisfaction
- Negative Impact on ULB Ratings & Reputation
- Public Health Risks & Air Pollution (diseases, odour, vectors)
- Resource Wastage & Inefficiency (low recovery, redundant units)
- Financial Strain on ULBs / Inefficient Use of Funds

Core problem

- Ineffective Waste Collection & Segregation System
- Suboptimal & Polluting Collection Fleet Operations
- Inefficient & Unsustainable Waste Processing
- Unscientific & Environmentally Damaging Waste Disposal Practices
- ineffective IEC initiatives & avoidable emissions across value chain

Causes

- Behavioral & Awareness Factors
- Technical & Infrastructure Limitations
- Financial Constraints & Economic Viability
- Operational & Logistical Deficiencies
- Policy, Governance & Enforcement Gaps
- Institutional Capacity & Coordination Issues

Case Studies

Dungarpur's Scientific Landfill Solution

Dungarpur built a lined, co-located landfill cell with leachate management, eliminating indiscriminate dumping, improving environmental conditions, and ensuring compliance with SWM Rules.

Indore, Madhya Pradesh – Market-Linked Composting

Indore Municipal Corporation collaborated with cooperatives, utilizing surplus compost through sales, achieving 100% utilization and steady revenue for O&M costs.

Electrifying Urban Waste Management: Pune's Partnership with EKA Mobility

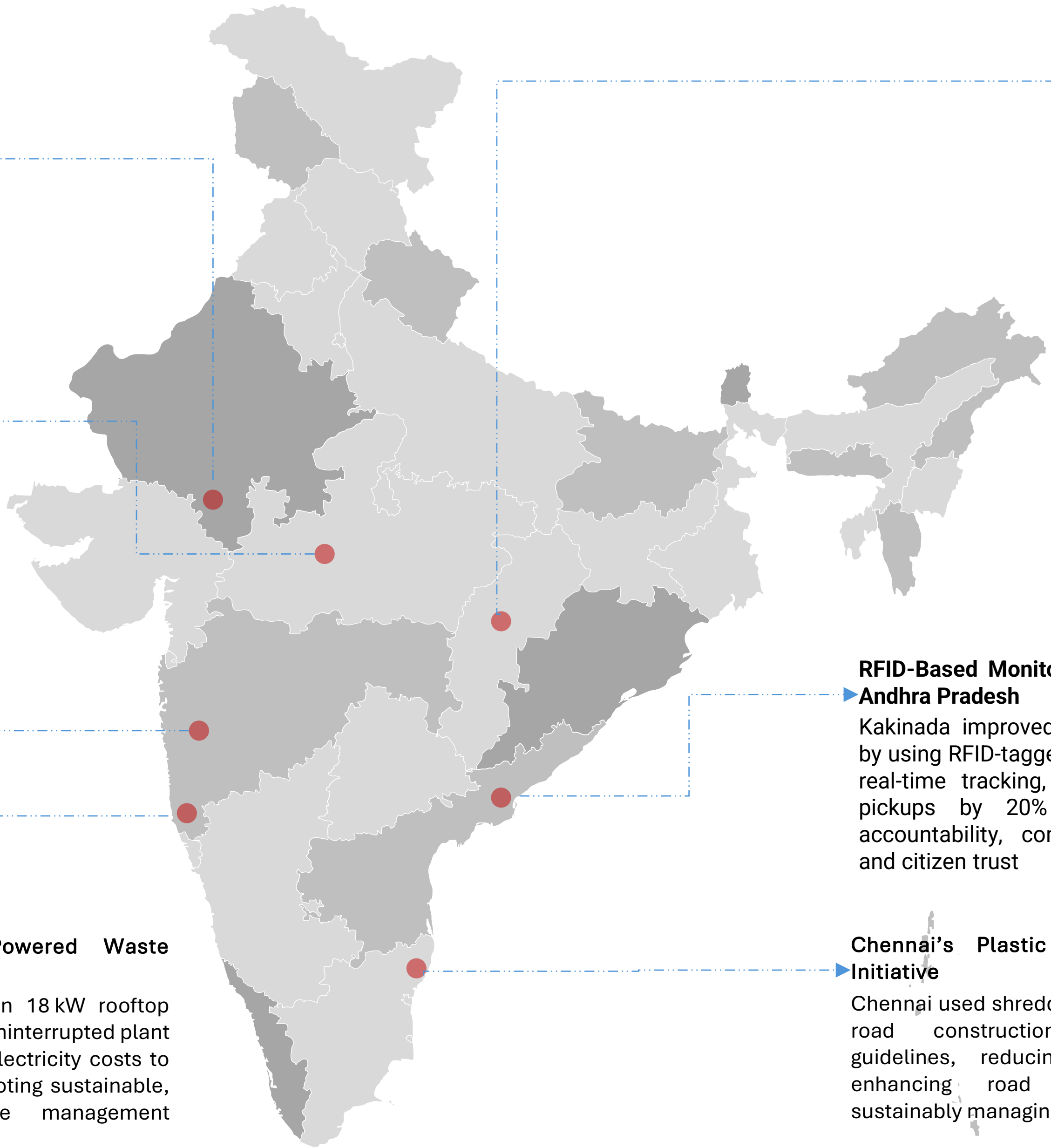
PMC partnered with EKA Mobility to deploy 1.5-tonne electric garbage tippers, reducing emissions, noise, and carbon footprint while improving waste management efficiency and air quality in the city.

Pune's RDF Pelletization and Co-processing Model

PMC set up an RDF pelletization unit and partnered with cement companies for co-processing, reducing landfill use and sustainably managing low-value plastic waste. for sanitation workers.

Vengurla's Solar-Powered Waste Processing Mode

Vengurla installed an 18 kW rooftop solar unit, ensuring uninterrupted plant operations, cutting electricity costs to near-zero, and promoting sustainable, low-emission waste management infrastructure.



Ambikapur's Sanitary Waste Management Initiative

Ambikapur introduced sealed sanitary waste collection and incineration, improving waste stream quality and ensuring safer, more hygienic conditions for sanitation workers.

Ambikapur's SHG-Led Waste Management Model

Ambikapur improved waste segregation through 500+ SHGs promoting source segregation, resulting in 90% compliance, employment generation, and the city's ranking as India's second cleanest in 2019.

RFID-Based Monitoring in Kakinada, Andhra Pradesh

Kakinada improved waste collection by using RFID-tagged households and real-time tracking, reducing missed pickups by 20% and enhancing accountability, complaint response, and citizen trust

Chennai's Plastic Waste-to-Roads Initiative

Chennai used shredded LDPE plastic in road construction per MoRTH guidelines, reducing bitumen use, enhancing road durability, and sustainably managing plastic waste.

Recommendation 1: Strengthening Door-to-Door Collection & Monitoring through an RFID-Based Mechanism

Issue Identification:

01 Many households are missed during routine waste collection due to route issues or oversight.

02 Without regular pickup, residents dump waste in public bins or open areas, creating Garbage Vulnerable Points (GVPs).

03 GVPs overflow, often leading to open burning (as seen in Viramgam), and release harmful pollutants that endanger public health.

04 The monitoring system is reactive and manual, with complaints logged only through visits or calls, often without proper follow-up.

Recommendation:

Practical | Cost-effective | Scalable

Household-Level RFID Tagging:

Each household will have a weatherproof RFID tag with a unique ID, fixed at the gate or entry point. These tags link to a central ULB database, enabling precise tracking of waste collection for every property.

Deployment of Handheld RFID Readers in Collection Vehicles:

Collection vehicles will carry handheld RFID readers to scan each household's tag during pickup. This creates a digital record with a timestamp, confirming daily service and identifying any missed properties.

Centralized Monitoring Dashboard for Real-Time Oversight:

RFID scan data will be uploaded to a central dashboard, highlighting unscanned households and triggering instant alerts to supervisors or contractors. This shifts monitoring from reactive to proactive, enabling faster response and complaint verification.

Linking RFID Data to Contractor Payment Structure:

Contractor payments will be based on verified RFID scan logs, ensuring only serviced properties are paid for. Repeatedly missed properties without justification will lead to proportional payment deductions.

Introduction of Performance-Based Incentives for Full Coverage:

The ULB can encourage full coverage by offering performance-based incentives to contractors. Example, consistent daily service to all tagged households can earn a bonus or payment increase, promoting proactive service.

Basis for Future Route Optimization and Governance Reforms:

Scan data can be used to optimize routes, monitor worker performance, and detect service gaps. The data supports accountability and planning, especially when paired with tools like GPS tracking and grievance dashboards.

Costing:

Town	No. of Collection Vehicles	RFID Reader Cost (INR)	No. of Households	RFID Tag Cost (INR)	Total Estimated Cost (INR)
Viramgam	14	₹2,52,000	22,752	₹3,41,280	₹5,93,280
Mansa	4	₹72,000	13,100	₹1,96,500	₹2,68,500

Based on market rates validated by SBM and smart city procurement documents, the unit cost of a basic RFID handheld reader and RFID tag is around ₹18,000 and ₹15, respectively.

- These values represent one-time capital costs for full deployment of the RFID tracking system.
- Dashboard development, training, and maintenance remain additional budget heads to be estimated separately.

❖ Contractual Amendments Needed:

Performance Linked Payment Clause: Revise the payment schedule to make contractor remuneration conditional on RFID-verified data. A minimum threshold (e.g., 95% coverage per month) should be established for full payment. Properties not scanned should be considered skipped unless justifiable (vacant/locked).

Penalty Clause for Skipped Properties: Introduce progressive financial penalties for repeated non-service of the same household (e.g., ₹10 per missed property after three consecutive skips, scaling upward). Missed pickups causing a GVP to form around 200m of these properties should trigger higher penalties.

Incentive Bonus Clause: Contractors achieving 100% verified coverage for all operational days in a month should be eligible for a fixed bonus amount or percentage based incentive (e.g., 5–10% of the contract value).

Mandatory RFID Integration Clause: Require the contractor to provide trained staff capable of using RFID readers, maintain scanning logs, and participate in system audits. If ULB owns the devices, contractor must maintain and operate them; if the contractor owns them, they must meet ULB technical standards.

Third-Party Audit Provision: A clause enabling the ULB to periodically verify RFID scan data through random calls to households or independent field checks should be included. This ensures transparency and prevents misuse (e.g., scanning tags without actual collection).

❖ Financing:

The proposed intervention requires a one-time investment of approximately ₹2,52,000 for Viramgam (covering 14 vehicles) and ₹72,000 for Mansa (covering 4 vehicles) for the procurement of handheld RFID readers. Including RFID tag costs, the total project cost rises to ₹5,93,280 for Viramgam and ₹2,68,500 for Mansa. Given the relatively low capital outlay for both towns, especially in the context of municipal infrastructure development, the project can be readily financed through a combination of central, state, and local funding sources:

Swachh Bharat Mission – Urban (SBM-U 2.0): RFID systems support SBM-U 2.0's digital goals and can be funded through innovation or performance grants.

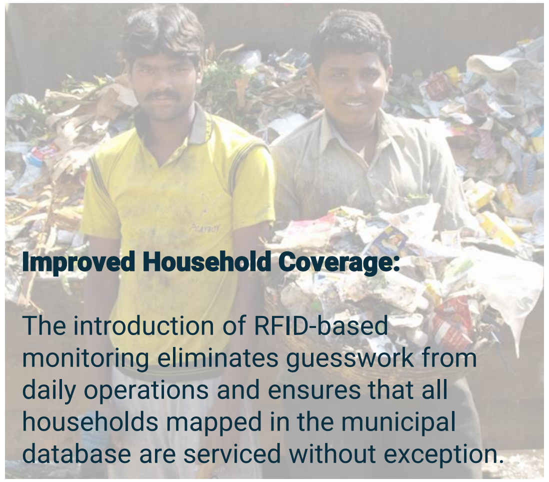
State Government Urban Development Grants: RFID qualifies as a capital investment and can be funded under state programs like GUDM for tech-based service improvements.

15th Finance Commission Tied Grants to ULBs: RFID equipment qualifies for full coverage under tied grants for sanitation and waste management.

Municipal Budgets and User Fees: ULBs can co-fund initially and later recover costs through a small monthly user fee surcharge for sustainability.

CSR and Local Industry Support: Local industries and CSR bodies can be approached to co-finance RFID tagging, as it offers visible environmental and social benefits aligned with CSR mandates.

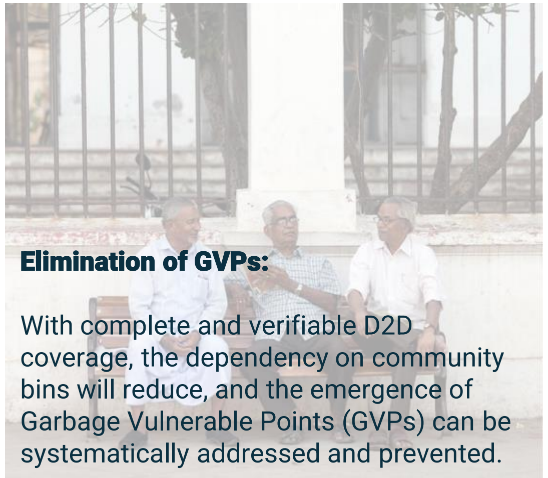
Impact:



Improved Household Coverage:

The introduction of RFID-based monitoring eliminates guesswork from daily operations and ensures that all households mapped in the municipal database are serviced without exception.

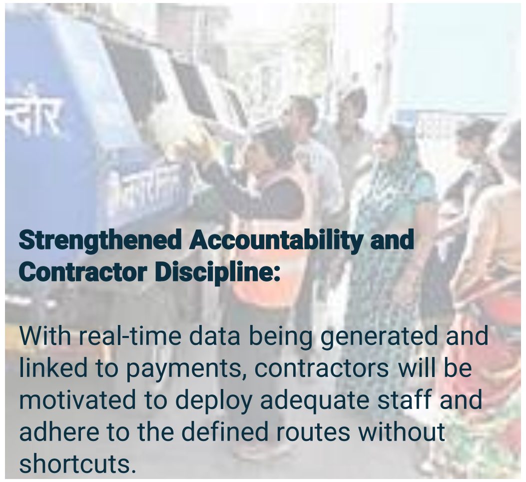
SOURCE: https://www.theatlantic.com/international/archive/2014/06/confessions-of-a-trash-tourist-india/373118/



Elimination of GVPs:

With complete and verifiable D2D coverage, the dependency on community bins will reduce, and the emergence of Garbage Vulnerable Points (GVPs) can be systematically addressed and prevented.

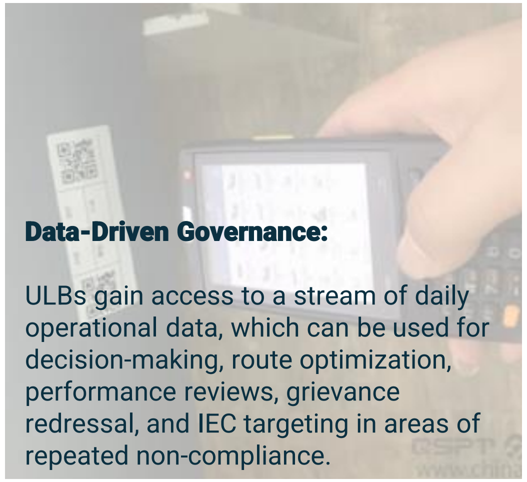
SOURCE: https://www.stuartfreedman.com/media/1d4ee83f-3669-4482-99cd-6ed922280ddb-three-old-men-sit-and-talk-on-a-bench-on-the-promenade-pondich



Strengthened Accountability and Contractor Discipline:

With real-time data being generated and linked to payments, contractors will be motivated to deploy adequate staff and adhere to the defined routes without shortcuts.

SOURCE: https://www.smartcityindore.org/solid-waste/



Data-Driven Governance:

ULBs gain access to a stream of daily operational data, which can be used for decision-making, route optimization, performance reviews, grievance redressal, and IEC targeting in areas of repeated non-compliance.

SOURCE: https://cn-qspt.en.made-in-china.com/product/ibtJFlMgJpDG/China-Pipe-Shop-Fabrication-Qr-Code-Collector.html

Scalability to Other Small and Medium Towns:

Cost-Effective for Class B & C Towns:

The low one-time capital investment required makes this model ideal for replication across Gujarat's small and medium towns, particularly those with fewer than 1 lakh population.

Rapid Implementation:

RFID tagging and handheld reader deployment do not require significant infrastructure changes and can be executed within a matter of weeks with basic staff training.

Supports SBM 2.0 Compliance:

The intervention directly contributes to service-level benchmarks and digital governance mandates under Swachh Survekshan and the Garbage-Free Cities framework.

Easily Adaptable with SHG Involvement:

The model can integrate with SHG-led operations in other towns, enabling both monitoring and community engagement through a decentralized framework.

Potential for Layered Technological Add-ons:

Once established, the RFID system can be integrated with other digital platforms like GPS tracking, citizen complaint dashboards, and ward-level performance dashboards.

Recommendation 2: Transitioning to Electric Vehicles Powered by Solar Energy for Sustainable Waste Collection

Issue Identification:

01 Emissions from the SWM fleet in Viramgam and Mansa can be reduced by introducing targeted interventions at the fleet operation stage.

02 ULBs and contractors noted that finding capable contractors is a persistent challenge in small and medium towns.

03 Low incentives compared to operational costs often lead contractors to skip properties to cut expenses.

04 Rising fuel prices are reducing profit margins, making waste collection services increasingly unstable and unpredictable.

Recommendation:

Superior Cost Efficiency:

The OSM Rage Plus EV tipper has an estimated operating cost of ₹2.13/km much lower than diesel mini-trucks (₹10–20/km resulting in substantial daily, monthly, and annual fuel savings.

Zero Emissions for Environmental Health:

Replacing diesel vehicles with EVs will completely eliminate tailpipe emissions from the collection fleet, directly contributing to cleaner air and a healthier environment in the towns.

Improved Contractor Engagement and Service Reliability:

The significantly lower and more predictable operational costs of the EV fleet will make collection contracts considerably more attractive to private operators, potentially leading to more competitive bidding and improved adherence to service routes and schedules.

Enabling Potential In-House Operations:

The reduced cost structure can empower the ULBs to consider managing the collection services directly, gaining full control over service quality and efficiency.

Facilitating SHG Participation:

The adoption of EVs can serve as a practical entry point for local Self-Help Groups (SHGs) to manage collection routes, fostering community involvement and reinforcing the practice of source segregation.

Integrated Charging Infrastructure with Revenue Potential:

Charging stations can be set up at the SWM plant with solar panels, allowing EV charging, grid feed-in of surplus power for ULB revenue, and driver facilities like rest and changing rooms.

Optimized for Urban Collection:

The OSM Rage Plus Garbage Tipper, with a 500 kg payload and practical range, is well-suited for daily waste collection needs in small and medium towns, especially where SWM plants are nearby.

❖ Costing:

Viramgam

Number of EV vehicles required:	Estimated total initial investment for Viramgam:
14	₹77,40,516

Mansa

Number of EV vehicles required:	Estimated total initial investment for Viramgam:
4	₹22,11,576

❖ Opportunity Cost:

Viramgam

Without Switching to EV (Diesel Fleet for 10 Years):	After Switching to EV (EV Fleet for 10 Years):
₹3,29,20,000	₹1,52,42,304

Savings = ₹1,76,77,696

Mansa

Without Switching to EV (Diesel Fleet for 10 Years):	After Switching to EV (EV Fleet for 10 Years):
₹74,00,000	₹43,54,944

Savings = ₹30,45,056

Financing:

ULBs can leverage government schemes like FAME and Swachh Bharat Mission to access subsidies for EV procurement and solar charging infrastructure.

Collaborations with financial institutions can offer concessional loans and tailored financing for EV fleet and renewable energy investments.

PPP models and internal revenue sources, such as user fees and solar power sales, can reduce upfront costs and support long-term operational sustainability.

Impact:

Environmental Impact:

Eliminates tailpipe emissions and reduces noise, improving air quality and curbing pollution from waste burning.

Economic Impact:

Cuts long-term operational costs, shields ULBs from fuel price hikes, generates solar revenue, and creates local green jobs.

Social Impact:

Enhances service reliability, fosters cleaner neighborhoods, empowers communities, and boosts the ULBs' public image.

Scalability to Other Small and Medium Towns:

Scalable Model:

This waste management model can be easily scaled and replicated across India's small and medium towns aiming for cleaner urban environments.

Vehicle Suitability:

The OSM Rage Plus, a compact 3-wheeler EV, is perfect for maneuvering through congested streets and narrow lanes typical in dense towns.

Affordability:

The low investment per EV makes it financially feasible for smaller ULBs with limited budgets to adopt clean waste collection solutions.

Solar Integration:

Utilizing existing SWM plant space for centralized solar charging ensures efficient land use and streamlined charging infrastructure for EV fleets.

Government Support:

Ongoing national initiatives promoting electric mobility and renewable energy provide strong policy backing and implementation support for such models.

Financial Incentives:

Subsidies and funding programs improve economic viability and accelerate the adoption of sustainable, tech-enabled waste management systems in ULBs.

Recommendation 3: Empowering SHGs for Integrated Waste Collection and IEC-Driven Segregation

Issue Identification:

01 **No sustained IEC framework** – Lack of continuous education and follow-up prevents lasting behavior change in waste segregation.

02 **Unsegregated waste collection** – Waste is not sorted at the source, and collection workers lack incentives to enforce segregation.

03 **Inefficient waste processing** – Mixed waste overwhelms SWM plants, leading to resource loss and poor processing outcomes.

04 **Limited household engagement** – Households lack personalized support, reducing participation and the impact of awareness campaigns.

Recommendation:

Social Reinforcement

Empower SHGs for Dual Roles: Collection and IEC:

SHGs should handle both door-to-door waste collection and behavior change outreach. By involving local women, they can build trust, ensure consistent messaging, and promote daily segregation habits.

Enhance RFID Systems for Waste Monitoring:

Upgrade RFID readers to record specific reasons for waste rejection, like "Mixed Waste - Not Collected. "This enables weekly reports on non-compliant households, supporting targeted follow-ups and better oversight.

Targeted Outreach

Implement SHG-Led Household Outreach Programs:

Use RFID data to guide SHG visits to non-segregating households during convenient time slots. These visits should address barriers—like lack of bins—and offer simple tools and live demos.

Integrate Local Community Liaisons for Real-Time Alerts:

Identify local liaisons (e.g., youth leaders) to report informal dumping and GVP formation. They help SHGs respond quickly through informal dialogue instead of formal penalties.

Practical Solutions

Use Soft Enforcement to Drive Behavior Change:

Start with a cycle of engagement, follow-up, education, and support instead of immediate fines. This builds long-term change using community trust and regular personal contact.

Incentives and rebates on property taxes if waste is segregated at HH level

Provide property tax rebates for households practicing waste segregation. Residents of the best-performing wards can receive additional incentives to encourage sustained segregation efforts.

❖ Impact:

Increased Segregation Compliance:

Personalized follow-ups and peer-level education result in better adherence to segregation norms.

SOURCE: https://www.deped.gov.ph/als-est/PDF/Proper%20Waste%20Management%20at%20Home.pdf

Empowered Local Workforce:

SHG members become agents of change, gaining respect and income within their communities.

SOURCE: https://www.hindustantimes.com/pune-news/civic-body-wants-pune-residents-to-segregate-garbage-at-home/story-F5qT9XkoerS3Ge8ipOXBzN.html

Reduced Processing Burden:

Segregated waste improves material recovery at SWM plants, reducing landfill dependency.

SOURCE: https://apnews.com/article/climate-change-heat-india-garbage-pickers-labor-heat-ba2664b6b651550141421466150229c1

Community Ownership:

By integrating a human-centered approach, ULBs shift waste management from a top-down mandate to a citizen-partnered movement.

SOURCE: https://thebetterindia.com/374388/northeast-arunachal-pradesh-sangti-zero-waste-management-community-driven-monpa-sustainability/

❖ Scalability to Other Small and Medium Towns:

Low-Cost & High-Impact:

SHG-led collection models offer a financially feasible alternative to third-party outsourcing, especially for small ULBs with limited budgets.
Minimal capital investment is needed beyond RFID integration and basic training, making this model suitable for towns with populations under 1 lakh.

Gender-Inclusive Urban Development:

Mobilizing women-led SHGs aligns with national policies promoting gender inclusion and livelihoods. It also brings unique social advantages, as women are often more attuned to domestic-level challenges around waste segregation and cleanliness.

Technology-Enabled but Community-Driven:

The dual use of RFID for data tracking and SHGs for household engagement represents an ideal mix of smart governance and grassroots participation. It creates robust, localized feedback systems, which can be further linked to mobile-based dashboards.

Replicable through SBM Templates:

The approach can be quickly adopted using existing SBM frameworks for IEC and DAY-NULM provisions for SHG funding and training. Many small towns already have SHGs registered under these programs, simplifying onboarding and scaling.

Builds Resilience in Informal Settlements:

SHGs often have better access and social capital in low-income and informal settlements, where municipal staff struggle to engage. This makes the model especially useful in towns with large informal populations that are underrepresented in formal sanitation systems.

Recommendation 4: Strengthening Waste Processing Infrastructure and Market Linkages for Processed Outputs

Issue Identification:

01 Non-Functional and Mismatched Infrastructure - Technologies are unsuitable for the local climate or poorly maintained.

02 Incomplete and Inefficient Processing Systems - Key components like gas storage and compost curing are missing.

03 Lack of End-Use and Market Linkages - No clear strategy for using compost, RDF (Refuse-Derived Fuel), or other by-products.

04 Operational and Planning Gaps - Machines remain idle due to unsegregated input, broken processing chains, and poor demand planning; sanitary waste management systems are also lacking.

Recommendation:

Technology Optimization | Climate Responsive | Practical Solutions

Upgrade Existing Technologies for Wet Waste Processing:

Install sealed biomethanation units with dome-based gas holders and H_2S scrubbers to safely capture biogas, generating 15–20 kWh of energy per tonne of wet waste. Ensure energy output is metered and safely stored to avoid leakage and fire risks. Construct covered curing racks under roofed sheds with proper aeration to maintain a 10-day compost curing cycle. This improves compost stability, safety, and alignment with market standards. Replace open vermicompost pits with mechanized OWCs suitable for arid regions, requiring less manual labor and space (10–100 m²). OWCs process up to 3 tonnes/day at low cost (₹100/tonne), generating compost worth ₹50–₹1500/day depending on quantity and demand.

Introduce Sanitary Waste Management Protocols:

Conduct targeted IEC campaigns to educate households on separating sanitary and diaper waste.
Introduce dedicated bins and sealed compartments in tipper vans to ensure hygienic collection.
Prevent contamination of other waste streams through separate handling.
Install compact incinerators (10–12 kg/day) near SWM sites for sanitary waste disposal.
Use models equipped with air pollution control devices and scrubbers for safe operation.
These systems cost ₹2.5–3 lakh and suit the waste volumes of small and medium towns.

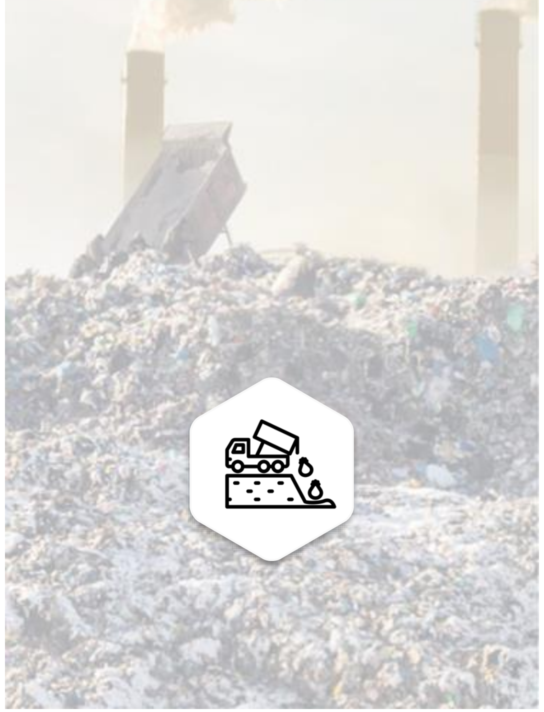
Create Market Linkages for Compost, RDF and Recycled Plastic:

Register under the MDA scheme to earn ₹1,500/tonne of compost sold; compost can also be priced at ₹3–₹5/kg in open markets. Ensure quality standards (C/N ratio 25:1, moisture <60%) to qualify for bulk procurement and build offtake contracts with agri buyers. Set up an RDF pellet unit (₹15–20 lakh) to process dry low-value waste; RDF (3000–3500 kcal/kg) can be sold to cement plants at ₹2.5/kg. Processing 1 ton/day of RDF can generate ₹2,500/day, reducing landfill load. Use shredded LDPE/HDPE (8–10% mix) in bitumen to build durable plastic roads as per MoRTH and CSIR-CRRI standards. Each kg of plastic paves 1 metre, saving ₹25,000–₹50,000/km and increasing road durability by 40–60%.

❖ Impact:

Reduction in Landfilling and Emissions:

By channeling organic and non-recyclable waste into productive processes like composting, biomethanation, RDF generation, and plastic road construction, a significant volume of waste is diverted from landfills. This reduces not only space constraints but also methane emissions and leachate contamination, directly supporting climate mitigation goals.



SOURCE: https://www.whatdesigncando.com/stories/waste-climate-change/

Enhanced Climate Co-Benefits:

Biomethanation displaces fossil fuel use by generating biogas, while RDF replaces coal in cement kilns.
Reuse of shredded plastic in roads offsets virgin bitumen usage and reduces urban heat impacts, aligning with India's GHG reduction and NDC targets.

SOURCE: https://biogas-india.com/rural-employment-generation-through-biogas-production-in-villages-of-india/

Operational Profitability and Circularity:

The sale of compost, RDF pellets, and plastic for roads generates revenue while minimizing recurring O&M costs. This reduces fiscal pressure on both the ULB and the contractor responsible for operating the plant, enabling more sustainable service delivery. It transforms the waste plant into a financially self-sustaining, circular economy node with predictable cash flows and reduced dependence on external subsidies.

SOURCE: https://www.un-pageindonesia.org/en/article/read/how-refused-derived-fuel-rdf-solve-waste-problems-in-indonesia

Improved Health and Safety:

Segregated sanitary waste management and better processing conditions protect sanitation workers from pathogen exposure and communities from odor and disease vectors. With the introduction of mechanized organic waste composters, manual handling of waste is minimized, thereby reducing occupational health risks.

SOURCE: https://thewire.in/environment/indias-megacities-mumbai-and-delhi-sitting-on-a-pile-of-waste

Recommendation 5: Climate Resilient Waste Processing Infrastructure and Market Linkages for Processed Outputs

Issue Identification:

01 Grid Dependency
The plant operates solely on electricity from the grid, with no backup or alternative energy source in place.

02 Operational Vulnerability
Power cuts, such as the previous two-day outage, can completely disrupt processing and lead to waste accumulation on-site.

03 Rising Energy Demand
Planned improvements and increased machine usage will drive up power needs, leading to higher operational costs.

04 Sustainability Risk
Continued reliance on unstable and expensive grid electricity endangers long-term efficiency and reliable waste management.

Recommendation:

Power Optimization

Localized Solutions

Strategic Placement

Conduct a Load Audit of Existing Machinery:

Inventory and assess daily energy needs of operating units (e.g., OWC, RDF units, shredders, curing sheds).

Introduce Climate-Sensitive Sanitary Waste Management Protocols:

Installing a 109 kWp solar PV system at the Viramgam SWM plant can significantly cut electricity costs and boost energy resilience. Based on annual consumption of 198,122 kWh, about 273 panels (400W each) are needed, assuming 5 kWh/day generation per kWp.

Siting and Installation Scope

The solar PV array can be installed using available rooftop and ground space within the SWM plant. Rooftop panels can utilize existing structures, minimizing land use and leveraging built infrastructure. Ground-mounted panels can be placed near vermicomposting pits with proper spacing to avoid interference. Site assessment is essential to evaluate shading, structural capacity, and maintenance access. An optimal mix of rooftop and ground setups will ensure efficient space use and energy output.

Grid-Tied System for Enhanced Resilience

A grid-tied solar PV system is recommended to ensure uninterrupted power supply and reduce costs at the Viramgam SWM plant. It allows excess solar energy to be exported to the grid via net metering, lowering electricity bills. During low solar generation, the plant can draw power from the grid, maintaining operations without disruption. This setup avoids the high cost and maintenance of battery storage by using the grid as a virtual backup. It offers a cost-effective and resilient energy solution using existing infrastructure. Ideal for small-town plants, this system balances performance, reliability, and financial feasibility.

❖ Costing:

Viramgam

Solar PV System Cost:

₹32,70,000

Installation Costs:

₹6,54,000

This represents the cost of the solar panels, inverters, mounting structures, and other necessary hardware to build the system. The estimate is based on the required system capacity (approximately 109 kWp) and a cost per kWp.

This covers the expenses associated with the physical installation of the system. It is estimated to be 20% of the Solar PV System Cost and includes:

- Labor costs for technicians and electricians.
- Costs for mounting structures and hardware.
- Electrical wiring and connections.
- System commissioning and testing.

❖ Opportunity Cost:

Viramgam

Without Switching to Solar for 25 Years:

₹6,61,78,884

After Switching to Solar for 25 Years:

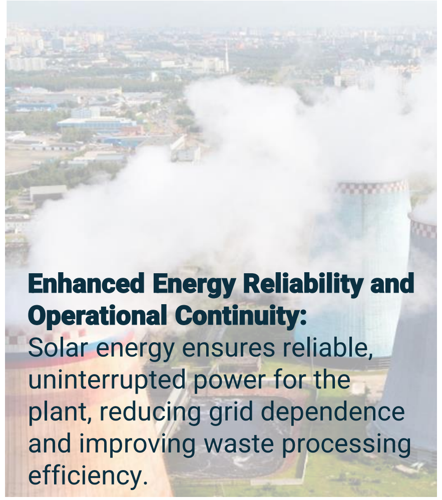
₹44,87,500

Current annual electricity consumption: 198,122 kWh/year
Estimated current annual electricity cost: Assuming ₹7 per kWh, ₹13,86,854 per year.
Total cost over 25 years (grid power): ₹6,61,78,884 (assuming 5% annual tariff increase)
Total estimated cost over 25 years (solar):

- Initial investment: ₹32,70,000 (for approximately 109 kW system)
- Estimated annual maintenance: ₹32,700 (1% of initial investment)
- Total maintenance over 25 years: ₹8,17,500
- Inverter replacement (2 times): ₹4,00,000
- Total estimated cost: ₹44,87,500

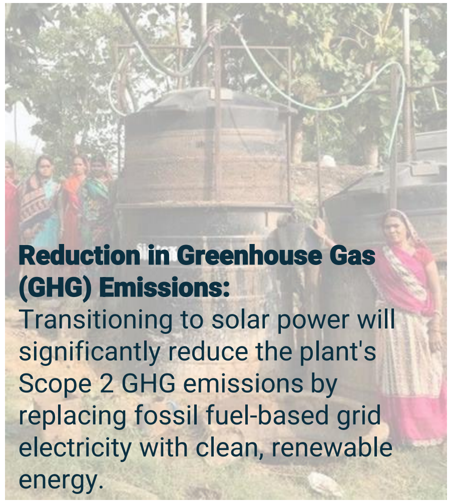
Savings = ₹6,16,91,384

❖ Impact:



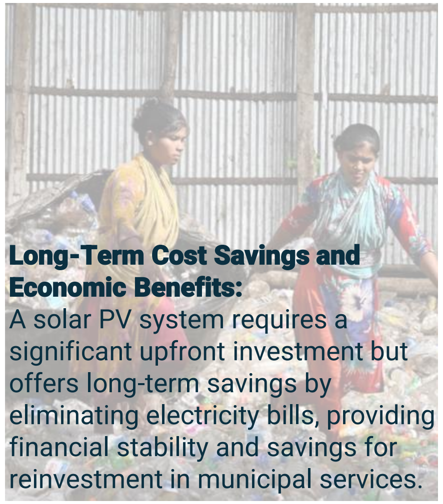
Enhanced Energy Reliability and Operational Continuity:
Solar energy ensures reliable, uninterrupted power for the plant, reducing grid dependence and improving waste processing efficiency.

SOURCE: https://www.indiabusinesstrade.in/blogs/waste-to-energy-in-india-time-to-up-the-ante/



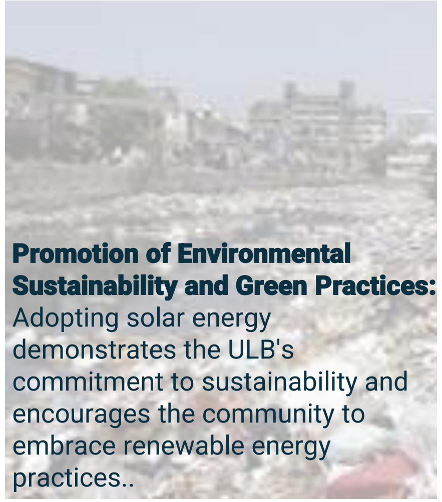
Reduction in Greenhouse Gas (GHG) Emissions:
Transitioning to solar power will significantly reduce the plant's Scope 2 GHG emissions by replacing fossil fuel-based grid electricity with clean, renewable energy.

SOURCE: https://biogas-india.com/rural-employment-generation-through-biogas-production-in-villages-of-india/



Long-Term Cost Savings and Economic Benefits:
A solar PV system requires a significant upfront investment but offers long-term savings by eliminating electricity bills, providing financial stability and savings for reinvestment in municipal services.

SOURCE: https://www.moneycontrol.com/news/environment/vision-2047-solid-waste-management-landfills-11223601.html



Promotion of Environmental Sustainability and Green Practices:
Adopting solar energy demonstrates the ULB's commitment to sustainability and encourages the community to embrace renewable energy practices..

SOURCE: https://energyasia.co.in/sustainability/harnessing-electricity-from-garbage-mumbais-wte-initiative/

Creation of Local Economic Opportunities:
Installing and maintaining solar PV systems can create local jobs and boost the economy through employment in installation, maintenance, and the solar supply chain.

SOURCE: https://thebetterindia.com/374388/northeast-arunachal-pradesh-sangti-zero-waste-management-community-driven-monpa-sustainability/

❖ Scalability to Other Small and Medium Towns:

Adaptability to Varying Energy Needs:

A modular solar PV system can be tailored to each SWM plant's energy needs, ensuring consistent and cost-effective power supply.

Leveraging Underutilized Spaces:

Available rooftop or open land at SWM plants can be used for solar PV installation, avoiding the need for extra land acquisition.

Standardized Technology and Decreasing Costs:

Solar PV is a cost-effective, standardized, and low-maintenance solution increasingly viable for budget-constrained ULBs.

Alignment with National Renewable Energy Goals:

Utilizing existing SWM plant space for centralized solar charging ensures efficient land use and streamlined charging infrastructure for EV fleets.

Empowering Local Technical Capacity:

Implementing solar at SWM plants aligns with national renewable energy goals and may unlock government financial and technical support for ULBs.

Showcasing Environmental Leadership:

ULB adoption of solar energy in waste management showcases environmental leadership and encourages broader community use of renewables.

Recommendation 6: Construction of a Scientific Disposal Facility

Issue Identification:

01 Unprocessable Residual Waste
Some waste remains unprocessable due to contamination, poor material quality, or low value.

02 Informal Dumping Practices
Residual waste is often dumped in open sites or stockpiled near processing facilities in towns like Viramgam and Mansa.

03 Environmental Hazards
These dumps cause pollution, odour, leachate runoff, vector breeding, and greenhouse gas emissions.

04 Open Burning by Operators
SWM staff resort to burning residual waste to reduce volume, worsening environmental and health risks.

Recommendation:

Identify Suitable Land Parcel Adjacent to SWM Plant:

- Minimum area of 0.5–1 acre for small towns generating <25 TPD residual waste.
- Ensure no overlap with waterbodies, habitation zones, or environmentally sensitive sites.

Design a Secured Landfill:

- Engineered liner system: HDPE liner, clay layer, geo-textile.
- Leachate collection and evaporation pond or treatment link.
- Fencing, access road, signage, stormwater diversion, and buffer vegetation.

Phase Construction into Modular Cells:

- Allows future expansion and avoids over-investment.
- Each cell can cater to 2–3 years of residual waste based on daily volume.
- Develop Basic Monitoring Infrastructure:
- Record of incoming loads, daily coverage with inert layer.
- Install basic sensors or manual leachate logs to track system performance.

Ensure Regulatory Compliance and Reporting:

- Register site under GPCB.
- Submit annual landfill utilization and monitoring reports.

Financing:

15th Finance Commission Grants:

Performance-based grants provided to ULBs can be allocated for capital infrastructure, including scientific disposal facilities.

Swachh Bharat Mission 2.0 (SBM-U):

Offers capital support for SWM infrastructure including scientific landfills under its Urban Infrastructure Fund.

State Grants via GUDM/UDD:

Gujarat Urban Development Mission or Urban Development Department periodically releases grants for SWM projects in small and medium towns.

District Mineral Foundation (DMF) or CSR:

In areas with industrial or mining activities, these funds can supplement landfill construction.

ULB Co-financing:

ULBs can allocate a portion of their annual budget and mobilize funds through user charges, tipping fees, or waste tax augmentation.

Scalability:

Parameter	Details
Ideal Town Size	Class B/C towns generating <5–10 TPD residual waste
Required Area	0.5–1 acre
Investment Range	₹20–40 lakh depending on liner and leachate systems
O&M Cost	₹1.5–2.5 lakh/year

Compliance Agencies GPCB, ULB, local health/environment department

Impact:

Environmental Protection:

Prevents contamination of soil and water by controlling leachate and surface runoff.

Odour and Vector Control:

Controlled tipping and regular covering eliminate the nuisance.

Regulatory Compliance:

Fulfils CPCB-GPCB requirements, reducing legal and reputational risk.

System Closure:

Makes the SWM system self-contained from collection to final disposal.

Rating and Funding Eligibility:

Boosts chances for Swachh Survekshan awards and central/state funding access.

GHG Reduction : Viramgam

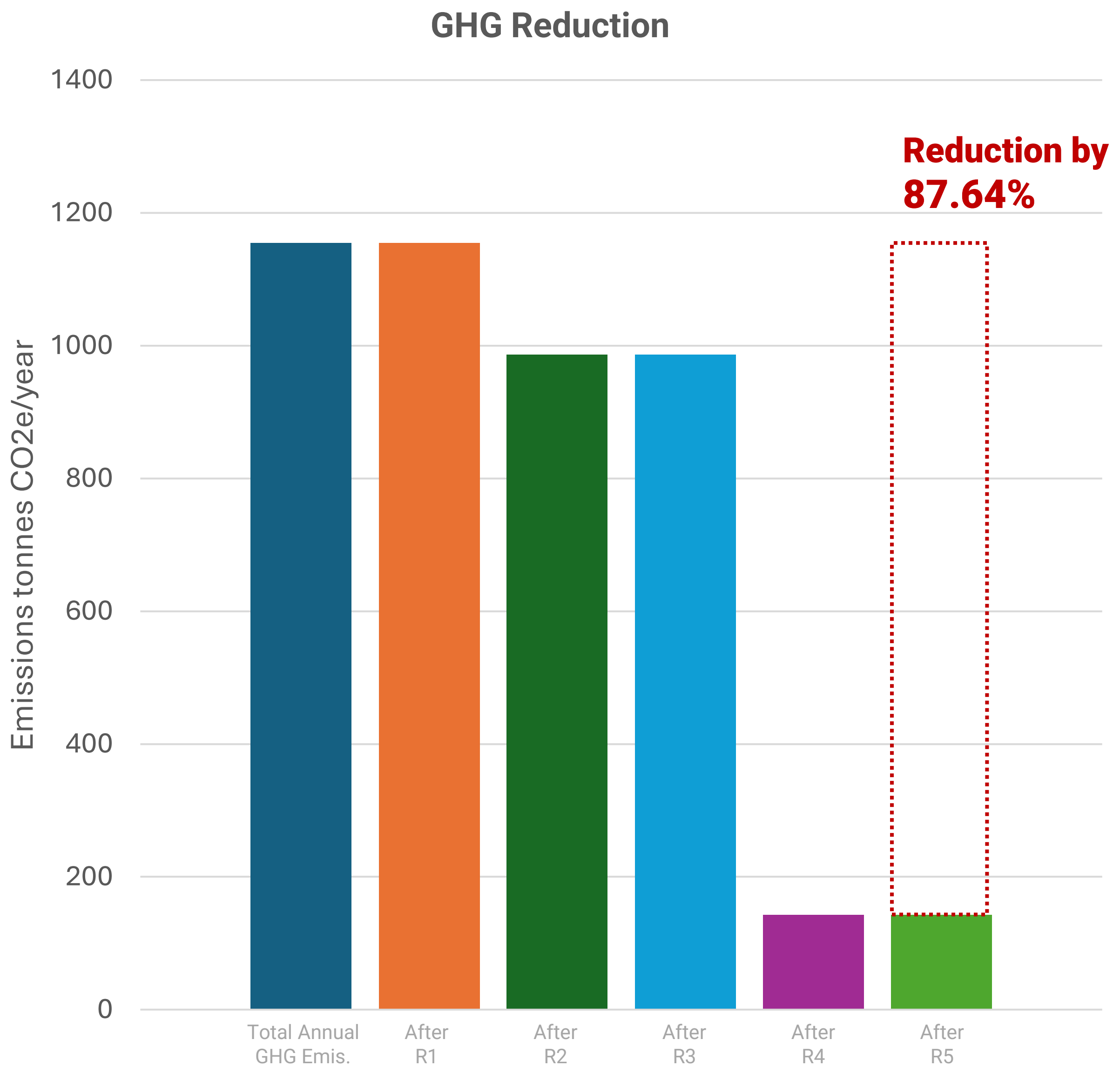
Recommendation 1:
Strengthening Door-to-Door Collection Monitoring through an RFID-Based Mechanism

Recommendation 2:
Transitioning to Electric Vehicles Powered by Solar Energy for Sustainable Waste Collection

Recommendation 3:
Empowering SHGs for Integrated Waste Collection and IEC-Driven Segregation

Recommendation 4:
Climate Resilient Waste Processing Infrastructure and Market Linkages for Processed Outputs

Recommendation 5:
Construction of a Scientific Disposal Facility



CONCLUSION

INPUT

- RFID D2D Monitoring System
- Centralized Dashboard
- SHG Engagement (Collection & IEC)
- Performance-Based Contracts
- Sustained IEC Campaigns

- EV Fleet Procurement
- Solar EV Charging Stations

- Processing Tech Upgrades
- Sanitary Waste Management
- Solar PV System for SWM Plant
- Market Linkages for By-products

- Engineered Landfill Construction
- Operational Monitoring Setup
- Regulatory Compliance Measures

OUTPUT

- Digitally Tracked D2D Collection
- Higher Household Segregation
- Reduced GVPs & Missed Collections
- Active SHG Field Involvement
- Real-Time Service Data

- Operational EV Collection Fleet
- Functional Solar Charging Infrastructure
- Zero Tailpipe Emissions
- Reduced Fuel & Maintenance Costs

- Increased Compost, Biogas, RDF Production
- Safe Sanitary Waste Disposal
- On-Site Solar Power Generation
- Established Markets for By-products
- Reduced Waste to Landfill

- Functional Scientific Landfill
- Controlled Residual Waste Disposal
- Effective Leachate & Gas Management

OUTCOME

- Increased Source Segregation Rates
- Efficient & Accountable D2D Services
- Cleaner Neighborhoods
- Better Quality Waste for Processing
- Higher Community Awareness & Ownership

- Reduced GHG, Air & Noise Pollution
- Lower, Predictable Operational Costs
- Improved SWM Contract Viability
- Potential for In-House/SHG Ops

- Higher Material & Energy Recovery
- Revenue from Processed Outputs
- Lower Plant Operational Costs & Scope 2 Emissions
- Strengthened Circular Economy

- Reduced Environmental Pollution
- Minimized Nuisance (Odour, Vectors)
- Full Regulatory Compliance
- Safe SWM Lifecycle Closure

IMPACT

- Improved, climate-resilient, and environmentally sustainable Solid Waste Management (SWM) services

- Strengthened ULB capacity

- Increased citizen satisfaction

- Increase performance in SLBs and Swacch Survekshan and similar indicator ranking

Thank You !

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Guides - Arwa Bharmal and Saubiya Sareshwala