

Sustainable Solid Waste Management Strategies for Greater Chennai Corporation

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Abstract – This paper investigates sustainable solid waste management (SWM) strategies for the Greater Chennai Corporation (GCC), one of India's largest urban local bodies generating approximately 6,300 tonnes per day (TPD) of municipal solid waste. The study analyses existing waste generation patterns, composition, and management infrastructure; evaluates the environmental impacts of major dumping sites at Perungudi and Kodungaiyur; and identifies institutional, technical, and planning gaps. Using primary field surveys, stakeholder consultations, secondary data analysis, and comparative case studies from Indore (India), Japan, Sweden, and San Francisco (USA), the research develops integrated and sustainable SWM strategies. Key findings reveal a critical infrastructure deficit—current processing capacity covers only 19% of generated waste—while source segregation compliance remains extremely low. The study proposes decentralized ward-level processing systems, mandatory source segregation, smart waste technologies (IoT sensors, AI-based recycling robots, pneumatic collection), community-based recycling hubs, and circular economy frameworks. The proposed Circular Resource Innovation District (CRID) at Perungudi and Decentralised Waste Commons (DWC) provide planning-based models for transitioning Chennai from a linear, dumping-dependent system to a resource-recovery-oriented urban metabolism.

Key Words: *Solid waste management, Greater Chennai Corporation, source segregation, circular economy, decentralized processing, smart waste technologies, Perungudi, Kodungaiyur, urban planning.*

1. INTRODUCTION

Waste management is the systematic process of collecting, transporting, treating, recycling, and disposing of waste materials in a way that minimises their harmful effects on human health, the environment, and society (WHO, 2024). Sustainable waste management aims to use material resources efficiently, reduce waste production, and deal with waste in a manner that actively contributes to economic, social, and environmental goals of sustainable development.

Waste is increasing rapidly across the world, in India, and in Kerala. Cities need simple and clear systems to collect, treat, and reuse waste. With good planning, recycling, and support from people and government, waste can become a resource instead of a problem. Kerala's local projects show that working together can keep cities clean, healthy, and sustainable.

Greater Chennai Corporation (GCC) is the municipal governing body of Chennai, the capital city of Tamil Nadu and one of India's major metropolitan cities. Established in 1688, it is the oldest municipal corporation in India. The corporation administers an area of about 426 km² and is divided into 15 zones with 200 wards. Rapid urbanization, population growth, and economic expansion have significantly increased municipal solid waste generation in the city.

2. NEED FOR THE STUDY

The urgent need for this study is underscored by the following critical challenges:

- Chennai generates around 6,300 tonnes of municipal solid waste per day, and waste generation is projected to increase to 11,793 TPD by 2040 due to rapid urbanisation and population growth (Sandhya Strategic Investment and Advisory, 2023, as cited in Times of India).

- Solid waste from all zones of Chennai is mainly transported to Perungudi and Kodungaiyur dumping grounds, which have been used for decades and cover hundreds of acres of land (Greater Chennai Corporation official release, 2025).
- Field observations and interaction with the Chief Town Planner revealed inadequate segregation at source and continued disposal of untreated waste in dumping sites, indicating gaps in the existing waste management system (Visual field survey and expert interview, 2026).
- Chennai has accumulated over 48.41 lakh tonnes of legacy waste, and biomining has reclaimed only about 100 acres of land, indicating extensive land consumption and environmental burden (Greater Chennai Corporation, 2025).
- Despite large investments in biomining and waste processing projects, significant quantities of waste continue to be disposed in dumping grounds, showing inefficiencies in existing systems (Greater Chennai Corporation, 2025).

3. AIM AND OBJECTIVES

3.1 Aim

To develop sustainable solid waste management strategies for Greater Chennai Corporation by analysing current waste generation patterns, existing management practices, environmental impacts, and system gaps, and by proposing practical and long-term solutions for improved urban waste management.

3.2 Objectives

- To analyze the current waste generation, composition, and major sources of municipal solid waste in Greater Chennai Corporation, while also assessing the existing solid waste management system, including collection, segregation, transportation, and treatment practices.
- To evaluate the environmental impacts of dumping sites such as Perungudi and Kodungaiyur and to examine community perceptions, public health concerns, and challenges related to waste management in affected areas.
- To identify institutional, technical, and planning gaps in the current waste management framework of Greater Chennai Corporation.
- To develop integrated and sustainable solid waste management strategies for Greater Chennai Corporation by analysing waste generation trends, environmental impacts, and system gaps, and by proposing planning-based and technology-driven solutions for long-term improvement.

4. METHODOLOGY

The study employs both primary and secondary data collection methods:

4.1 Secondary Data Collection

Literature review of published research, government reports, and international case studies; literature case studies from Indore, Japan, Sweden, and San Francisco.

4.2 Primary Data Collection

Visual field surveys of Perungudi and Kodungaiyur dumping sites; stakeholder meetings with the Chief Town Planner and Assistant Town Planner of Chennai Metropolitan Area; and household surveys across selected zones.

The methodology progressed from background study and aim definition → data collection (secondary + primary) → analysis → gap analysis → strategy development.

5. LITERATURE REVIEW

A systematic review of fourteen key studies was conducted, examining global and Indian perspectives on solid waste management, smart technologies, circular economy, and community participation.

Table 1: Literature Review Summary

No.	Title / Authors / Year	Methods	Key Findings	Parameters
1	Pioneering zero-waste technologies (Rahul Kumar et al., 2025)	Comparative review & case studies	Integrated zero-waste technologies require cohesive strategies and stakeholder cooperation.	Circular economy, community participation, waste valorization
2	Zero waste approaches towards sustainable waste management (Awasthi et al.)	Systems review & technology evaluation	Zero waste needs teamwork across technology, policy, and communities.	Circular economy, stakeholder collaboration
3	Smart cities: Zurich, Oslo, Copenhagen (Oyadeyi et al., 2022)	PRISMA literature review	Policy consistency, PPPs, and community participation are key to successful waste management.	Technological innovation, equity indicators
4	Revolutionizing urban SWM with AI & IoT (Lakhout, 2021)	Systematic review	AI/IoT enhance route optimization but face cost and scalability barriers.	Technological integration, data monitoring
5	Business Model of SWM in Sweden (Corvellec et al.)	Comparative case study	Combining collection, processing and recycling markets supports circular flows.	Circular economy, value creation
6	Circular Economy in Urban Waste Management: Bengaluru (Sangeetha & Manasi, 2025)	Qualitative interviews & site visits	CE projects reduce waste and create socio-economic benefits; infrastructure constraints exist.	CE adoption, behavior change
7	SWM Awareness in Gated Communities, Chennai (Preetha et al., 2018)	Awareness study	Awareness levels shape SWM practices; innovative approaches improve community engagement.	Community participation, behavior practices

8	SWM Awareness – Homemakers in Chennai (Vimaladevi et al., 2024)	Household survey	Homemakers' knowledge significantly influences segregation and recycling behavior.	Household behavior, sustainable lifestyles
9	Innovative SWM strategies for smart cities in Tamil Nadu (Ganesh et al., 2024)	Systematic review & stakeholder interviews	Integrated framework with source segregation, localized processing, and WTE improves sustainability.	Source segregation, circular economy
10	Municipal solid waste: Opportunities, challenges & management policies in India	Review	Highlights sustainable recycling, energy recovery, and emission mitigation as key improvements.	Recycling, sustainable policies
11	SWM in Urban India: Imperatives for Improvement (Satpal Singh)	National SWM review	Improved collection, treatment, and sustainability strategies needed.	Collection efficiency, public health
12	Data-Driven Smart Solutions for Urban Waste Management in India (Chandrika et al., 2025)	Data-based model evaluation	Smart tech improves collection, landfill reduction, and citizen participation aligning with SDGs.	Smart tech, SDG alignment
13	Systematic literature review on MSW using ML & DL (Dawar et al., 2025)	Systematic review	AI/ML are emerging tools in waste classification and sustainable disposal planning.	AI/ML methods, environmental sustainability
14	6 Smart Waste Management Technologies Emerging In 2026 (Joe Romuno, 2023/2024)	Review-based study	Smart waste technologies improve collection efficiency, recycling rates, and operational performance.	Collection efficiency, emissions reduction

Key themes emerging from the literature include: the necessity of source segregation, the role of decentralised processing, integration of circular economy principles, community and stakeholder engagement, and the potential of smart technologies such as IoT and AI-based systems to transform waste management.

6. STUDY AREA: GREATER CHENNAI CORPORATION

Greater Chennai Corporation (GCC) administers an area of approximately 426 km², divided into 15 zones and 200 wards. The present population of Chennai is estimated at 7.1 million, with projected growth to 9.6 million by 2026. The city generates approximately 6,150 TPD of municipal solid waste (2025), rising to 6,650 TPD by 2026.

6.1 Perungudi Dumping Yard

The Perungudi Dumping Yard is located in the southern part of Chennai, near the ecologically sensitive Pallikaranai marshland. Covering approximately 300 acres, it serves waste from the southern and central zones of GCC. Field observations revealed large-scale open dumping of mixed waste, unlined waste heaps, polluted drains, leachate formation, and absence of scientific landfill infrastructure.

6.2 Kodungaiyur Dumping Yard

The Kodungaiyur Dumping Yard is located in the northern part of Chennai and covers approximately 300 acres. It serves as a major disposal facility for northern and central zones of GCC. Bio-mining and waste processing activities are currently being undertaken to remove legacy waste and reclaim land.

7. PRIMARY DATA ANALYSIS

7.1 Waste Generation and Processing Capacity (2025–2026)

Current waste generation stands at 6,150 TPD (2025) rising to 6,650 TPD (2026). The waste composition is 52% wet waste, 40% dry waste, and 8% street sweeping/inerts. The total current processing capacity is only 696 TPD, leaving a critical gap of approximately 5,354 TPD (80% of waste unprocessed).

Table 2: Processing Facilities – Present Capacity and Under Construction

S.No.	Type of Processing Facility	Present Capacity (TPD)	Under Construction (TPD)
1	Micro Composting Centers @ 22 locations	116	Nil
2	Coconut and Garden Waste Processing Centers @ KDG and PDG	160	Nil
3	Bio CNG Plant (Chetpet & Madhavaram)	200 + 120*	500 (Koyambedu 2 nos, Sholinganallur 2 nos, Madhavaram 1 no)
4	Windrow Composting Plant @ Zone 2 Manali	100	100 (Perungudi Dumping Yard reclaimed land)
	Total	696	600

The GAP analysis highlights a severe infrastructure deficit in waste processing, where current capacity covers just 19% of the projected 6,150 TPD waste quantity for 2026, leaving an 81% shortfall of 4,970 TPD. Wet waste shows the largest gap at 2,540 TPD, underscoring urgency for bio-composting expansions, while dry waste's 2,430 TPD shortfall demands MRF and baling investments. Proposed plants totalling 5,300 TPD offer near-complete coverage.

7.2 Bio-CNG Plant Development Schedule

Table 3: Bio-CNG Plant Locations and Completion Schedule

Sl.No.	Zone / Location	Design Capacity (MT)	Concessionaire	Probable Date of Completion
1	Zone 8 – Chetpet	100*	M/s. Srinivasa Waste Management	In Operation
2	Zone 2 – Madhavaram Plant 1	100*	M/s. Maha Sakthi	In Operation
3	Zone 2 – Madhavaram Plant 2	100	M/s. Maha Sakthi	31.03.2026
4	Zone 15 – Sholinganallur Plant 1	100	M/s. Maha Sakthi	31.03.2026
5	Zone 15 – Sholinganallur Plant 2	100	M/s. Maha Sakthi	31.03.2026
6	Zone 10 – Koyambedu Plant 1	100	M/s. Maha Sakthi	30.06.2026
7	Zone 10 – Koyambedu Plant 2	100	M/s. Maha Sakthi	Under Proposal
8	Zone 4 – Kodungaiyur	550	Proposed under IWPF – DBFOT model (PPP mode), work order issued 11.03.2025	Preliminary work in progress

8. CASE STUDY ANALYSIS

8.1 Indore, India

Indore was ranked India's Cleanest City (Swachh Survekshan) for seven consecutive years (2017–2023). Before 2015, Indore faced unmanaged waste dumps, overflowing landfills, and severe public health issues. The transformation was achieved through: mandatory source segregation (>98% compliance), 100% door-to-door collection with GPS-tracked vehicles, 10 micro composting centres and 3 transfer stations, bio-methanation plants converting 550 TPD to compost and energy, and 100-acre Devguradia landfill reclamation to an eco-park. These methods are directly applicable to Chennai's context.

8.2 Japan

Japan developed a multi-tier governance model incorporating 34 Waste-to-Energy (WTE) plants, a strict landfill ban (2005) reducing landfill use to under 1%, Extended Producer Responsibility (EPR) for packaging waste, and nationwide public engagement achieving 99% segregation participation.

8.3 Sweden

Sweden achieves over 50% energy recovery from household waste, a 35% recycling rate, and 15% composting rate. Key strategies include mandatory source segregation, WTE for non-recyclable waste, EPR for producers, circular economy practices, and strong public participation frameworks.

8.4 San Francisco, USA

San Francisco introduced a mandatory three-bin system (blue-green-black), achieving over 80% diversion rate by 2010—ahead of its target. Key strategies include mandatory recycling and composting ordinances, Public-Private Partnerships with Recology, 600 tons/day of composted organics, and a 15% GHG reduction since 2005.

9. SWOT ANALYSIS – GCC WASTE MANAGEMENT SYSTEM

STRENGTHS (S)	WEAKNESSES (W)
<ul style="list-style-type: none"> • Strong institutional framework under GCC with established waste collection system • Existing door-to-door collection system across most zones • Continuous high waste generation (~6,300 TPD) ensuring availability of recyclable material • Ongoing bio-mining and land reclamation at dumping sites • Public-Private Partnership (PPP) involvement in collection and transport • Availability of informal waste workers (unorganized recycling sector) • Compatibility with successful Indian case studies like Indore 	<ul style="list-style-type: none"> • Poor source segregation at household and commercial levels leading to mixed waste stream • Overdependence on centralized dumping at Perungudi and Kodungaiyur • Lack of decentralized infrastructure such as ward-level composting units and MRFs • Significant gap between waste generation and processing capacity (~19% efficiency) • Environmental degradation due to leachate, methane emissions, and open dumping • Weak enforcement of waste management rules and policies • Informal sector not fully integrated into formal waste management system
OPPORTUNITIES (O)	THREATS (T)
<ul style="list-style-type: none"> • Transition towards circular economy (waste as resource) • Potential for decentralized waste processing at ward/zonal level • Reuse of reclaimed landfill land for waste processing and public infrastructure • Integration of smart technologies (IoT bins, GPS tracking, digital monitoring) • Behavioural change through incentives and awareness programs • Scope for integrating waste management into urban planning and land-use strategies • Development of recycling markets and resource recovery industries 	<ul style="list-style-type: none"> • Rapid urbanization increasing waste generation beyond system capacity • Environmental risk to sensitive ecosystems like Pallikaranai Marsh • Land scarcity due to continuous expansion of dumping sites • Climate impacts from methane emissions and landfill fires • Policy-implementation gap and weak monitoring mechanisms • Public resistance and low participation in segregation practices • Increasing pressure on infrastructure due to IT corridor expansion

10. SMART WASTE MANAGEMENT TECHNOLOGIES

The following smart technologies are identified as best practices applicable to Chennai:

10.1 Smart Bin Sensors (IoT-Enabled Waste Bins)

Smart bins use sensors and IoT technology to monitor waste levels and send real-time data to waste management authorities. Barcelona (Spain) successfully implemented access-controlled smart bins integrated with a centralized digital monitoring platform, optimising collection routes and reducing unnecessary trips and fuel consumption.

10.2 AI-Based Recycling Robots

AI robots automatically identify and separate recyclable materials using high-resolution cameras and machine learning. ZenRobotics (Finland) introduced the world's first AI robotic waste sorting system, deployed in Helsinki, Amsterdam, and London.

10.3 Pneumatic Waste Collection System

Underground pipes transport waste automatically using vacuum technology. Invented in the 1950s by Swedish company Envac, these systems reduce carbon emissions by up to 90% compared to conventional trash collection. Songdo (South Korea) operates a fully automated pneumatic waste collection system.

10.4 Solar-Powered Trash Compactors

Solar-powered bins compress waste and reduce collection frequency. New York City installed Bigbelly compacting bins that hold 5–8 times more waste than traditional bins, reducing collection frequency by up to 80% and lowering operational costs significantly.

10.5 E-Waste Recycling Kiosks

Automated kiosks allow the public to safely deposit mobile phones, batteries, and electronics, with digital incentives for participation. The USA's ecoATM kiosks exemplify this model.

10.6 Recycling Apps and Digital Platforms

Singapore's ALBA STEP UP App and San Francisco's Recology Mobile App demonstrate how digital platforms can engage citizens through gamification, collection schedule tracking, and real-time reporting of illegal dumping.

11. PROPOSALS AND STRATEGIES

11.1 Vision

Vision: *"To transition Greater Chennai from a linear waste-dependent system into a spatially distributed circular resource network, where waste is intercepted at source, processed within its own urban fabric, and reintegrated into the city's ecological and economic cycles, minimising landfill dependency and restoring environmentally sensitive landscapes."*

11.2 Mission

- To restructure waste management from a centralized dumping model to a decentralized ward-based processing network.
- To institutionalize mandatory source segregation through spatial, behavioural, and technological interventions.
- To convert landfill zones like Perungudi and Kodungaiyur into resource recovery landscapes.
- To integrate informal sector and community participation into formal waste systems.
- To protect critical ecosystems like Pallikaranai Marsh through waste-buffer planning.
- To embed waste infrastructure into land-use planning frameworks.

11.3 Circular Resource Innovation District (CRID) – Perungudi

The proposal transforms landfill-adjacent areas at Perungudi into resource recovery and livelihood hubs incorporating: waste collection and sorting; recycling and upcycling to handcrafted products; an Eco-Market and Tourist Sales Hub connecting to Chennai's tourism economy; a Skill Development and Training Centre for craft-making, recycling techniques, and entrepreneurship; and an Organic Waste Processing Unit for composting and biogas production with compost sold for urban farming.

11.4 Achieving 100% Waste Segregation: Implementation Pathway

The pathway to full segregation involves: (i) eliminating mixed waste collection without segregation; (ii) enforcing colour-coded bin systems; (iii) conducting bulk generator audits with QR tracking for compliance; and (iv) ensuring enforcement from all large sources, moving progressively towards 100% waste segregation.

11.5 Key Strategy Recommendations

- Implement mandatory three-bin (wet, dry, hazardous) source segregation across all households and commercial areas.
- Achieve 100% door-to-door segregated waste collection with strict GPS-based monitoring.
- Establish ward-level composting facilities and decentralised Material Recovery Facilities (MRFs).
- Enforce strict regulations and penalties for non-segregation and illegal dumping.
- Promote Extended Producer Responsibility (EPR) to manage plastic and packaging waste.
- Deploy IoT-enabled smart bins, AI-based sorting robots, and digital monitoring platforms.
- Conduct continuous public awareness and citizen participation programs (reward-based systems).
- Integrate waste management infrastructure planning into GCC's land-use and master planning frameworks.
- Use reclaimed land at Perungudi and Kodungaiyur for decentralised processing infrastructure.

12. CONCLUSIONS

This study establishes that Greater Chennai Corporation faces a critical and urgent solid waste management crisis, characterised by a massive gap between waste generation (6,150 TPD) and processing capacity (696 TPD), persistent failure of source segregation, and severe environmental degradation at Perungudi and Kodungaiyur dumping sites.

The research demonstrates that sustainable, long-term solutions require a fundamental transition from the current centralized, dumping-oriented approach to an integrated, decentralised circular resource system. Drawing on successful models from Indore, Japan, Sweden, and San Francisco, the proposed strategies—mandatory segregation, ward-level processing, smart technologies, community recycling hubs, EPR, and ecosystem protection—offer a comprehensive and implementable pathway for Chennai.

The study underscores that waste management in Chennai must be reconceptualised as an urban planning challenge requiring spatial, institutional, technological, and behavioural interventions simultaneously. Implementation of the Circular Resource Innovation District at Perungudi, coupled with the Decentralised Waste Commons network and smart monitoring infrastructure, offers Chennai a model for transforming waste into a resource and restoring the city's ecological assets.

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