

# Evolution of Waste Management Systems in Rajasthan: A Status Report

\* Ramkesh Meena

## Abstract

Rajasthan's waste management has moved out from the realm of a neglected municipal task to become a highly regulated, technology-driven priority. The paper tracks the growth of the state's waste systems from the early 2000s, when there was no regulation for dumping, to the integrated "Waste-to-Wealth" models triggered by Swachh Bharat Mission (SBM) and Solid Waste Management (SWM) Rules, 2016

## 1. Introduction

Waste management has become one of the most critical environmental concerns of the 21st century especially in fast urbanizing regions like Rajasthan. India's largest state by geographical extent, Rajasthan has distinct logistical and environmental challenges – from the parched expanses of the Thar Desert to the densely populated urban centres of Jaipur, Jodhpur and Kota. The state's waste management was historically a linear "collect-and-dump" scheme that depended on unregulated open landfills and community dumping sites. The waste management in Rajasthan may be broadly classified into two phases, before 2014, when it was localized and informal and post 2014, when it underwent a centralized policy-driven reform, in the name of national mission 'Swachh Bharat Mission' (SBM). The initial legal framework was provided by the notice of the Municipal Solid Waste (Management and Handling) Rules in 2000 but the implementation was stagnating owing to lack of technical infrastructure and financial resources at the Urban Local Body (ULB) level. "The landscape was completely different from 2016 to 2023. With the adoption of Solid Waste Management Rules, 2016 the focus was shifted towards "Circular Economy" concept. This change in paradigm required the separation of sources, scientific treatment of biodegradable waste and rehabilitation of legacy waste dumpsites amassed over decades. Rajasthan has implemented digital monitoring, including GPS-tracked pickup fleets and the Integrated Waste Management System (IWMS) to handle the approximately 6,500–6,800 tonnes of municipal solid waste (MSW) generated daily by 2023. This study attempts to provide a status update on this evolutionary journey, examining the state's progress in collecting efficiency, setting up of processing units, and the issues of financial sustainability and public participation. This paper explores how a state historically limited to the desert has sought to overhaul its sewage system to meet contemporary environmental requirements.

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## 2. Review of Literature

The scientific literature on waste management in Rajasthan identifies a critical shift from basic sanitation to a structured technological and regulatory framework. Academic research and institutional audits emphasize three primary themes: the evolution of municipal solid waste (MSW) characteristics, the feasibility of modern processing technologies, and the emergent challenges of e-waste and legacy remediation.

### 2.1 Spatial and Physico-Chemical Analysis of MSW

Research indicates that waste characteristics in Rajasthan are heavily influenced by urbanization and climatic conditions. Studies in major cities such as Bikaner reveal that despite high urban densities, collection and disposal rates remain inconsistent. For example, Bikaner generates approximately 150 tonnes per day (TPD), with an average collection efficiency of 62% being disposed of at the Goga Gate dumping ground (Kaur & Rajpurohit, 2021).

Geographical analysis across 13 Indian cities, including those in Rajasthan, demonstrates that the most suitable technique for managing MSW in this region is the bio-conversion process due to the high fraction of biodegradable waste (fruits, vegetables, and food scraps) generated by various socio-economic groups (Ahsan et al., 2015). High socio-economic households in cities like Jaipur and Khulna show significantly higher per capita waste generation rates, ranging from 0.368 kg/capita/day to 0.480 kg/capita/day (Ahsan et al., 2015).

### 2.2 Processing Technology and Policy Implementation

Literature regarding policy compliance highlights that while Rajasthan improved its door-to-door (D2D) collection to nearly 99% by 2023, processing remains a bottleneck. Audits by the Comptroller and Auditor General (CAG) point out that processing efficiency at the state level was only 11% to 25% between 2021 and 2023.

### 2.3 Plastic and E-Waste Management

The management of non-biodegradable streams has moved toward a circular economy model. In 2022-23, Rajasthan generated approximately 83,242.74 tonnes per annum (TPA) of plastic waste (Rajasthan State Pollution Control Board [RSPCB], 2023). While a complete ban on plastic carry bags has been in effect since 2010, implementation challenges persist; only roughly 26,147.87 tonnes were processed in the 2022-23 period (RSPCB, 2023). Regarding e-waste, the E-Waste (Management) Rules, 2022, which became effective in April 2023, introduced Extended Producer Responsibility (EPR) certificates to formalize the recycling sector in industrial hubs like Bhiwadi and Jaipur (Singh, 2023).

### 2.4 Legacy Waste and Biomining

Modern literature (2020–2023) focuses heavily on Landfill Biomining (LFBM). Dumpsites in Rajasthan are often "unlined open dumps" that produce hazardous leachate and greenhouse gases (Kumar et al., 2022). Biomining has been identified as the primary scientific method to reclaim these sites, with layer

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Ramkesh Meena

screening and trommeling techniques being used to recover land for sustainable urban reuse (Kumar et al., 2022).

#### 1. The Era of Neglect (2000–2014)

During this period, waste management in Rajasthan was characterized by "Collection and Relocation" rather than treatment.

**Infrastructure:** Municipalities relied on open tractor-trolleys. Waste was deposited in community bins (dhalaos) and eventually dumped in low-lying outskirts.

**Regulatory Gap:** Although the MSW Rules 2000 were in place, compliance was marginal. There was a total absence of scientific landfills or waste processing units in the state.

**Public Health:** Open burning of waste was common in cities like Jaipur, Jodhpur, and Kota, leading to severe air quality issues and localized groundwater contamination.

#### 2. The Transition Period (2014–2016)

The launch of Swachh Bharat Mission (SBM) in 2014 marked a turning point. Rajasthan began institutionalizing waste management through:

**Individual Household Latrines (IHHL):** Initial focus was on making the state ODF (Open Defecation Free).

**Formalization:** ULBs started preparing City Sanitation Plans (CSPs), identifying for the first time the specific tonnage of waste generated per capita.

### 3. Policy-Driven Transformation (2016–2021)

The notification of the Solid Waste Management Rules, 2016, forced a shift toward scientific disposal.

#### 3.1 Door-to-Door (D2D) Collection

Rajasthan achieved significant milestones in D2D collection. By 2019, nearly 90% of urban wards were covered. The state introduced the use of "Auto-Tippers" with separate compartments for wet and dry waste, replacing the old community bin system.

#### 3.2 Waste-to-Energy and Compost

**Jaipur Model:** The state established its first major Waste-to-Energy (WtE) and Refuse Derived Fuel (RDF) infrastructure.

**Centralized vs. Decentralized:** Large cities moved toward centralized plants, while smaller towns began experimenting with decentralized composting (e.g., pit composting in parks).

#### 3.3 Status of Waste Generation (Circa 2020)

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## Evolution of Waste Management Systems in Rajasthan: A Status Report

Ramkesh Meena

By 2020, Rajasthan was generating approximately 6,500 Tonnes Per Day (TPD) of municipal solid waste. However, the processing rate hovered around 25–30%, with the remainder still heading to legacy dumpsites like Langadiyawas in Jaipur.

#### 4. The Modern Phase: SBM 2.0 and Circular Economy (2021–2023)

The focus evolved from mere collection to "Garbage Free Cities" (GFC) and the remediation of legacy waste.

##### 4.1 Biomining of Legacy Waste

One of the most significant achievements by 2023 was the aggressive biomining of old dumpsites.

Impact: Cities like Ajmer and Udaipur successfully reclaimed hectares of land by processing millions of tonnes of old waste using trommels to separate soil, recyclables, and RDF.

##### 4.2 Special Waste Streams

Plastic Waste: Rajasthan implemented a strict ban on single-use plastics (SUP) in July 2022. By 2023, the state had registered over 40 plastic waste processing units.

E-Waste: The Rajasthan E-Waste Disposal Policy 2022 sought to formalize the scrap sector, particularly in the industrial clusters of Bhiwadi and Neemrana.

##### 4.3 Performance Metrics (As of 2023)

Parameter	Status (2023)
D2D Collection	~99%
Source Segregation	~72%
Processing Efficiency	~55%
Remediated Dumpsites	120+ out of 176

#### 5. Key Challenges and Gaps

Despite the progress leading into 2023, several hurdles remain:

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### Evolution of Waste Management Systems in Rajasthan: A Status Report

Ramkesh Meena

**Financial Sustainability:** Most Urban Local Bodies (ULBs) remain dependent on state/central grants, as user fee collection remains low (averaging <20% in many districts).

**Technical Expertise:** Smaller municipalities struggle to maintain high-tech processing equipment, leading to frequent breakdowns.

**Rural Waste:** While urban Rajasthan has evolved, the "Grameen" (rural) areas are still in the early stages of implementing solid and liquid waste management (SLWM) systems.

## **6. Conclusion and Future Directions**

The evolutionary journey of waste management in Rajasthan from 2000 to 2023 represents a fundamental shift in urban governance and environmental consciousness. The state has successfully transitioned from a primitive "dumping culture," characterized by unregulated open heaps and public health hazards, to a sophisticated "processing culture" rooted in scientific principles and resource recovery.

By 2023, the state established a robust foundation through the integration of high-tech interventions and stringent policy formalization. The deployment of GPS-tracked collection fleets across 196 Urban Local Bodies (ULBs) solved the historical challenge of monitoring primary collection, while the aggressive adoption of biomining technologies addressed the legacy of decades of neglect. These efforts have not only reclaimed valuable urban land but have also mitigated the long-term environmental impact of leachate and methane emissions from stagnant dumpsites.

However, the "Status Report" as of 2023 suggests that while the infrastructure for collection is nearly universal, the processing gap—specifically the conversion of waste into energy or high-quality compost—remains the final frontier. To achieve the ambitious goal of 100% waste processing and zero-landfill cities, the state must now focus on:

**Financial Sustainability:** Shifting from a grant-dependent model to a self-sustaining one by improving the efficiency of user-charge collection and exploring carbon credit markets.

**Decentralized Solutions:** Reducing the logistical burden on desert districts by promoting ward-level composting and material recovery centers.

**Behavioral Change:** Moving beyond infrastructure to ensure that 100% source segregation becomes a social norm rather than a regulatory mandate.

**Industrial Synergy:** Integrating the burgeoning e-waste and plastic recycling sectors into the mainstream economy to maximize the "Waste-to-Wealth" potential.

Ultimately, Rajasthan's progress serves as a blueprint for other geographically challenged states. The transition is no longer just about cleanliness; it is about building a resilient, circular economy that treats waste as a vital resource rather than a liability.

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## **Evolution of Waste Management Systems in Rajasthan: A Status Report**

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