

Implementation Gaps in Urban Solid Waste Management: Evidence from Ward-Level Capacity and Coordination Across Indian Cities

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Abstract

Urban solid waste management in India operates under a formal regulatory framework mandating segregation at source and its preservation through collection. Yet segregation outcomes remain inconsistent despite widespread door-to-door collection coverage. This study examines why such implementation gaps persist at the ward level. Existing literature largely focuses on financial and governance constraints at national or city scales, with limited attention to operational dynamics during primary collection.

Using a multi-city exploratory approach based on primary survey responses collected through a structured questionnaire (Google Form), the study analyses the segregation–collection interface where household practices intersect with municipal systems. Findings indicate that while segregation at source exists, it remains fragile and is frequently undermined during collection due to infrastructural gaps, limited supervision, and coordination challenges among actors. Mixing during collection further generates behavioural feedback that weakens sustained compliance.

The study demonstrates that implementation failure is reproduced through routine interactions between institutional capacity constraints and coordination gaps at the frontline of service delivery. Strengthening segregation preservation at the ward level is therefore critical to translating regulatory intent into sustained practice.

Keywords: Urban solid waste management, segregation at source, implementation gap, institutional capacity, coordination, ward-level governance, India

Introduction

Urban solid waste management (SWM) has emerged as a critical governance challenge in Indian cities. According to the Central Pollution Control Board (CPCB), India generated approximately 170,000 tonnes of municipal solid waste per day in 2021–22. While nearly 92 per cent of this waste was collected, only about 54 per cent was scientifically treated, with 24 per cent deposited in landfills and approximately 22 per cent remaining unaccounted for within the waste supply chain (CPCB, 2024). These figures suggest that although collection systems are largely operational, significant gaps persist in downstream processing and waste handling.

Beyond its environmental implications, improper waste management affects public health and places pressure on urban infrastructure. As a highly visible municipal service, SWM is experienced daily by residents through door-to-door collection and neighbourhood aggregation points, making it a direct indicator of local governance performance.

India has established a formal regulatory framework for urban solid waste management through the Solid Waste Management Rules, 2016, notified under the Environment (Protection) Act, 1986. These rules mandate segregation at source, door-to-door collection of segregated waste, prevention of mixing during transportation, and scientific processing of residual waste. Urban Local Bodies (ULBs) are responsible for implementation, supported by monitoring and reporting mechanisms intended to strengthen compliance (Ministry of Environment, Forest and Climate Change [MoEFCC], 2016). In addition to this statutory framework, subsequent programmatic guidelines under the Swachh Bharat Mission (Urban), issued by the Ministry of Housing and Urban Affairs, have further reinforced implementation by emphasising multi-stream segregation, improved monitoring systems, and stronger operational accountability (Ministry of Housing and Urban Affairs [MoHUA], 2026).

In practice, collection systems function regularly across many urban areas, often through a combination of municipal personnel and private contractors. Waste is removed from households on schedule, and visible accumulation in neighbourhoods is reduced. However, despite policy clarity and routine service delivery, segregation-based outcomes remain uneven. Mixed waste continues to reach aggregation points and landfills, and sustained segregation at source has not stabilised across urban contexts.

This divergence between regulatory intent and everyday practice raises a central implementation question. If segregation is mandated and collection systems are operational, where does implementation break down? Why does segregation fail to stabilise as a routine practice despite policy emphasis and service coverage?

One possible explanation is that the system functions more effectively as a waste removal mechanism than as an integrated waste management process. Waste may be cleared from public spaces, but segregation integrity is not consistently preserved as it moves from households into collection systems (Guerrero et al., 2013; Marshall & Farahbakhsh, 2013; Kumar et al., 2017). The issue, therefore, lies not in the absence of activity, but in everyday implementation dynamics.

This study focuses on the segregation and primary collection stage of urban SWM, which represents the first institutional interface between households and municipal systems. It examines how institutional capacity constraints and coordination gaps shape the preservation of segregation during routine operations at the ward level, where policy design meets frontline administrative practice (Zurbrügg et al., 2012). The study addresses the broader question of how implementation failure is reproduced despite policy mandates and active collection systems, while also examining the role of institutional capacity, coordination between actors, and their influence on household compliance over time.

Policy and Institutional Context

Urban solid waste management (SWM) in India is governed by the Solid Waste Management Rules, 2016, notified under the Environment (Protection) Act, 1986 (Ministry of Environment, Forest and Climate Change [MoEFCC], 2016). These Rules apply to Urban Local Bodies (ULBs), institutions, commercial establishments, and residential entities.

A central requirement is segregation at source, with ULBs responsible for ensuring that segregated waste is collected and transported without intermixing. The framework prohibits mixing, open dumping, and open burning. Programmatic guidelines under the Swachh Bharat Mission (Urban) further reinforce multi-stream segregation including wet, dry, sanitary, and special care waste—and emphasise monitoring and operational accountability (Ministry of Housing and Urban Affairs [MoHUA], 2026).

Segregation is positioned as a foundational condition for enabling composting, material recovery, and landfill diversion. Performance assessment mechanisms such as Swachh Survekshan evaluate cities on indicators including segregation rates, collection efficiency, and processing outcomes, reinforcing the expectation that segregation must be preserved beyond the household stage (MoHUA, 2023).

Although policy is articulated nationally, implementation occurs at municipal and ward levels. Ward-level systems typically include sanitation supervisors, frontline workers, and private contractors operating under municipal oversight. These actors are responsible for organising

collection routes, managing operations, and ensuring that segregation is preserved during collection and transport.

Supervisory mechanisms include inspection of aggregation points, enforcement against open dumping, and response to citizen complaints. Additional guidelines impose compliance obligations on bulk waste generators, including on-site processing and reporting, with ULBs responsible for monitoring and enforcement (MoHUA, 2026).

Taken together, the framework establishes a clear implementation sequence: segregation at source, preservation during collection, and scientific processing. The ward-level segregation–collection interface therefore becomes the critical operational point where policy intent must translate into routine administrative practice.

Literature Review

Existing scholarship identifies persistent implementation challenges in urban solid waste management (SWM) in India despite the presence of a formal regulatory framework. Rapid urbanisation, rising waste generation, and uneven municipal preparedness have placed significant pressure on urban governance systems (Joseph, 2002; World Bank, 2018). Financial constraints in Urban Local Bodies (ULBs), weak enforcement of segregation norms, and inconsistent service quality are frequently cited as key barriers (NITI Aayog, 2021; World Bank, 2018). Policy assessments similarly note that while collection coverage has improved in many cities, segregation compliance and downstream processing outcomes remain uneven (CSE, 2020). However, much of this literature operates at national or city-administrative scales and relies primarily on secondary data.

A substantial body of research attributes these implementation gaps to institutional capacity limitations within municipalities. Inadequate infrastructure, financial constraints, administrative weaknesses, and limited technical expertise are identified as structural barriers (Gupta et al., 2015; Joshi & Ahmed, 2016; Kumar et al., 2017). While these studies establish the importance of institutional capacity, they largely conceptualise it at a macro level. Empirical attention to how capacity constraints manifest in routine collection practices such as vehicle design, compartmentalisation, frontline supervision, and enforcement at the ward level remains limited. As a result, the operational implications of capacity deficits are insufficiently examined.

SWM is also widely framed as a governance challenge involving multiple actors, including households, municipal authorities, private contractors, and informal waste workers (Marshall & Farahbakhsh, 2013; Wilson et al., 2015). Fragmented accountability, weak monitoring

systems, and limited coordination are commonly identified constraints (CSE, 2020; NITI Aayog, 2021). However, existing analyses tend to focus on policy or administrative levels, with limited empirical examination of how coordination gaps unfold during everyday collection practices. In particular, the interaction between household segregation behaviour and frontline collection processes remains underexplored.

Research on informal waste picker integration highlights that structured collaboration between municipalities and informal actors can improve recovery outcomes (Chikarmane, 2012). These studies emphasise the value of institutional recognition and formal–informal linkages in strengthening material recovery systems. However, they primarily focus on integration models rather than examining how informal-formal interactions influence segregation integrity during primary collection. Their implications for ward-level implementation dynamics are therefore less clearly articulated.

Segregation at source is widely recognised as essential for enabling recycling and composting (Guerrero et al., 2013; Kumar et al., 2017; Zurbrügg et al., 2012). Weak compliance and monitoring are frequently identified as constraints (CSE, 2020; Gupta et al., 2015). Yet, most discussions emphasise aggregate compliance levels or policy design rather than examining whether segregation is preserved during collection and transport. Empirical evidence on segregation integrity at the primary collection stage where waste transitions from households to municipal systems remains limited.

Overall, while existing literature convincingly documents financial, institutional, and governance constraints in India's SWM system, it remains concentrated at national and city scales. There is limited empirical examination of how institutional capacity constraints and coordination gaps interact during primary collection at the ward level. In particular, the literature does not adequately explain how segregation integrity is undermined in routine operations despite policy mandates and active collection systems.

This study addresses that gap by examining ward-level segregation and collection practices across multiple urban contexts, focusing on how institutional capacity and coordination dynamics shape everyday implementation outcomes.

Analytical Framework

Implementation in policy analysis refers to the translation of formal rules into routine administrative practice. In urban solid waste management (SWM), implementation is conceptualised as an operational chain beginning with segregation at source and extending through primary collection and handling. Policy mandates require that waste segregated at the

household level be preserved during collection and transportation to enable appropriate downstream processing.

This study defines implementation failure as the breakdown of segregation integrity within this operational chain, particularly at the ward-level segregation–collection interface where waste transitions from households to collection systems. The analytical focus is therefore not on the presence of collection services, but on whether segregation is preserved during routine operations.

To examine this, the framework is structured around a causal relationship linking institutional capacity and coordination across actors to the outcome of segregation preservation during collection.

Institutional capacity refers to the ability of ward-level administrative systems to operationalise segregation mandates in everyday practice. It is operationalised through observable indicators captured in the survey instrument, including availability of separate bins, presence of compartmentalised collection vehicles, regularity of collection schedules, and existence of monitoring or supervisory mechanisms. These factors determine whether the system is materially capable of handling segregated waste without intermixing. Thus, institutional capacity shapes the system’s ability to preserve segregation, while coordination determines whether this capacity is effectively realised during collection. In contexts where such capacity is weak, even compliant household behaviour is unlikely to translate into preserved segregation.

Coordination refers to the degree of alignment between household segregation practices and collection-stage handling by institutional actors, including sanitation workers, contractors, and municipal supervisors. It is reflected in whether segregated waste handed over by households is maintained or mixed during collection, as reported by respondents across wards. Observed patterns of mixing during collection are therefore treated as empirical indicators of coordination failure at the household–collection interface. Such misalignment may arise due to unclear role definition, weak enforcement, lack of accountability, or operational pressures faced by frontline workers.

The framework proposes the following causal mechanism:

- Low institutional capacity (e.g., absence of infrastructure, limited monitoring) reduces the system’s ability to handle segregated waste
- Coordination gaps (e.g., misalignment between households and collection actors) result in mixing during collection

- Observed outcome: breakdown of segregation preservation at the collection stage
- Feedback effect: repeated mixing reduces household incentives to segregate, leading to behavioural erosion over time

Implementation failure is thus conceptualised as a self-reinforcing process, where capacity constraints and coordination gaps interact to produce sustained breakdown in segregation practices.

This framework distinguishes between three categories of actors:

- Households, as waste generators responsible for initial segregation
- Frontline collection workers and contractors, as operational handlers of waste during collection
- Municipal authorities and supervisory officials, responsible for monitoring, enforcement, and system design

Failure emerges not from any single actor, but from misalignment across these levels.

As the analysis relies on self-reported observations collected through a structured questionnaire, the findings reflect perceived practices, which may differ from directly observed operational behaviour. However, consistent patterns across responses provide indicative evidence of ward-level implementation dynamics.

By explicitly linking institutional capacity and coordination dynamics to observable outcomes in collection practices, the framework enables empirical examination of how and why segregation fails to stabilise in routine urban waste management systems.

Research Methodology

This study adopts an exploratory, multi-city research design to examine implementation dynamics in urban solid waste management (SWM) at the ward level. The focus is on the segregation and primary collection stage, where households interact directly with municipal or contractor-led collection systems. The study analyses how institutional capacity constraints and coordination gaps shape the preservation of segregation during routine collection.

The unit of analysis is the ward-level segregation–collection interface, defined as the point at which waste moves from households to collection systems. The analysis focuses on three operational dimensions: (i) household segregation practices at source, (ii) handling of segregated waste during collection, and (iii) infrastructural and supervisory conditions influencing the preservation of segregation. Downstream processes such as recycling, processing, and landfill management are not examined.

Data were collected through a structured primary survey administered via an online questionnaire (Google Forms), generating a total of 91 responses. The responses were collected across multiple urban locations in India, including cities such as Mumbai, Pune, Gurugram, New Delhi, Hyderabad, Ahmedabad, Kolkata, Howrah, Bhubaneswar, Cuttack, Noida, Thrissur, and others, capturing variation across metropolitan and non-metropolitan administrative contexts. The sample includes cities from multiple states, reflecting diversity in local governance structures and service delivery conditions.

The survey instrument was designed to capture observable practices rather than perceptions. Key variables measured include: frequency and type of household segregation (wet–dry, multi-stream, or none), mode of waste handover, whether segregation is preserved or mixed during collection, type of collection system (municipal staff or private contractors), availability of separate bins, presence and frequency of monitoring or supervision, condition of secondary aggregation points, and factors influencing continuation or discontinuation of segregation behaviour. Respondents were also invited to provide brief observational descriptions to supplement structured responses. All responses were anonymised, and no personally identifiable information was collected.

The analysis adopts a qualitative, pattern-based approach. Descriptive distributions are used to identify recurring trends across responses without attempting statistical generalisation. Open-ended observations are used to provide contextual depth and support interpretation of patterns. Findings are interpreted in relation to policy mandates under the Solid Waste Management Rules and existing literature on institutional capacity and coordination.

This study is exploratory and does not claim national representativeness. The sample is network-based and relies on self-reported observations collected through an online survey instrument, which may introduce response bias and limit representativeness across socio-economic and geographic contexts. In addition, the absence of direct field observation constrains verification of reported practices. However, the multi-city scope and focus on operational processes provide meaningful insight into ward-level implementation dynamics.

Empirical Findings: Reproducing the Implementation Gap at the Ward Level

Segregation at Source

Segregation at source constitutes the foundational step in the urban solid waste management chain, as it determines the effectiveness of downstream processes such as collection, transportation, and processing. The empirical findings, however, indicate that this stage is characterised by uneven adoption and significant behavioural variability.

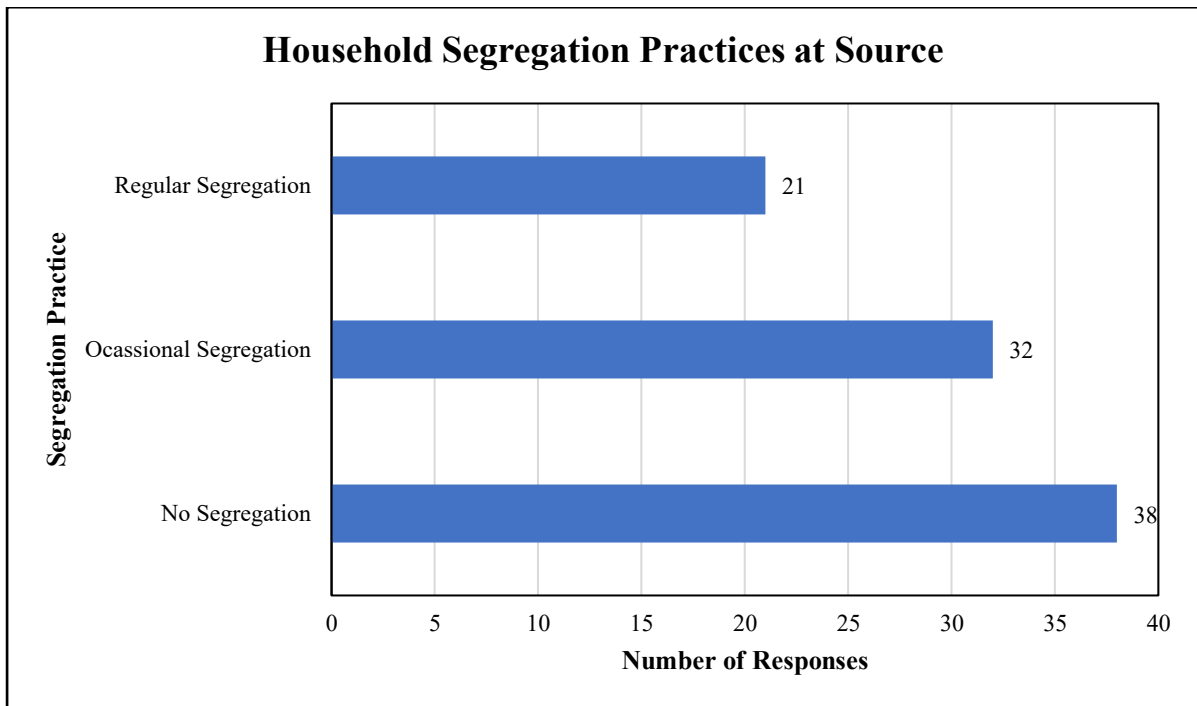


Figure 1. Household segregation practices at source reported by respondents

Figure 1 indicates that only a limited proportion of households report regular segregation (21 responses). A larger segment engages in occasional segregation (32 responses), while the largest group does not practice segregation at all (38 responses). This distribution shows that segregation remains fragmented and inconsistently practiced across households, with no clear evidence of stabilisation as a routine behaviour.

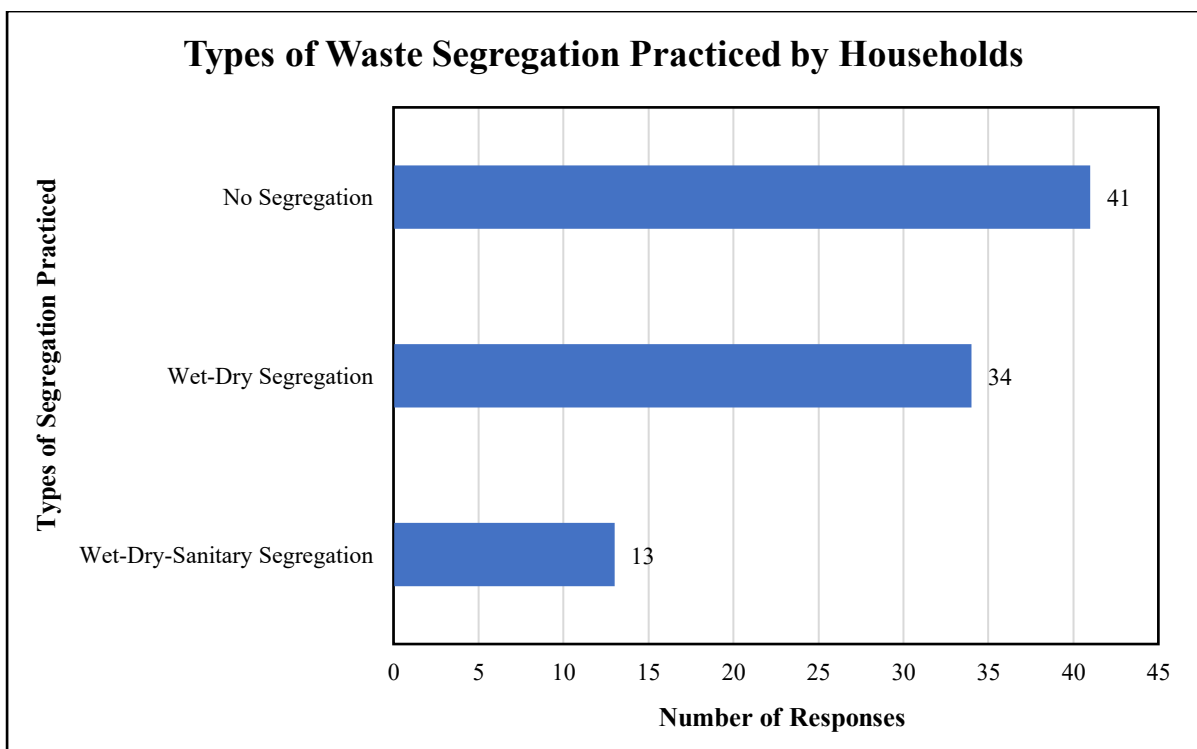


Figure 2. Types of waste segregation practiced by households

Figure 2 further shows that among households reporting segregation, the dominant practice is basic wet–dry separation (34 responses), while a smaller proportion reports additional segregation of sanitary waste (13 responses). At the same time, a substantial share of respondents reports no segregation, with waste handed over in mixed form. Even where segregation occurs, it remains limited in scope and falls short of the multi-stream framework envisaged under national regulations.

Taken together, these findings indicate that segregation at source remains behaviourally fragile. Although mandated by policy, it has not been institutionalised as a consistent household practice. This fragility becomes critical as waste enters the collection system, where the preservation of segregation determines the viability of downstream processing.

Collection-Stage

The collection stage represents a critical interface between household-level practices and the formal waste management system. While it is expected to reinforce and sustain segregation achieved at source, the empirical findings suggest a disconnect between service coverage and procedural integrity.

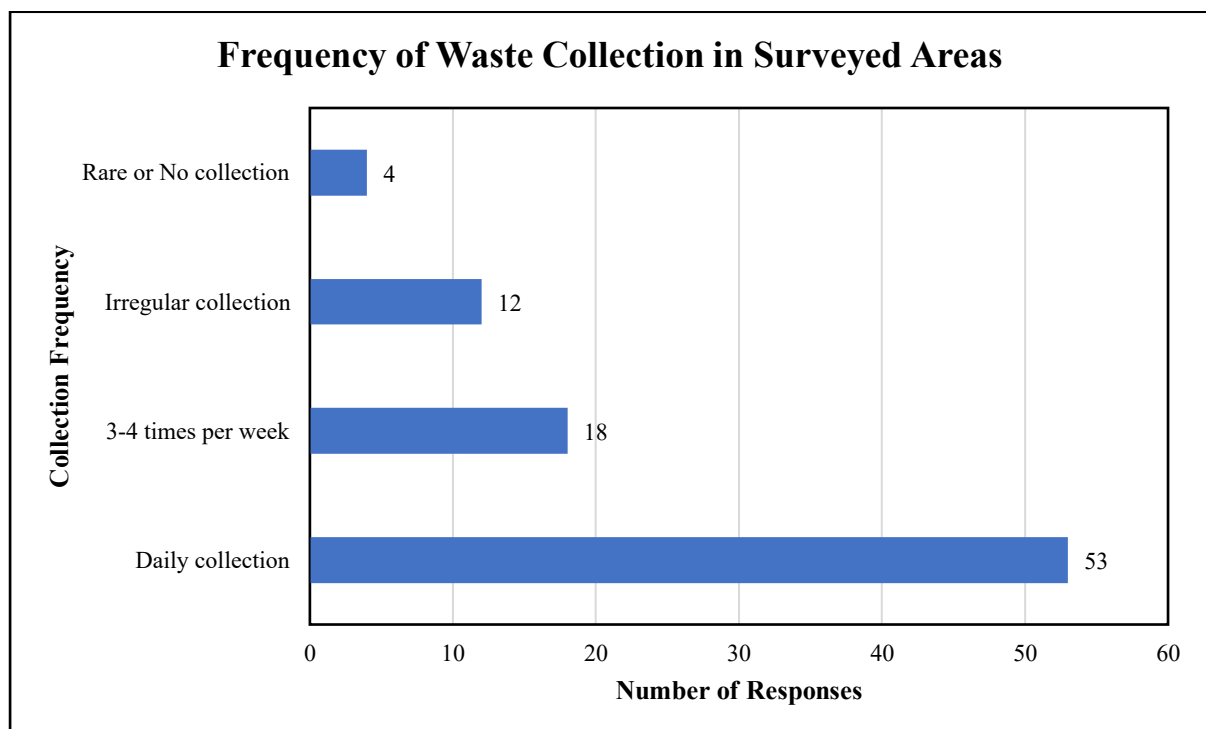


Figure 3. Frequency of waste collection in surveyed areas

Figure 3 indicates that waste collection services are widely operational. A majority of respondents (53 responses) report daily collection, while 18 responses indicate collection occurring three to four times per week. Only a small proportion experience irregular (12

responses) or minimal/no collection (4 responses). This suggests that collection systems demonstrate substantial operational coverage.

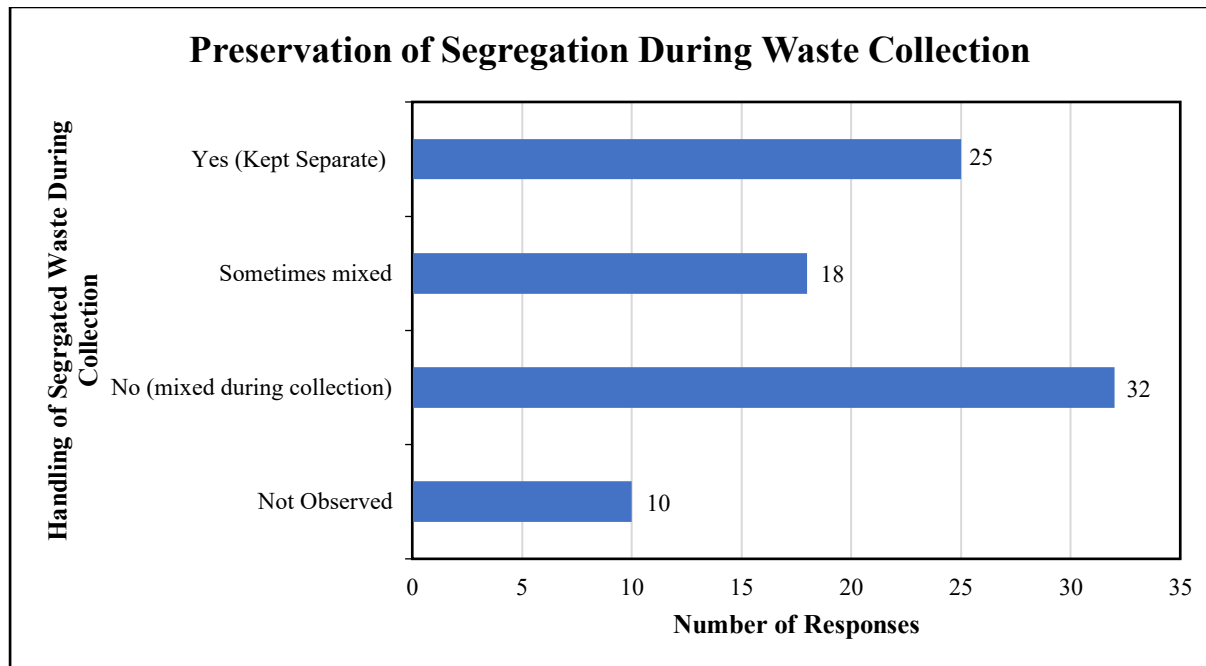


Figure 4. Preservation of segregation during waste collection

However, Figure 4 highlights a breakdown in segregation preservation. The largest group of respondents (32 responses) report that waste is mixed during collection, effectively negating household-level segregation. An additional 18 responses indicate occasional mixing, pointing to inconsistency in collection practices. Only 25 responses report consistent preservation of segregation, while 10 respondents indicate limited visibility.

These findings reveal a structural misalignment between service delivery and procedural compliance. While collection systems are active, they do not consistently uphold segregation mandates. The collection stage thus functions primarily as a logistical removal mechanism rather than a regulatory interface ensuring quality and compliance. This results in a pattern that can be characterised as “coverage without preservation.”

Institutional Capacity

Institutional capacity plays a key role in shaping implementation outcomes beyond household behaviour, particularly through infrastructure and supervisory mechanisms.

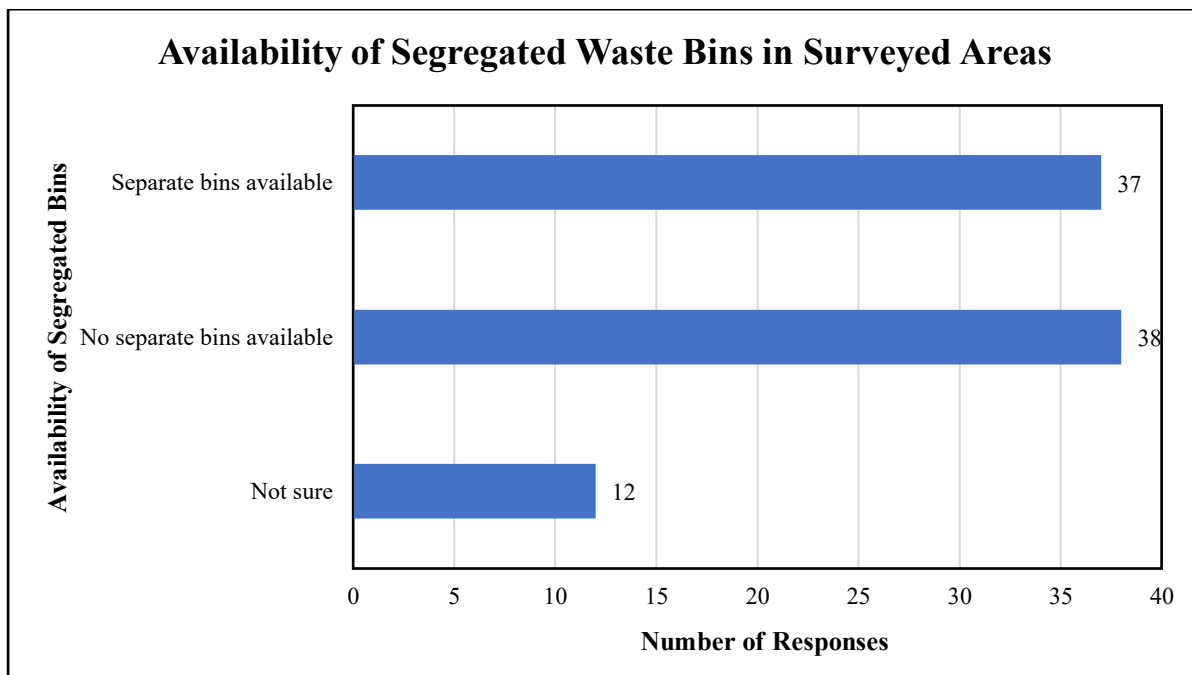


Figure 5. Availability of segregated waste bins in surveyed areas

Figure 5 indicates that access to segregated waste bins is uneven, with 38 respondents reporting no availability, 37 reporting access, and 12 remaining uncertain. This suggests that basic infrastructural support for segregation is inconsistent across contexts.

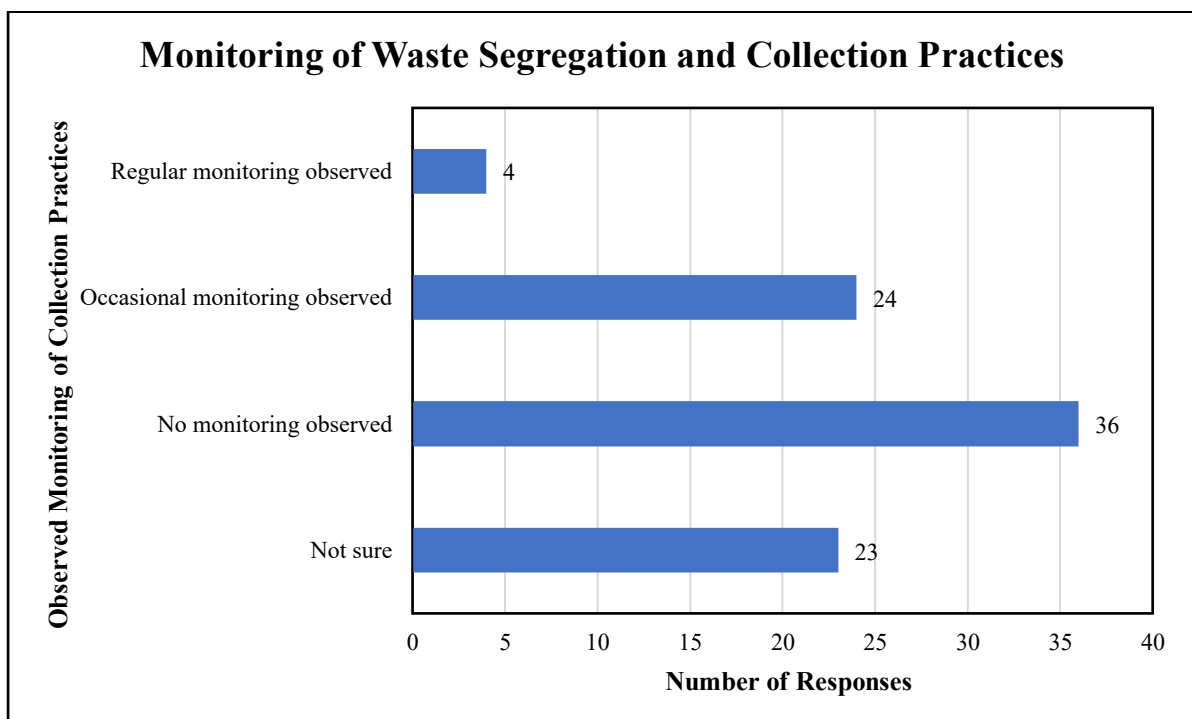


Figure 6. Observed monitoring of waste segregation and collection practices

Figure 6 further indicates weak supervisory enforcement. A majority of respondents (36) report no monitoring, while 24 observe only occasional monitoring and just 4 report regular oversight.

A significant proportion (23) remain uncertain, indicating low visibility of enforcement mechanisms.

Together, these findings suggest that institutional capacity constraints are not primarily about service absence, but about the adequacy of infrastructure and consistency of supervision required to sustain segregation. Weak provisioning and limited enforcement reduce the system's ability to translate policy mandates into routine practice.

Coordination Across Actors

Waste collection at the ward level involves multiple actors, including municipal staff, private contractors, and, in some cases, informal arrangements. The findings indicate that this multi-actor structure introduces coordination challenges.

Figure 7 shows that a majority of respondents (47) identify municipal staff as primary collectors, while a substantial proportion (24) report private contractors operating under municipal oversight. A smaller segment (13) is unaware of who collects waste, and a few cases indicate irregular arrangements.

This distribution reflects a mixed institutional system. While such arrangements may support service coverage, they also create variability in operational practices. Combined with weak monitoring, this suggests fragmented accountability and limited alignment across actors. As a result, inconsistencies in segregation preservation may arise not only from operational constraints but also from coordination gaps within the system.

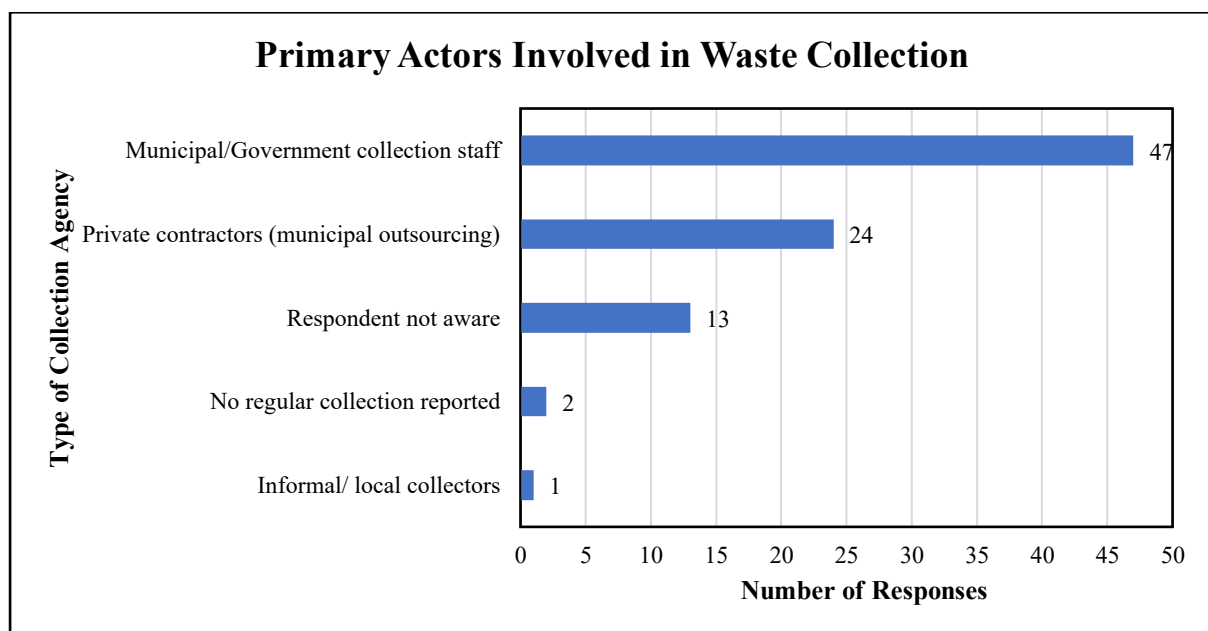


Figure 7. Primary actors involved in household waste collection

Behavioural Feedback

Household segregation behaviour appears shaped not only by awareness but by feedback from the system itself.

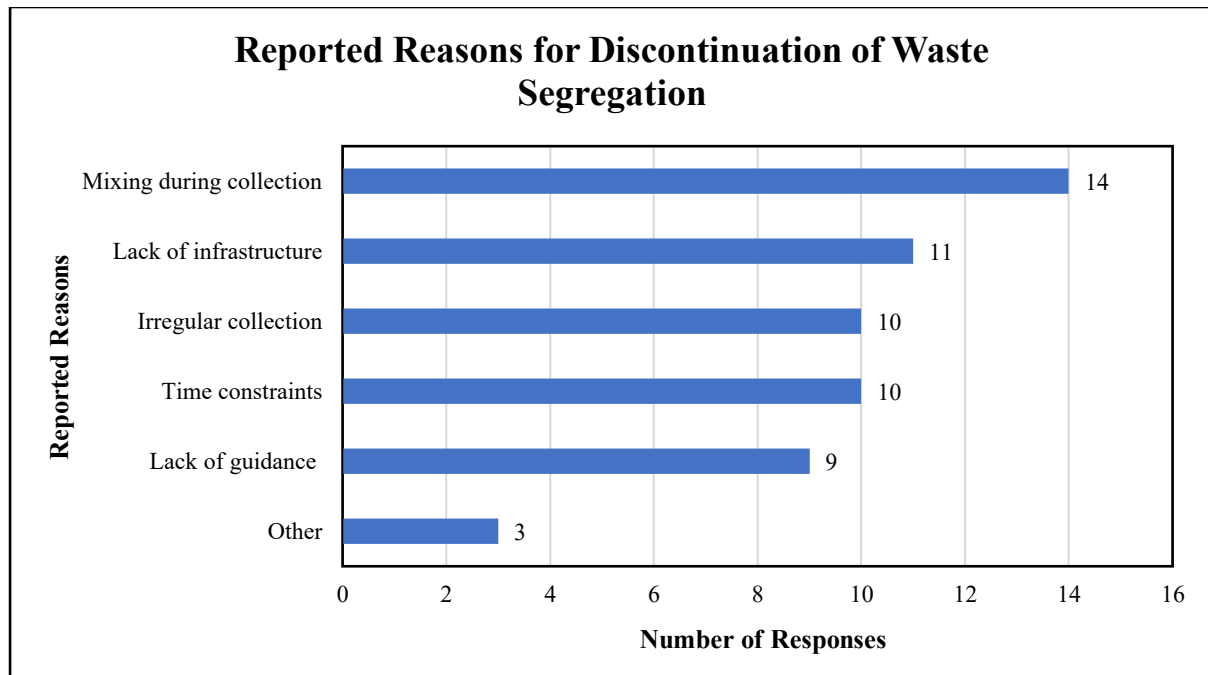


Figure 8. Reported reasons influencing household segregation behaviour

Figure 8 indicates that the most frequently cited reason for non-compliance is mixing during collection (14 responses), suggesting that household efforts are often undermined. Other factors include lack of infrastructure (11 responses), irregular collection (10), time constraints (10), and lack of guidance (9).

These patterns suggest that non-compliance reflects behavioural erosion driven by weak institutional support. When segregation is not preserved or facilitated, households have reduced incentive to sustain the practice. Behaviour, therefore, responds dynamically to perceived system credibility.

Synthesis

Across urban contexts, a consistent pattern emerges. Segregation at source exists but remains uneven, while collection systems are active and regular. However, segregation systematically breaks down at the collection stage, shaped by infrastructural gaps, weak supervision, operational pressures, and coordination failures.

This indicates that implementation failure does not arise from the absence of policy or service provision, but from dysfunction at the segregation–collection interface. In this context, segregation fails to stabilise as a sustained practice, as household efforts are not reinforced by institutional processes.

The findings thus resolve the research puzzle: despite formal mandates and routine collection, ward-level dynamics undermine the preservation of segregation, producing a self-reinforcing implementation gap in everyday waste management.

Cross-City Analysis: Consistency and Variation Across Urban Contexts

Across the surveyed urban contexts, a broadly consistent pattern emerges in the functioning of the waste management system. While the degree of segregation at source varies across areas, it remains uneven in most cases, with only partial and irregular compliance. At the same time, collection services are largely operational, indicating that basic service delivery is present across locations.

Despite these variations, a common outcome is observed: segregation frequently fails to be preserved during collection. This breakdown is linked to similar constraints across contexts, including uneven infrastructural support, limited monitoring, and coordination challenges among actors. While the intensity of these factors may differ across areas, their combined effect produces comparable implementation outcomes.

Thus, the evidence suggests that the implementation gap is not location-specific but reflects a broader systemic pattern where similar institutional and operational constraints shape outcomes across urban contexts.

Discussion

The findings of this study shift attention from macro-level explanations of implementation failure to the operational dynamics of service delivery at the ward level. While existing literature has highlighted financial, institutional, and governance constraints in urban solid waste management (Joshi & Ahmed, 2016; Kumar et al., 2017), the empirical evidence from this study demonstrates that implementation breakdown is reproduced within routine collection practices, particularly at the interface between households and collection systems.

Survey responses indicate that although a section of households report practicing segregation, a substantial proportion of respondents observe that waste is mixed during collection. This suggests that behavioural compliance at the household level is not consistently matched by collection-stage practices. The persistence of mixing, despite the presence of regular collection systems, points to a breakdown in the preservation of segregation rather than a failure of service provision per se.

For instance, respondents from Howrah and Bhubaneswar reported that segregated waste handed over in separate containers was routinely combined into single collection vehicles,

indicating the absence of compartmentalised infrastructure. Similarly, in Gurugram and Pune, respondents noted limited or no supervisory presence during collection rounds, with mixing occurring despite regular service coverage. These ward-level observations illustrate how segregation breakdown is reproduced within routine collection practices.

This reframes implementation failure not as a consequence of policy absence, but as a process shaped by the interaction between institutional capacity and coordination. Where infrastructural provisions such as compartmentalised vehicles and separate bins are limited, and where monitoring is weak or absent, collection systems are unable to handle segregated waste effectively. At the same time, coordination gaps between households and collection actors result in segregated waste being mixed during handover or transport. The combined effect is a breakdown of segregation integrity at the ward level.

The findings also contribute to the literature on multi-actor governance by demonstrating that coordination gaps are not only administrative but operational in nature. While prior studies emphasise fragmented accountability at higher levels ([Marshall & Farahbakhsh, 2013](#); [Wilson et al., 2015](#)), this study shows that misalignment between household behaviour and frontline collection practices generates a feedback loop that weakens compliance over time. When households repeatedly observe that segregated waste is mixed during collection, the perceived value of segregation declines, leading to gradual behavioural erosion. Non-compliance thus emerges as an outcome of system-level inconsistency rather than a lack of awareness alone.

At the ward level, this dynamic reflects the interaction between three sets of actors. Households initiate segregation, frontline workers and contractors manage collection, and municipal authorities are responsible for supervision and system design. Implementation failure arises when these actors are not aligned: when households segregate but collection systems do not preserve it, or when supervisory mechanisms fail to enforce compliance among collection staff. The problem is therefore relational rather than actor-specific.

Comparative cases reinforce this interpretation by illustrating how institutional design can sustain segregation integrity. In Indore, the use of compartmentalised collection systems combined with on-ground supervision has reduced mixing during collection ([Indore Municipal Corporation, n.d.](#)). Hyderabad's deployment of GPS-tracked vehicles and monitored routes enhances accountability in waste transport ([Greater Hyderabad Municipal Corporation \[GHMC\], 2024](#)). Similarly, Seoul's pay-as-you-throw system integrates economic incentives with continuous monitoring to reinforce compliance ([City of Seoul, 2017](#)). These cases indicate that preservation of segregation depends less on awareness and more on system design,

particularly the alignment of infrastructure, monitoring, and incentives at the point of collection.

At a broader level, the findings suggest that urban SWM systems in India currently function more effectively as mechanisms of waste removal than as integrated waste management systems. While waste is regularly cleared from neighbourhoods, the institutional processes required to sustain segregation and enable recovery remain uneven. This distinction highlights the importance of strengthening the segregation–collection interface as a critical site of policy implementation.

This study is exploratory and based on self-reported survey data collected through a structured questionnaire, which limits statistical generalisability and may reflect perception-based biases. It does not incorporate administrative datasets or longitudinal observation. Future research could integrate ward-level operational data, direct field observation, and time-series analysis to examine how institutional capacity and coordination dynamics evolve over time.

Conclusion

Urban solid waste management in India operates within a regulatory framework mandating segregation at source and its preservation through collection. This study shows that implementation breakdown occurs at the ward-level interface where household practices meet collection systems, rather than due to absence of policy or service provision.

Across urban contexts, segregation remains uneven and is frequently not preserved during primary collection. Survey evidence across multiple wards indicates persistent mixing despite household efforts, reflecting a failure in the preservation stage of the waste management chain. This breakdown is driven by infrastructural gaps, weak supervision, and misalignment among households, collection workers, contractors, and municipal supervisors, leading to behavioural erosion over time.

Addressing this requires embedding accountability within routine operations. A **ward-level, citizen-verified reporting platform** can link instances of mixing to specific collection routes and contractor performance. A **segregation integrity index** can rank wards based on both household compliance and collection-stage preservation. **Collective incentives**, such as user fee rebates or neighbourhood-level recognition, can reinforce compliance through visible feedback.

These mechanisms enable continuous, decentralised monitoring and align actors at the point of collection, making segregation preservation enforceable in practice. As findings are based on

self-reported observations, they reflect perceived practices and may not fully capture actual operational behaviour.

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