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Urban Waste Management: An Empirical Assessment of Household Recycling Behaviours under National Program Swachh Bharat Abhiyan

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Abstract:

Effective solid waste management (SWM) is an important pillar of urban economic sustainability and resource efficiency. This study evaluates household waste segregation and recycling practices within the framework of India's national Swachh Bharat Abhiyan (SBM) program. Utilizing primary survey data from 600 households in urban and peri-urban locations, the research investigates the disconnect between high public awareness and low rates of actual segregation behaviour. Through a descriptive-analytical framework, the study identifies socio-economic barriers, including lack of infrastructural incentives and perceived low economic value of waste, that hinder the transition to a circular economy at the household level. The findings provide evidence-based policy recommendations for municipal authorities to optimize resource recovery and reduce the financial burden of waste disposal through targeted economic incentives and improved source-segregation logistics.

Keywords: waste segregation, recycling, Swachh Bharat Abhiyan, circular economy, urban economics, household behaviour.

JEL Classification: O53; Q21; D12; H72; O13.

Introduction

Segregation of household waste and its recycling are the basis to sustainable urban governance and environmental control, especially in the framework of fast-growing cities and towns in India. Swachh Bharat Abhiyan (Clean India Mission), a national programme initiated by the Government of India in 2014, has put municipal solid waste management (MSWM), which puts special attention upon source segregation (wet, dry, and hazardous waste) and door-to-door collection and scientific processing as the key to creating 100% clean cities (MoHUA, 2016; ImPRI Insights, 2025). Swachh Bharat Mission (SBM)- Urban and Rural, are both aimed at institutionalizing responsible waste management by engaging households in direct activity of segregation and recycling of wastes with the goal of delivering better environmental results and human health outcome.

Although policy frameworks and enforcement mechanisms have been in place, actual transfer of the segregation norms to the household practices is uneven. National cleanliness surveys carried out within Swachh Survekshan provide examples of existing gaps: lots of cities

report a high level of structured waste management, however, source segregation falls behind collection and processing indicators, and some cities also report a lower percentage of waste segregated at the source despite high door to door coverage (OpenCity, 2025). Socio-economic conditions, the level of knowledge, and the mechanisms of institutional support that differ in many parts determine the household awareness and the practice of segregation.

Empirical evidence of cities in South India shows that despite households being conscious of segregation norms, the practice is affected by demographic variables (e.g., age, education, income) and the availability of civic services (Abhiharshan and Samudyatha, 2025). Equally, the determinants of segregation practices in households in the urban areas like Delhi have also been analysed, and the results indicate that environmental awareness and perceived convenience of segregation also play a crucial role in compliance (Kaur and Kaur, 2024). Therefore, household behaviour is another important aspect that should be understood to determine the viability of the waste management element of SBM.

Household-level recycling, though conceptually consistent with segregation, is also likely to be under-studied in macro-assessments. The level of segregation and the presence of the infrastructure that would direct the segregated materials to the right value chains are determinants of the recycling practices. It also involves incorporation of the actors in the informal sector and decentralised composting or material recovery units that have been reported to increase effective recycling when integrated with the household programs (NITI Aayog, 2021). Thus, the household waste management needs to be thoroughly assessed in the areas of not only segregation but also the involvement in and results of the further recycling.

Problem Statement

The Swachh Bharat Abhiyan policy ambition is based on the vision of full-scale adherence to household waste separation and the subsequent recycling, but the experience of the field indicates that the overall implementation is still concerned with difficulties. Although formal waste regulations (SWM Rules 2016) require a source segregation and a scientific processing, households often demonstrate the inconsistent or partial compliance with them because of the lack of awareness, an attitudinal tendency, and limitations of the infrastructure. As an example, the data of national surveys show that the coverage of door-to-door collection can be almost complete in most cities, but the source segregation is not usually comparable (OpenCity, 2025). This lack of connection compromises recycling systems with the result of contaminated wastes streams and a decrease in the material recovery.

According to secondary data and local research findings, the actual waste segregation behaviour is much influenced by such factors as socio-economic status, reliability of civic service, and perceptions related to behaviour. Even though the information campaigns and regulating guidelines have been maintained, residential behaviour has been a weak link in the waste management chain and it is undermining the mission goal of attaining sustainable sanitation and circular use of resources. The absence of systematic evaluation at household level prevents the evidence-based policy changes that can be more effective in aligning the community behaviour with the targets of national waste management in the context of SBM.

Aim and Objectives of the Study

The proposed study will evaluate the prevailing circumstances, predictors, and obstacles of house waste separation and recycling in the context of Swachh Bharat Abhiyan in the sampled urban and semi-urban locations in India.

Objectives:

O1: To measure the knowledge of households on waste segregation rules stipulated in SWM Rules and SBM programmes.

O2: To evaluate the real household behaviour in terms of waste separation and involvement in recycling or composting behaviour.

O3: To determine socio-economic, institutional and behavioural issues that control compliance and non-compliance of segregation norms.

O4: To analyse the congruence between the national policies and the real-life household practices and propose policy changes.

Research Questions

The research questions that will be used in this study are:

RQ1: How much do households understand the required norms of waste segregation under Swachh Bharat Abhiyan and the SWM Rules, 2016?

RQ1: What is the extent of segregation of sources and recycling or composting activities by households living in selected urban and semi-urban regions?

RQ1: How are socio-economic, behavioural and institutional factors related to the household compliance and non-compliance to the waste segregation and recycling practices?

RQ1: To what extent do the municipal waste management systems facilitate household segregation and recycling?

1. Literature Review

Kumar et al. (2024) reviewed the contribution of Swachh Bharat Mission as a holistic reform agenda that will help to reform municipal sanitation and waste management in India. They point out in their analysis that SBM incorporates sanitation, behavioural change and solid waste management to promote not only community but household level participation that is key to source segregation and effective recycling infrastructure. In the study, it is highlighted that even with good intentions of policies, there are practical gaps in ensuring that a national directive is translated into a local uptake of behaviour particularly in terms of household waste management practices.

Kaur et al. (2023) and Kaur and Kaur (2024) concentrated on the structural factors influencing the household waste segregation in India by conducting an empirical investigation of more than 700 households. Their results indicate that environmental consciousness and certain knowledge on the segregation practices are significant predictors of household adherence to the segregation practices. They state that despite the existence of waste governance frameworks, lack of behavioural knowledge and clear guidance on implementation at household level is a major limiting factor to the adoption of best practices.

Kapoor and Chakma (2024) included an institutional analysis of municipal solid waste management in India and proved that the city with a strong organizational capacity, monitoring, and segregation rule enforcement, and the active involvement of citizens indicate a high degree of source segregation rate. They also stress that decentralized governing and good local leadership is necessary when it comes to converting the national policies under SBM into tangible household behaviour transformation.

Sahoo et al. (2022) examined motivational, opportunity, and ability variables, which play a role in the household waste segregation behaviour in Ujjain city in Central India. Their results suggest that, although most households are driven to separate wastes, they do not always have the regular opportunity (e.g., convenient infrastructure) and capacity (e.g., knowledge and skills) to perform such a task regularly. The researchers state that the integration of self-help groups and the localized education can be considered as the key facilitators to enhance solid waste segregation literacy among households.

Another article, written by Kaur and Kaur (2024) has also contributed to the understanding of the determinants of behaviour as household size, level of education, and income play a significant role in determining segregation behaviour. Their study proposes that better educated households with a higher rate of environmental awareness (through formal education and exposure to public campaign) have a higher degree of segregation practice when compared to households that were not exposed to the campaign. They also posit that knowledge de-mystification is important to justify actual adoption of the segregation behaviour.

Basistha et al. (2024) researched the discrepancy between stated intention to segregate waste and behaviour in urban India. They discovered that although a lot of households' express intentions to participate in the segregation, the structural constraints, such as lack of uniform collections and access to recycling facilities undermine this intention-behaviour relationship. They refine this detachment as the so-called contribution action gap that leads to the necessity of a joint social facilitation and municipal responsibility system.

The study by Abhiharshan and Samudyatha (2025) is a quantitative cross-sectional study carried out in South India, which investigated the relationship between household demographic profiles and solid waste practices. Their findings indicate that more than 60 percent of the households who were surveyed use waste bins, though most of them do not segregate appropriately at the source. The research mentions education and awareness initiatives about civic behaviours as effective factors increasing the adherence to the waste segregation rules, especially in urban settings when the role of municipal involvement is more prominent.

ImPRI Insights (2025) examined the way the recycling systems are combined with national sanitation campaigns, such as SBM. They point out that recycling processes, particularly at the decentralized levels require good segregation practice at the household level so as to have clean recyclable streams. Moreover, the literature focuses on the contributions of informal sector staff, including waste pickers and small-scale recyclers, to supplementary formal systems with households supplying segregated dry wasted materials, which are then redirected to the recycling channels.

In their empirical results, Abhiharshan and Samudyatha (2025) observed that in the situations where segregated waste is practiced by households, only a part of the dry waste goes into systematic recycling systems because of fragmented connections among households and recycling facilities. This brings out the importance of the fact that recycling as

a sustainable measure must not only be a change in household behaviour but also stable collection-processing channels that will connect segregated waste to formal recycling markets.

The Perspective of Service Providers and Program Managers (Sahoo et al., 2024) studied findings of waste service providers regarding the interaction between household segregation and recycling activities and the urban waste management system. Providers noted that lack of uniform participation of households, poor informatics in tracking segregated waste, and poor incentives at the local level on recycling activities are some of the major constraints to uptake recycling. These aspects diminish the ability of the municipal organizations to direct isolated materials into successful recycling channels.

New studies concerning the waste segregation behaviour (such as studies by Sahoo et al., 2022; Basistha et al., 2024) continue to record that behavioural determinants are gaining more knowledge, but still, little information has been conducted on how the behavioural determinants interplay with the macro-level policy cycles such as Swachh Bharat Abhiyan. The lack of studies, which bridge between micro-behavioural factors (e.g., motivation and ability) and macro governance systems and decentralized recycling infrastructure, is also noteworthy. Combined studies across behavioural science, urban government, and social-economic investigation are limited.

Moreover, the comparative studies between urban, peri-urban, and rural settings are not well represented, even though they have different infrastructures and socio-demographic statuses that might contribute to changing household practices. There are also gaps in discussing the long-term sustainability of behaviour change, especially with respect to the phase that follows the initial awareness initiatives and the way in which behavioural initiatives may become integrated in the policy frameworks of the municipalities.

1.2. Research Methodology

The research design used in this paper is a descriptive analytical research design to evaluate the household waste segregation and recycling under Swachh Bharat Abhiyan. Descriptive research will be suitable to describe existing phenomena, i.e., the levels of awareness, behaviour, and barriers among households, and not manipulating variables (Creswell and Creswell, 2018). The analytical part will also entail the study of correlations among socio-demographic variables (e.g., education, income) and the household practices to get a better insight into the determinants of segregation and recycling behaviour.

It uses a cross-sectional methodology, gathering data at given moment in time in order to give an overview of household practices and perceptions. In solid waste management studies, cross-sectional surveys are highly applicable in the production of baseline data on the basis of which a policy and municipality interventions can be drawn (Babbie, 2020). The data obtained by means of the structured questionnaires in the households will be triangulated with the data on municipal waste in order to validate them. Analytical tests in the form of chi-square and regression combined with descriptive statistics will increase the ability of the study to find significant predictors of segregation and recycling behaviours (Bryman, 2021).

Data Sources

This study will use a household survey as the main source of primary data that will be conducted on the citizens of selected urban and peri-urban areas. Primary surveys can directly measure behavioural practices, perceptions, and self-reported adherence to the standards of segregation and recycling (Moreno Solaz et al., 2023). The data will be gathered using

structured questionnaires that will capture information along four main dimensions, that is, awareness of waste segregation rules under Swachh Bharat Abhiyan, actual segregation behaviour, recycling participation, and perceived barriers.

Besides primary data, secondary data will be retrieved in the form of municipal solid waste management report, Swachh Survekshan performance indicators, and official SBM documentation. Secondary records are used to be able to contextualize and benchmark the performance of the primary surveys with the larger city-wide results (MoHUA, 2016; OpenCity, 2025). The use of both primary and secondary sources will guarantee a mixed-data framework, which will increase validity and policy relevance.

Field visits and participant observation will help in the collection of data by checking the infrastructure availability (e.g., the availability of segregated bins and collection vehicles). These observational checks enhance the credibility of the self-reported data, since they help to record the misalignment between the reported and actual practices (Gupta et al., 2025).

Sampling and Variables

The sampling methodology will be a multi-stage sampling method to assure representativeness in the study region. To begin with, purposive sample will be used to select urban wards or municipalities that will be the subjects of Swachh Survekshan performance and demographic diversity. Simple random sampling in each of the selected wards will be used to select households. The size of the target sample is 600 households based on the balance between analytical power and resources, and it was with reference to the sample sizes of similar studies that utilized waste practises with a sample size of between 250 and 708 households (Kaur et al., 2023; Jain et al., 2025).

The most important independent variables are the socio-demographic factors (age, gender, education, income), the level of awareness, and accessibility to municipal services. Dependent variables include household waste segregation (e.g., into wet/dry bins), and recycling (composting, hand over recyclables). Other control variables like bins availability and collection frequency will also be taken into account to moderate the service-level variations.

Data Analysis and Analytical Framework.

The analysis of data will take place in three steps. To begin with, descriptive statistics (frequencies, percentages, means) will be used to describe the household characteristics, awareness levels, and the rate of segregation and recycling behaviours. Descriptive analysis helps in achieving a baseline insight and determining trends like the percentage of households engaging in regular segregation (Gupta et al., 2025).

Second, the chi-square tests and t-tests are going to be used in bivariate analysis to review the relationships between socio-demographic variables and household practices. Such tests are useful in finding out whether key variables like education level or reliability of municipal services play a significant role in household compliance. Third, the multivariate regression analysis will be used to determine the most critical predictors of effective segregation and recycling behaviour and conditional upon confounding factors (Moreno Solaz et al., 2023).

Any statistical analysis will be done with the help of SPSS or any other software and any results will be understood at a significance level of $p < 0.05$. Thematic analysis of qualitative data will be done on the open-ended survey responses to complement the quantitative results.

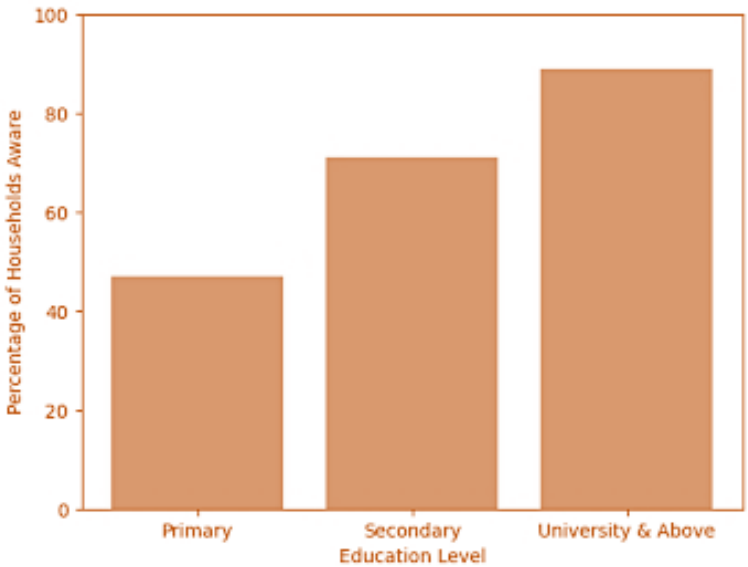
2. Findings and Analysis

This section presents empirical evidence derived from the household survey (N = 600) conducted across selected urban and peri-urban areas. The analysis progresses from awareness to behavioural implementation, recycling participation, structural barriers, and institutional mediation effects.

Overall awareness of source segregation under Swachh Bharat Abhiyan (SBM) is relatively high. As illustrated in Figure 1, 76% of respondents report familiarity with basic segregation categories (wet and dry waste), indicating effective penetration of awareness campaigns.

Figure 1 represents general awareness of households. About 76% of the interviewees reported to be aware of what waste segregation means and they identified it as wet and dry waste at the domestic level. The findings are in line with the current national data reporting indicating that approximately 39.9% of households separate their waste into biodegradable and non-biodegradable waste and 92.7% of the households have organized their waste disposal to organic waste (Press Information Bureau, 2025). The awareness level of households regarding waste segregation is shown in reference to Figure 1.

Figure 1: Bar Chart of Categories of Awareness



Source: Authors' survey (2025).

However, awareness is strongly differentiated by educational attainment (Table 1). Households with university-level education exhibit significantly higher awareness (89%) compared to those with only primary education (47%). A chi-square test confirms a statistically significant association between education level and awareness ($p < 0.05$). This finding supports prior literature emphasizing the role of formal education in facilitating environmental norm internalization (Kaur et al., 2023; Sahoo et al., 2022)

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Table 1: Household Awareness of Waste Segregation by Education Level

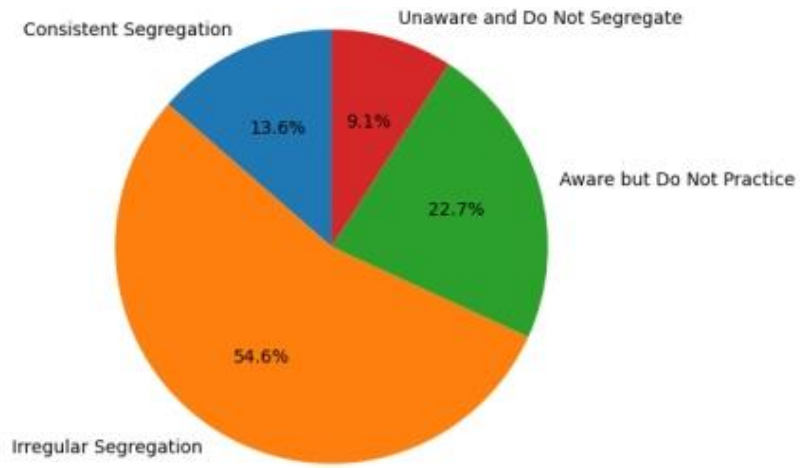
Education Level	Aware (%)	Partially Aware (%)	Unaware (%)
Primary	47	32	21
Secondary	71	19	10
University	89	7	4

Note: Data from structured household surveys (2025).

Despite high aggregate awareness, qualitative responses suggest that informational clarity regarding specific segregation categories remains uneven, indicating that cognitive awareness does not automatically translate into procedural understanding.

While awareness levels are substantial, behavioural consistency remains limited. As shown in Figure 2, only 13.6% of households report consistent multi-stream segregation. A further 4.5% segregate irregularly, 22.7% are aware but do not practice segregation, and 9.1% remain both unaware and non-compliant.

Figure 2: Patterns of Household Segregation Behaviour



Source: Authors' survey (2025).

These findings confirm the presence of an awareness–action gap, consistent with contribution–action literature in urban waste management (Basistha et al., 2024). The gap suggests that behavioural adoption depends on enabling conditions beyond awareness alone.

Beyond segregation itself, recycling participation reflects the depth of engagement with circular economy practices. Table 2 and Figure 3 provide a breakdown of downstream recycling behaviour.

As presented in Table 2, household engagement in downstream recycling activities remains heterogeneous. While 41% of respondents report handing over segregated dry waste to formal collection systems, only 33% compost wet waste at the household level, and 28% sell recyclables to informal collectors. Notably, 31% of households do not participate in any structured recycling practice. These figures indicate that although segregation awareness is relatively widespread, full integration into circular economy practices remains partial and uneven. The relatively higher reliance on informal recyclers underscores the continued importance of informal waste markets in India's recycling ecosystem, consistent with findings by ImPRI Insights (2025) and NITI Aayog (2021). The data suggest that recycling participation is strongly conditioned by accessibility to value recovery channels rather than awareness alone.

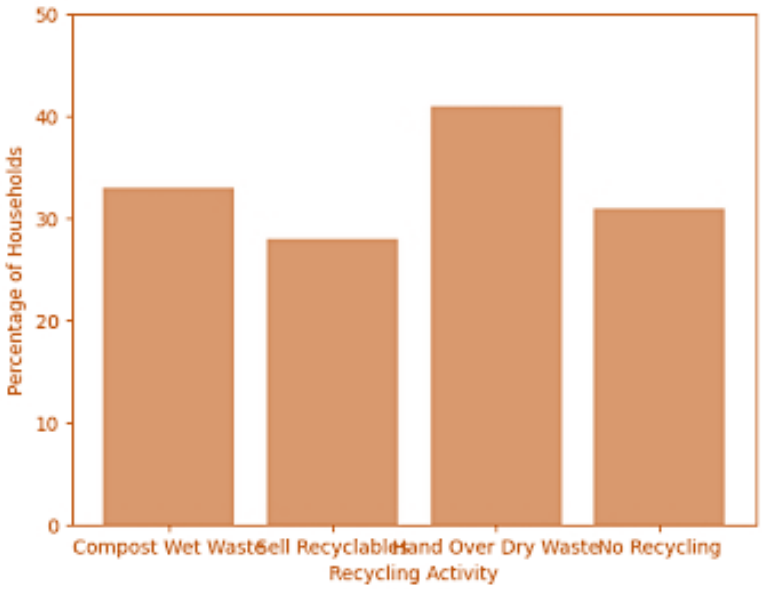
Table 2. Pattern of household recycling participation

Recycling Practice	Percentage of Households
Compost owns wet waste	33%
Sell recyclables to collectors	28%
Hand over segregated dry waste	41%
Do not participate	31%

Note: Survey responses regarding recycling activities (2025).

Figure 3 visualizes household recycling engagement across different waste streams, highlighting variation in participation intensity. While composting of organic waste and sale of dry recyclables to informal collectors represent significant participation channels, a substantial proportion of households remain outside structured recycling systems. The distribution indicates that recycling behaviour is conditional upon both material type and accessibility to recovery networks. The relatively stronger engagement with dry waste markets reflects the economic value embedded in recyclable materials and the operational presence of informal collectors. These findings reinforce the structural dependence of recycling performance on downstream value-chain integration rather than awareness alone, consistent with circular economy frameworks emphasizing system connectivity and material recovery logistics.

Figure 3: Waste by waste recycling

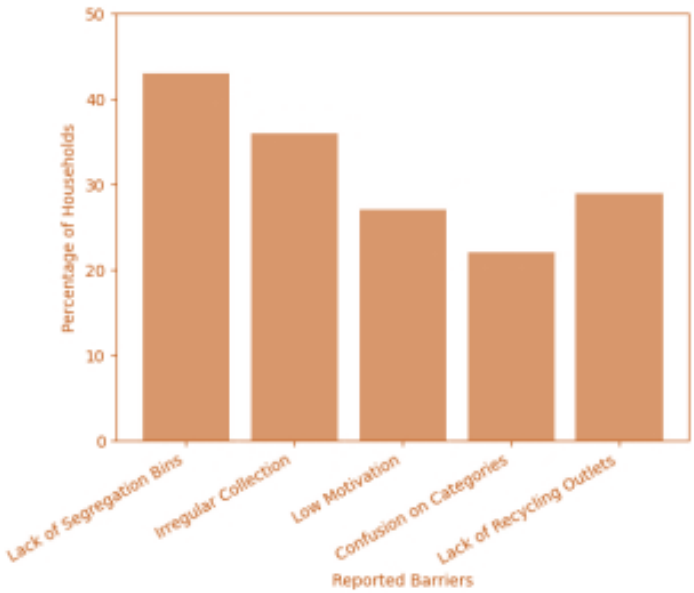


Source: Authors' survey (2025).

The composting households mainly indicated that they produced kitchen and garden wastes. Approximately one-third of households both composted wet waste at home and 28% sold dry recyclables (paper, plastic, glass) to itinerant waste collectors or home re-cyclers. It is interesting to note that 41% said they disposed of some type of segregated dry waste to official collections; 31% said they did not take part in any type of recycling. These reactions are corroborated by works that note that informal waste markets are an important medium of recyclables although there are formal regulations (OpenCity, 2025).

Figure 4 presents the distribution of perceived barriers affecting household segregation and recycling practices. Structural constraints, particularly the lack of segregation containers and irregular municipal services, emerge as dominant impediments. Behavioural and informational factors, such as motivational resistance and confusion regarding waste categories, appear secondary but still significant. The prominence of infrastructural barriers suggests that compliance is strongly mediated by service reliability and system design. These findings align with behavioural-environmental models that posit opportunity structures as a precondition for sustained pro-environmental action. In the absence of reliable collection and processing systems, household motivation alone proves insufficient to sustain consistent segregation behaviour.

Figure 4: Barriers to Segregation and Recycling



Source: Authors' survey (2025).

These are in line with the wider evaluations that poor infrastructure and poor enforcement curtail efficacy of segregation against policy directives. It is reported that mixed waste usually finds its way into the collection cycles and makes household segregation attempts pointless (Popular Waste Segregation Report, 2025).

Table 3 provides a structured breakdown of the principal barriers affecting household compliance with segregation norms. The most frequently cited constraint is the lack of segregation containers (43%), followed by irregular municipal services (36%) and limited recycling outlets (29%). Behavioural resistance and motivational fatigue account for 27% of responses, while 22% report confusion regarding segregation categories. These results confirm that infrastructural and service-delivery deficiencies outweigh purely informational deficits. The findings reinforce behavioural frameworks proposed by Sahoo et al. (2022), which emphasize that motivation alone is insufficient without opportunity and systemic support. In the absence of reliable collection systems, even well-informed households may disengage from segregation practices, leading to contamination of recyclable streams and inefficiencies in municipal waste processing.

Table 3: Household Barriers to Waste Segregation and Recycling

Barrier Category	Frequency (%)
Lack of segregation containers	43%
Irregular municipal services	36%
Low motivation/behavioural resistance	27%
Confusion on segregation categories	22%
Lack of recycling outlets	29%

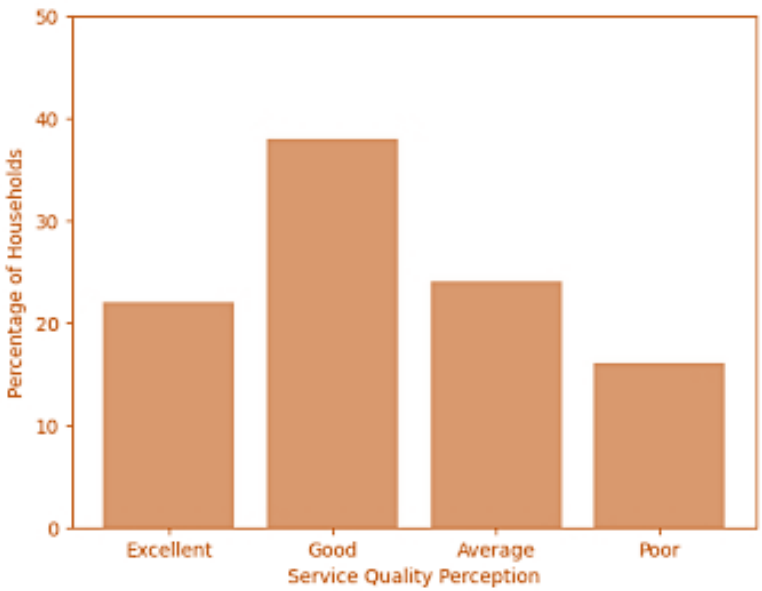
Interestingly, one of the qualitative recurrent themes was that although households segregate waste at source, the waste collectors occasionally segregated waste on transit, deteriorating further segregation (Panchkula case reports, 2025).

The practices in households are affected by the municipal support systems. Regular door-to-door collection by the municipal and responsive feedback mechanisms were highly linked to increased segregation and recycling rates.

The identified barriers (Figure 4) suggest that institutional performance may play a mediating role. This hypothesis is examined further through service quality evaluations presented in Figure 5.

Figure 5 illustrates household evaluations of municipal waste collection service quality. A majority of respondents rate service performance as either “Good” or “Excellent,” while a notable minority report average or poor experiences. The distribution of service quality perceptions provides contextual grounding for subsequent compliance analysis. Institutional reliability and perceived responsiveness appear to play a critical role in reinforcing household engagement in segregation practices. These findings support governance-oriented interpretations of urban waste management, wherein trust in public service delivery enhances behavioural compliance and reduces attrition in environmental participation efforts.

Figure 5: Municipal Collection Service Quality



Source: Authors’ survey (2025).

Institutional performance emerges as a critical mediating factor. Figure 5 presents household evaluations of municipal waste collection services, while Table 4 quantifies the relationship between perceived service quality and segregation consistency.

Households rating services as “Excellent” demonstrate a 42% rate of consistent segregation, compared to only 9% among those rating services as “Poor.” A chi-square test confirms a statistically significant association between service quality perception and segregation compliance ($p < 0.01$).

This pattern indicates that behavioural compliance is strongly conditioned by governance reliability and service responsiveness. Municipal accountability mechanisms, predictable collection schedules, and visible follow-up activities appear to reinforce household participation. The evidence therefore supports a governance-mediated interpretation of waste segregation behaviour: compliance is co-produced by citizen engagement and institutional capacity.

Table 4: Association Between Service Quality and Segregation Compliance

Service Quality	Consistent Segregation (%)
Excellent	42%
Good	28%
Average	15%
Poor	9%

Collectively, the empirical evidence reveals a structured interaction between awareness, behavioural determinants, and institutional conditions:

1. Awareness under SBM is substantial but insufficient on its own.
2. Segregation consistency remains limited due to infrastructural constraints.
3. Recycling participation depends on accessible recovery networks.
4. Institutional reliability significantly enhances compliance.

The results demonstrate that household waste management outcomes are not merely a function of individual behavioural intent, but are deeply embedded within governance structures and service delivery systems.

Effective implementation of SBM objectives therefore requires synchronized behavioural, infrastructural, and institutional interventions.

3. Discussion

The empirical findings reveal a structured divergence between policy-driven awareness and sustained household behavioural adoption under the Swachh Bharat Abhiyan (SBM). While awareness of segregation norms is widespread, consistent multi-stream segregation and recycling participation remain uneven. This pattern confirms the persistence of an awareness, action gap in urban waste governance.

The results suggest that awareness functions as a necessary but insufficient condition for behavioural transformation. Although educational attainment significantly enhances awareness levels, behavioural compliance depends more strongly on institutional and infrastructural conditions. This finding aligns with behavioural-environmental frameworks emphasizing that pro-environmental action requires the alignment of motivation, opportunity, and ability (Sahoo et al., 2022). In the absence of reliable service delivery and accessible

recycling channels, informational campaigns alone cannot produce durable behavioural change.

A central contribution of this study is the identification of governance quality as a mediating factor in household waste management outcomes. The strong statistical association between perceived municipal service quality and segregation consistency indicates that behavioural compliance is co-produced by citizens and institutions. Households are more likely to engage in sustained segregation when collection systems are predictable, containers are available, and institutional follow-through is visible. Conversely, perceived post-collection mixing of segregated waste undermines trust and weakens compliance incentives.

These findings extend prior research by demonstrating that infrastructure reliability and service accountability are more decisive determinants of behavioural stability than awareness intensity. While earlier studies have emphasized demographic predictors or motivational drivers, the present results underscore the structural role of municipal capacity and governance responsiveness in shaping environmental behaviour.

The heterogeneous patterns of recycling participation further reinforce this institutional interpretation. Engagement in composting and dry waste sales is strongly conditioned by access to recovery networks and informal market linkages. This suggests that circular economy performance depends not only on segregation at source but also on the integration of downstream value chains. Without stable material recovery facilities and coordinated recycling channels, household-level segregation cannot fully translate into systemic resource efficiency.

From a governance perspective, the results highlight the importance of multi-level policy coherence. National policy directives under SBM establish normative frameworks, yet effective implementation occurs at the municipal level. Variations in service reliability and monitoring mechanisms across localities help explain differences in segregation compliance. The findings therefore support a governance-mediated model of environmental behaviour, in which institutional trust, service quality, and accountability mechanisms directly shape citizen participation.

Importantly, the results also caution against overreliance on enforcement-based strategies. While fines and monitoring systems may generate short-term compliance, sustainable behavioural transformation appears more closely associated with service quality, feedback loops, and visible material recovery outcomes. This reinforces the need for synchronized behavioural communication and infrastructural strengthening.

In sum, the study demonstrates that household waste segregation under SBM is embedded within a broader institutional ecosystem. Behavioural intent, educational attainment, and awareness campaigns operate within the constraints and incentives created by municipal service systems. Effective urban waste governance therefore requires coordinated interventions that align informational efforts with infrastructural capacity and governance credibility.

4. Policy Implications and Recommendations

The findings indicate that improving household waste segregation under Swachh Bharat Abhiyan (SBM) requires a transition from awareness-centric strategies toward governance-integrated implementation models. While informational campaigns have successfully elevated public awareness, behavioural persistence is structurally conditioned by institutional reliability and infrastructural adequacy.

First, policy interventions must prioritize service consistency and infrastructural sufficiency. The strong association between perceived municipal service quality and segregation compliance demonstrates that behavioural adoption is reinforced when households observe predictable collection systems and credible material handling practices. Investment in standardized dual-bin distribution, route regularity, and transparent post-collection processing should therefore be treated as core behavioural instruments rather than purely logistical components.

Second, institutional credibility must be strengthened through feedback and accountability mechanisms. Digital monitoring systems, periodic compliance audits, and community-level reporting dashboards can enhance transparency and reinforce behavioural norms. Evidence suggests that when households perceive that segregated waste is genuinely processed separately, compliance rates increase. Thus, institutional trust functions as a behavioural multiplier.

Third, policy frameworks should formalize the integration of informal recycling networks into municipal systems. A significant proportion of households rely on informal collectors for dry waste disposal, underscoring the embedded role of decentralized recovery channels. Structured partnerships with informal actors can improve recovery rates while enhancing livelihoods and system efficiency.

Fourth, behavioural change communication (BCC) strategies should evolve from generalized awareness messaging to habit-forming reinforcement models. Targeted, locality-specific interventions, particularly in peri-urban and lower-education clusters, can address confusion regarding segregation categories and strengthen procedural clarity. However, communication must be synchronized with visible service improvements to avoid erosion of trust.

Fifth, policymakers should adopt a multi-level governance alignment approach, ensuring coherence between national directives, municipal execution, and household experience. Variability in service quality across localities suggests that SBM outcomes depend on decentralized administrative capacity. Strengthening municipal governance performance metrics, linked to segregation consistency and recycling integration, can enhance systemic accountability. These recommendations emphasize that sustainable waste governance requires behavioural, infrastructural, and institutional integration. Awareness is foundational, but durable compliance emerges only when policy design embeds behavioural incentives within reliable service ecosystems.

Conclusion

This study provides an empirical assessment of household waste segregation and recycling behaviour within the framework of Swachh Bharat Abhiyan. The findings reveal a pronounced awareness–action gap: although knowledge of segregation norms is widespread, consistent behavioural implementation remains limited.

The evidence demonstrates that household compliance is not determined solely by awareness or socio-demographic factors, but is significantly mediated by institutional performance and service reliability. Municipal governance quality, manifested through predictable collection systems, infrastructural adequacy, and credible waste processing, emerges as a decisive determinant of behavioural persistence.

Recycling participation further depends on the integration of downstream recovery networks, including informal sector linkages. Thus, circular economy outcomes are contingent upon system connectivity rather than isolated household intent.

The study advances the understanding of urban waste governance by positioning segregation behaviour within a governance-mediated framework. Effective implementation of national sanitation objectives requires synchronized behavioural communication, infrastructural strengthening, and institutional accountability.

Moreover, recent local programs like door-to-door segregation drives, awareness motivations show examples of innovation in local enforcement showcasing how local authorities are trying to strengthen household adherence (Times of India articles about Chandigarh and Mohali).

In general, it can be concluded that the Swachh Bharat Abhiyan has established a sound base of awareness and policy frameworks, but to bring the mission to life, more robust connections between the citizen behaviour, service delivery mechanisms, and waste processing infrastructure are needed. It is hoped that through future endeavours in the areas of maintaining changes in behaviour, closing gaps in the infrastructure (or infrastructure) as well as institutionalizing feedback systems, household segregation and recycling will become normal and effective within varied settings in India.

CRediT Authorship Contribution Statement

S. Vairamani: Conceptualization, Methodology, Investigation, Writing – original draft, Supervision. K. Rajesh: Investigation, Data curation, Formal analysis, Visualization, Validation.

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N/A

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data Availability Statement

The data that support the findings of this study were sourced from World Bank, World Development Indicators, with the dataset spans 2000 to 2024.

Ethical Approval Statement

Ethical approval was waived by WDI (where the data was sourced from) due to the use of anonymised secondary data and the retrospective nature of the study.

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