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ORIGINAL

Assessment of solid waste management practices in budgam town, jammu and kashmir: Trends, composition, and infrastructure gaps

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ABSTRACT

Budgam town, which is quickly becoming more urbanized in Jammu and Kashmir, is producing a lot more municipal solid waste (MSW) because the population is growing and people's consumption patterns are changing. This study gives a full picture of how Budgam handles its MSW based on field data collected from 13 municipal wards through household surveys, waste quantification, site inspections, and stakeholder interviews done between January and May 2024. The results show that the amount of waste produced every day has gone up sharply, from 6.5 metric tons in 2022 to 8.8 metric tons in 2024. This is mostly because more homes and businesses are being built. Waste composition analysis shows that biodegradable materials make up most of the waste (about 60–65%), with food waste alone making up 40.3%. This shows that decentralized composting interventions could work. However, the lack of a scientifically managed landfill, the low level of household segregation (12.5%), and the poor infrastructure, on the other hand, pose serious risks to the environment and public health. The study suggests a multi-pronged approach that includes ward-level composting units, material recovery facilities, and community awareness programs, and strict enforcement of source segregation in line with the Solid Waste Management Rules, 2016. These results give municipal planners and policymakers a data-driven basis for improving waste management in small cities like Budgam in a way that is both sustainable and open to everyone.

KEY WORDS

Municipal solid waste (MSW); Budgam; Biodegradable materials; Decentralized composting; Landfill; Source segregation

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Introduction

Municipal solid waste, the byproduct of daily urban life, poses a major environmental and logistical challenge that requires strict management to protect public health and the ecosystem. According to Arena and Link et al., the core constituents of this waste include food remains, paper, plastics, fabrics, and recyclable debris like metal, glass, and old furniture [1,2]. Because it is composed of diverse, inconsistent materials, MSW lacks a uniform internal structure or standardized physical properties [3-5]. Municipal solid waste (MSW) generation is increasing rapidly worldwide due to urbanization, population growth, and changing consumption patterns. In 2016, global MSW production exceeded 2.01 billion tonnes, and without urgent intervention, it is projected to rise by 70% to 3.40 billion tonnes by 2050 [6]. Mismanagement of this waste through open dumping, uncontrolled landfilling, and open burning poses serious risks to human health, increases greenhouse gas emissions, and degrades land and water resources [7].

India, with its population of nearly 1.4 billion, produces around 62 million tonnes of municipal solid waste every year. Unfortunately, almost 70% of this waste is not managed properly, contributing to problems like urban flooding, polluted air and water, and the spread of diseases [8-10]. Rapid urban growth has put immense pressure on Urban Local Bodies (ULBs), many of which lack the infrastructure, funding, and enforcement needed to ensure proper waste segregation and disposal [11]. National initiatives such as the Swachh Bharat Mission have improved door-to-door waste collection and encouraged public–private partnerships [12]. However, significant gaps remain—especially in smaller towns and hilly regions, where limited resources and difficult terrain make effective waste management even more challenging [13,14].

Budgam town, the administrative headquarters of Budgam district in Jammu and Kashmir, is a clear example of the waste-management challenges faced by many growing towns. Spread across 13 municipal wards and home to around 15,334 people living in nearly 2,480 households, the town has seen its daily waste generation rise noticeably—from 6–7 tons in 2022 to 8–9.5 tons by 2024 [15]. However, facilities for proper waste disposal remain limited. Apart from an old dump site at Mamath and a newly established site at Pallar, the town lacks scientifically managed waste-processing areas, resulting in most waste being disposed of in unsustainable ways. What makes the situation more concerning is that a large portion of the waste is biodegradable (60–65%), with food waste alone making up 40.3%. This highlights a significant missed opportunity for composting and turning organic waste into useful resources.

This study aims to achieve three main goals:

- Understand how municipal solid waste (MSW) generation in Budgam has changed in recent years,
- Analyze what waste is made up of, and
- Identify the key gaps in existing infrastructure and policies.

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By combining detailed field data with insights into national and global waste-management practices, we hope to guide practical, targeted solutions. These may include steps like setting up decentralized facilities for processing organic waste, strengthening waste segregation at the source, and encouraging greater community participation. Together, such measures can help Budgam move toward a cleaner, healthier, and more sustainable waste-management system.

Study Area

Budgam town is in the central Kashmir region and serves as the administrative headquarters of Budgam district. Budgam District is geographically positioned between the coordinates of 33° 20' to 34° 54' N latitude and 73° 55' to 75° 35' E longitude. Covering a total area of 1,361 square kilometers, the region features a diverse topography that transitions from rugged mountain ranges to flat plains, maintaining a mean elevation of approximately 1,610 meters (5,281 feet). A defining geological hallmark of this area is the Karewa formations—unique, elevated plateau-like landforms that characterize the district's physical landscape [16]. With a growing population of about 15,334 people and nearly 2,480 households, the town is witnessing rapid urbanization. Increasing population density, expanding urban areas, and rising commercial activities have all contributed to a significant increase in solid waste generation. However, the municipality currently lacks sufficient infrastructure for proper, scientific waste management. This makes Budgam an important case for studying existing waste management challenges and exploring possible improvements. The study covered all 13 municipal wards that fall under the Budgam Municipal Committee (Figure 1 and Figure2).

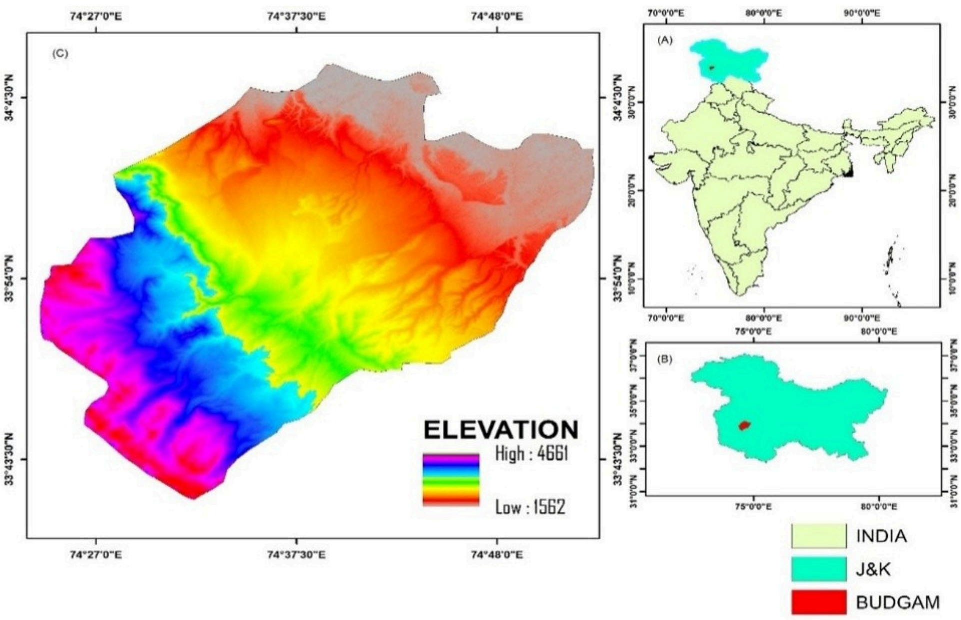

Figure 1. Study area map.

Figure 2. Study area.

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Methodology

This study used a mixed-methods approach that combined field surveys, quantitative measurements, and on-the-ground observations to understand how solid waste is generated, its composition, and how it is managed in Budgam town, Jammu and Kashmir.

Data collection techniques

Fieldwork was carried out between January and May 2024 using the following methods:

Household surveys

A structured questionnaire was given to a randomly selected group of households from all 13 municipal wards. The survey collected information on how much waste each household produced, whether they practiced waste segregation, and their level of awareness about proper waste management.

Direct waste quantification

Waste samples were collected from selected households and community bins for three consecutive days each month. These samples were weighed using calibrated portable digital scales and then manually sorted into categories such as food waste, paper, plastics, and metals.

Site inspections

The research team visited the old landfill site at Mamatha and the new landfill site at Pallor to observe how waste was being disposed of and managed. The team documented segregation procedures, site conditions, and general operations. Photographs were taken, and informal conversations were held with sanitation workers to better understand day-to-day challenges.

Key informant interviews

Semi-structured interviews were conducted with officials from the Budgam Municipal Committee, sanitation staff, and representatives from local NGOs. These discussions provided valuable insights into institutional capacity, existing waste management policies, and the operational difficulties faced on the ground.

Waste categorization and analysis

The collected solid waste was sorted into ten main categories for analysis: Food waste, Paper, Glass, Ferrous metals, Polythenes, Rags, Plastics, Biomedical waste, Horticultural waste, and Miscellaneous items (such as construction debris and ceramics). Each type of waste was weighed individually, and its percentage of the total daily waste was calculated during the sampling period. Focus was placed on identifying the biodegradable portion, as this is especially important for composting and strategies aimed at recovering organic waste.

Data processing and limitations

All the quantitative data were entered and carefully cleaned using Microsoft Excel 365. Descriptive statistics helped summarize trends in waste generation, while graphs and charts were created using Matplotlib in Python to visually represent the findings.

However, the study had a few limitations:

- Seasonal variations could not be considered due to time constraints.
- Biomedical waste was not traced back to its specific sources, such as clinics or hospitals.
- Waste generated by military and railway facilities was not included in the formal collection data because access to this information was restricted.

Despite these limitations, this study offers a solid baseline for understanding solid waste management in Budgam and can guide evidence-based planning and interventions in the future.

Results

This section shares the study's key findings, combining both quantitative data and observational insights. The results are organized around several main themes: the demographic profile of the town, trends in waste generation, the composition of waste, existing disposal infrastructure, and noticeable gaps in waste management. Together, they provide a clear picture of the current state of (MSW) management in Budgam town.

Demographic and household profile

Budgam town, which is divided into 13 municipal wards, is home to around 15,334 people living in approximately 2,480 households. On average, each household comprises 5 to 6 members, reflecting typical patterns seen in the region's census data. The town features a mix of land uses, with densely populated residential areas alongside markets, small businesses, and public institutions. This mix contributes to a varied and complex waste stream across the town.

Trends in solid waste generation (2022–2024)

Field-based quantification revealed a consistent annual rise in daily waste generation: (Table 1).

Table 1 . Year-wise trends in Estimated Waste Generation (MT/day).

Year	Estimated Waste Generation (MT/day)
2022	6.0 – 7.0
2023	7.0 – 8.0
2024	8.0 – 9.5

This rising trend reflects Budgam's ongoing urban growth and the impact of changing consumption habits. By 2024, the town will produce around 8.8 metric tons of waste each day, a roughly 41% increase over just two years (Figure 3). The increase in waste per person is especially noticeable in areas with busy weekly markets and more densely populated neighbourhoods.

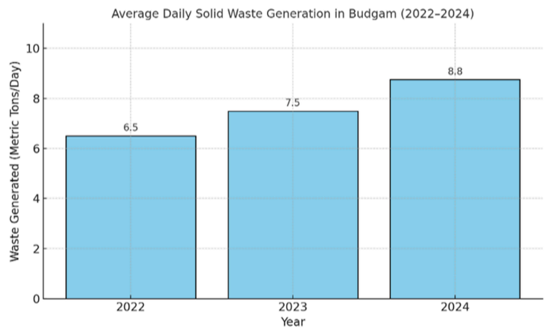

Figure 3. Average daily (MSW) generation in Budgam town from 2022 to 2024. A steady increase is observed, from 6.5 metric tons/day in 2022 to 8.8 metric tons/day in 2024, reflecting urban growth and rising consumption.

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Waste composition analysis

A detailed waste composition study revealed that biodegradable materials dominate the waste stream, offering potential for compost-based interventions. The category-wise breakdown is as follows: (Table 2).

Table 2 . Proportion of Different Waste Categories .

Waste Category	Proportion (%)
Food Waste	40.3
Paper	9.1
Glass	9.1
Metal (Ferrous)	7.1
Polythenes	2.7
Rags	2.3
Plastics	0.4
Biomedical Waste	2.3
Horticultural Waste	4.1
Miscellaneous	14.6

Approximately 60–65% of the total waste was found to be biodegradable, comprising food scraps, garden clippings, and paper-based materials. The plastic fraction was surprisingly low (0.4%), which may be attributed to informal sector recovery or underreporting. Notably, biomedical waste, although modest in volume (2.3%), was observed to be co-disposed with general waste, posing a critical public health hazard (Figure 4).

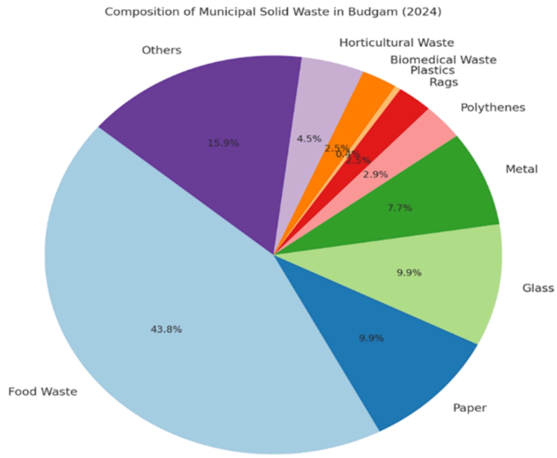

Figure 4. Composition of (MSW) in Budgam (2024), based on field survey data. Food waste accounts for the largest fraction (43.8%), followed by paper and glass (9.9% each), metal (7.7%), and others, including biomedical, horticultural, plastic, and polyethylene waste.

Landfill infrastructure and waste disposal practices

Budgam town currently does not have a centralized, engineered landfill. Waste disposal in the town depends on a few sites:

- **Mamath (Old site):** This site lacks a scientific design and is now only partially functional.
- **Pallar (New site):** The main designated disposal site for (MSW), but it is poorly equipped. There is limited control of leachate, no system for capturing methane, and no source segregation in place.

Some efforts toward scientific disposal, such as partial segregation and covering of waste, were observed only at Pallor. However, there are no operational waste treatment units within the town's wards. Additionally,

- Waste from the railway is managed separately but remains untreated.
- Waste from the military camp is not included in the municipal collection system.
- Visual inspections revealed that waste is not segregated at the source. Mixed waste is collected using handcarts and dumped at transfer stations without any processing.

Seasonal and spatial variation

Although this study primarily relied on cross-sectional data, insights from sanitation staff highlighted some noticeable patterns:

- Waste generation tends to increase during the summer months and around festival seasons.
- Wards with bustling market areas, such as Ward 3 and Ward 5, produce about 30–40% more waste per person compared to the quieter, residential outskirts.

Community awareness and participation

The household survey revealed that awareness about proper waste segregation is generally low:

- Only around 12.5% of households practice any form of segregation.
- About 85% of residents were unhappy with how often and reliably waste was collected.
- Most people didn't know where the landfill sites were or what ultimately happened to their waste.

On a positive note, several community members expressed interest in home composting, especially in households with open backyard spaces, showing potential for environmentally friendly practices.

Discussion

Waste generation trends: Urban growth and capacity constraints

Budgam has seen a sharp increase in daily waste, rising from around 6 MT per day in 2022 to nearly 8.8 MT per day in 2024. This trend reflects the broader pattern of urbanization across India [17]. Rapid city growth often leads to higher per-person waste generation, especially when waste management infrastructure and collection services cannot keep up [18]. Studies suggest that municipal waste in Indian cities could grow from about 62 million tons in 2020 to nearly 165 million tons by 2030 [18,19]. Research also shows a clear link between city size and waste production: as populations double, waste output nearly doubles as well, highlighting a steady and predictable increase [20].

Composition analysis: High biodegradable waste & potential for composting

In Budgam, biodegradable waste makes up roughly 60–65% of the total, with food waste alone accounting for 40.3%. This highlights the strong potential for decentralized composting. Similar studies in other Indian towns have found that organic waste is nutrient-rich and has high moisture content, making it ideal for composting or anaerobic digestion [21]. Reviews of composting practices show that well-managed systems can divert significant

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amounts of organic waste from landfills, reduce methane emissions, and recycle nutrients effectively [22]. When contamination is controlled, compost quality is excellent, with favourable pH levels, C:N ratios, and low heavy metal content [23].

Infrastructure gaps: Risks of open disposal and lack of engineered landfills

Budgam lacks a properly engineered landfill, except for the sites at Pallar and Mamath, which raises serious environmental and public health concerns, a problem that mirrors the wider issue of unsanitary dumping seen across India [24,19]. In many smaller cities, poor waste segregation and open dumping contribute to methane emissions and leachate contamination [24]. Without setting up more localized processing facilities, the city's wards remain vulnerable to poorly managed waste sites that fail to meet the standards set by the SWM Rules, 2016.

Community practices: Low segregation rates and awareness gaps

Household segregation of waste remains low, at around 12.5%, and many people are dissatisfied with current waste management systems, highlighting significant behavioral challenges. Studies in similar urban areas show that structured awareness programs, along with the inclusion of informal recyclers, can greatly improve participation and system efficiency [21]. Interviews with key stakeholders in both rural and urban settings reveal that public knowledge and practices around waste management are often limited, even when infrastructure is in place. Targeted initiatives such as school-based programs, self-help group involvement, and hands-on composting training at the household level could help shift these patterns and encourage better waste management practices.

Environmental and health implications of co-disposal

Mixing biomedical waste with regular municipal trash is a serious health and environmental concern. Studies show that it can expose people to harmful pathogens, contaminate surface water, and increase the spread of diseases carried by insects [19]. On top of that, when organic waste decomposes in dumps, it releases methane—a potent greenhouse gas that worsens air quality and makes it harder to fight climate change [18].

Policy fit and implementation gaps

India's Solid Waste Management Rules say households should separate waste, get door-to-door pickup, have local composting, and ensure scientific disposal. Many city and town bodies don't have the staff, money or infrastructure to put all of that in place [24]. National campaigns like the Swachh Bharat Mission have helped expand collection, but enforcing the rules and changing everyday behaviour, especially in smaller towns, remains a challenge [18]. Rather than relying on top-down fixes, real progress will come from ward-level systems that involve residents, municipal workers and local conditions.

Strategic implications and pathways forward

Budgam faces a growing waste challenge, with a large proportion of organic waste, limited infrastructure, and low community participation. Addressing this requires a comprehensive approach:

Ward-level composting

Set up small composting sites, especially in areas generating high amounts of organic waste.

Recycling facilities

Establish Material Recovery Facilities (MRFs) to handle paper, glass, metals, and other recyclables.

Segregation at source

Promote door-to-door waste separation, involving informal waste collectors, to improve efficiency.

Awareness and training

Run campaigns, conduct surveys on community knowledge and practices, and offer composting workshops to encourage behaviour change.

Stronger governance

Align municipal operations with Solid Waste Management (SWM) rules and provide the necessary technical and financial support.

Biomedical and site management

Ensure proper segregation of biomedical waste and design sites to minimise public health risks.

Strengths and limitations concerning literature

This study used a mixed-method approach combining household surveys, waste sampling, and interviews to provide well-rounded insights, like another research conducted in India [21]. However, there are some limitations. Seasonal variations were not considered, and certain waste sources, such as biomedical and institutional sources (like health centres and railway camps), were not fully accounted for. Future studies should include longitudinal sampling and assess the feasibility and costs of composting or Material Recovery Facility (MRF/MTF) investments.

Conclusion

Budgam's (MSW) profile, dominated by organic material, constrained by limited infrastructure, and shaped by low community participation, presents both pressing challenges and promising opportunities. The town has experienced a rapid rise in waste generation over the past two years, from around 6 MT/day in 2022 to nearly 8.8 MT/day in 2024, with higher per-capita waste in densely populated wards and market areas. Composition analysis shows that 60–65% of the waste is biodegradable, with food waste alone accounting for over 40%, highlighting strong potential for decentralized composting and organic resource recovery. Despite this opportunity, Budgam's waste management system remains fragmented. Disposal sites such as Pallar and Mamath are inadequately equipped, lacking leachate control, methane capture, and source segregation, while biomedical and institutional waste streams, including from health centres, military, and railway camps, remain largely unmonitored. These gaps pose serious environmental and public health risks, including the co-disposal of hazardous biomedical waste and greenhouse gas emissions from decomposing organic matter. Community engagement is currently low, with only about 12.5% of households practicing segregation. Yet interest in home composting among households with backyard space suggests that targeted behavioural interventions could be effective. Drawing lessons from successful Indian models of decentralized composting, source segregation, and inclusive

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waste governance, Budgam can develop a localized solid waste management roadmap that balances technical infrastructure, community participation, and policy reinforcement.

A comprehensive strategy for Budgam should include ward-level composting, Material Recovery Facilities (MRFs) for recyclables, door-to-door segregation, awareness and training programs, and strengthened governance aligned with India's SWM Rules (2016). By combining these interventions, the town can transform its waste management challenges into opportunities for environmental sustainability, economic gains, and improved public health. Future research should address current limitations, such as seasonal variations and unmonitored institutional waste streams and assess the feasibility and cost-effectiveness of composting and MRF investments. With coordinated action across infrastructure, policy, and community engagement, Budgam has the potential to establish a resilient, inclusive, and sustainable waste management system that can serve as a model for other growing towns.

Disclosure Statement

The Authors declare that there is no conflict of interest.

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