Fixing the Cracks in Bengaluru's Waste System: Advancing Solid Waste Management through Climate Action Planning

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Executive Summary: The city of Bengaluru, located in Karnataka, India, has experienced rapid urbanization that strains solid waste management and drainage infrastructure. Recognizing these challenges, the Bruhat Bengaluru Mahanagara Palike (BBMP) launched the Bengaluru Climate Action Plan (BCAP) in 2023, which included four specific goals pertaining to solid waste management: (a) divert solid waste from landfills by better segregation of solid waste at the source; (b) increase resource recovery and circular economy by promoting decentralized solid waste management systems; (c) implement scientific landfills with gas capture systems and suitably repurpose closed landfills/dump sites; and (d) create inclusive and hazard-resilient solid waste management (SWM) infrastructure and services. This brief examines BCAP's SWM goals and evaluates them against national laws and implementation challenges. To improve SWM in Bengaluru and overcome implementation gaps, this brief recommends creating a framework for dumpsite location planning, standardized waste segregation systems, timely and reliable waste collection schedules, multilingual public education, and centralized oversight. By aligning local initiatives such as BCAP's SWM goals with national laws, Bengaluru has the potential to position itself as a leader in circular economy-driven, climate-resilient urban governance.

I. Background: Urban strain and waste governance

Solid Waste Management (SWM) in Bengaluru is facing a critical challenge: struggling infrastructure cannot manage increasing waste generation of urban Bengaluru. Rapid urban growth in the city has led to scarcity of land, causing residential and commercial developments to encroach on solid waste facilities (Naveen 2021). Urban growth has also contributed to more than 60 illegal dumping sites that pose a health risk to the public, as they can lead to environmental contamination and the spread of disease (Naveen and Sivapullaiah 2020). Beyond illegal dumping, Naveen (2021, 100004) notes that inadequate waste treatment is a concern; despite 60% of household waste being collected in Bengaluru only 15% undergoes treatment. Additionally, the lack of public awareness regarding proper solid waste management practices makes it difficult to change these established practices (Naveen 2021, 100004; Naveen and Sivapullaiah 2020). As solid waste management problems have grown, municipalities have shifted their focus toward improved oversight and policy reform.

Bruhat Bengaluru Mahanagara Palike (BBMP), the local municipal corporation, has overseen solid waste management since its formation in 2007

(Roy 2022, 133-146). Bengaluru Solid Waste Management Limited (BSWML) manages SWM projects on behalf of BBMP and oversees the collection, transportation, and processing of solid waste from both commercial and household outlets. Additionally, BSWML's operational capacity is limited to that of a service contractor, as it lacks statutory authority. In 2021 the Karnataka State Cabinet approved the formation of BSWML, effectively shifting solid management duties to BSWML (Menezes 2021). The newly formed BSWML is partly owned by BBMP and partly owned by the state government. Overall, the city's growing waste crisis reveals a gap between the demands of rapid urbanization and current governance. The formation of BSWML signifies the city's commitment to address solid waste management, move toward policy reforms, and build a coordinated administrative body.

II. The BCAP framework: Goals and institutional roles

In 2022, Bengaluru became the first city in South Asia to join the C40's Inclusive Climate Action (ICA) programme: a global network of cities that have unified to confront the climate crisis (C40 Cities n.d.). In 2023, Bengaluru further solidified its commitment by launching its first Climate Action and Resilience Plan (BCAP) through BBMP, making it the third Indian city to have a climate action plan.

Figure 1: Summary of BCAP's SWM goals and targets. Source: BCAP final report (https://apps.bbmpgov.in/bcap/).

The motivation behind BCAP was to build a resilient city, actively adapting to climate change while prioritizing citizen voices. To achieve these objectives the BCAP's final report contains short, medium, and long-term goals across seven sectors: energy and buildings; transportation; solid waste; air quality; water, wastewater and stormwater; urban planning; greening and biodiversity; and disaster management. To facilitate the implementation of BCAP, in 2024 the commissioner of BBMP also launched the Climate Action Cell (CAC). The CAC functions under the Chairpersonship of the Special Commissioner, Forest, Environment, and Climate Change Management Wing of BBMP along with representation from relevant stakeholder departments. For this brief we focus on the solid waste section of the BCAP.

SWM is a central pillar of the Bengaluru Climate Action Plan. The BCAP report identifies four SWM goals, summarized in Figure 1, each supported by sub-goals noting measurable outcomes, departmental responsibilities and emphasizing inclusivity, information, education and communication as indicators of progress. These goals are grounded in the Integrated Solid Waste Management approach or ISWM framework (Bengaluru Climate Action Cell 2023), which considers sustainability, waste reduction, and conditions for proper waste disposal (Batista et al. 2021, 1-14). By adopting ISWM, BCAP's SWM goals

aim to reduce emissions, improve energy efficiency, and promote social equity. In practice, SWM in Bengaluru is highly fragmented and involves multiple stakeholders, often under contractual agreements with BBMP. BBMP directly only manages about 30% of solid waste mobilization (Prashanth et al. 2020, 2935–45). This arrangement has produced systemic challenges, including limited funding, communication deficiencies, and uneven regulatory enforcement. Together, these obstacles complicate efforts to achieve the ambitious SWM goals laid out in the BCAP.

III. Solid waste management in Bengaluru: Aligning BCAP goals with India's national solid waste management rules

Achieving BCAP's SWM goals directly depends upon BBMP's compliance with the national legislation defined by the Ministry of Environment, Forest, and Climate Change (Ministry of Environment Forest and Climate Change 2016, 1-4). This legislation encompasses the Solid Waste Management Rules (SWMR) of 2016, which establish a national standard while delegating implementation responsibilities for various state and local governments. At the city level in Bengaluru, BBMP is responsible for upholding and implementing local by-laws that comply with SWMR. Recognizing the specific challenges posed by plastic waste, the Plastic Waste Rules (PWR) of 2018, an extension of SWMR, are also relevant to BCAP's SWM goals (Ministry of Environment Forest and Climate Change 2018, 1-20). Studies show that plastic waste can take up to 1,000 years to decompose in landfills (Rustagi et al. 2011, 100-103) and is incorporated extensively into most daily use items. In this section, we discuss how BCAP's SWM goals align with SWMR and PWR, including waste segregation, decentralized recycling, and landfill management.

i. Responsibilities for source separation and multi-level compliance enforcement

Section one of the 2016 SWMR declares that it is the duty of the solid waste generators to properly separate waste into three categories: biodegradable, non-biodegradable, and domestic hazardous. The exceptions to these categories are infrastructure waste and horticulture waste. Additionally , it is the responsibility of the Chief Secretary of a particular state or union territory to uphold efficient solid waste transportation systems and support solid waste centers. This position must also enforce compliance to ensure that there are no violations of the SWMR. Additionally, sections five and six of SWMR state that the local government must uphold compliance with plastic waste separation facilities and bylaws, while section eight emphasizes that efforts should be made to minimize the generation of waste and establish a recycling pickup fee. The district magistrate must designate appropriate sites for solid waste processing and review the performance levels of the processing plants quarterly. At the local level, SWM goals support these regulations by charting a legislative pathway to enforce the segregation of solid waste at the source. These guidelines are a step in the right direction to ensure that underperforming segregation systems can be penalized, diverting unnecessary solid waste from landfills. A potential improvement to the SWM goals could be the inclusion of more detailed categories of solid waste, which could facilitate the proper disposal of all waste materials.

ii. Promoting decentralized systems for enhanced resource recovery

The SWMR states that to increase resource recovery and promote decentralized waste systems, the legislative responsibility of promoting local initiatives for solid waste collection, segregation, and processing lies with the local authorities and village panchayats (rural area government bodies). This lessens the administrative burden of larger solid waste processing units while also promoting recycling within communities. A decentralized system makes it easier to recycle organic materials or plastics and produces fewer transportation-related emissions by disposing of solid waste at local facilities. BCAP's SWM goals are designed to support SWMR, by utilizing promotional efforts to encourage recycling, incentives, and wide-reaching social media announcements. While these promotional efforts inadvertently lead to an increase in resource recovery; this outcome is not explicitly discussed within SWMR. Future clarifications around SWM goals could include the funding framework, assessment, and impact of these promotional efforts.

iii. Scientific and sustainable landfill management

Additionally, SWMR states that each landfill site must install gas collection systems, ideally in

conjunction with geomembranes, and undergo regular monitoring. Collected gas should only be used for thermal or power applications; otherwise, it must be "flared" or burned. The concentration of methane gas output must not exceed twenty-five percent of the lower explosive limit to ensure a stable local environment. Once landfills have reached their "capped" amount of solid waste, a layer of clay or soil, followed by a drainage layer and then a vegetative layer, must be sustained for fifteen years, after which the landfills can then be urbanized for human use. BCAP's SWM goals support SWMR's landfill policies by outlining the scientific maintenance and strategic action necessary to sustain landfills. Hence landfills in Bengaluru could potentially harvest methane, which could be used as a renewable energy source or be sold, thus helping the local economy.

iv. Resilient infrastructure and safety regulations

The SWMR emphasizes that self-help groups and informal solid waste collectors that voluntarily manage solid waste are necessary to support proper SWM. Additionally, SWMR states that the construction and closing plan of a proposed landfill must be made available to the public, including information on the capped limit of the landfill, gas ventilation, fencing, lighting, weighbridges, inspection facilities, and utilities like drinking water and sanitary facilities. A landfill must maintain a buffer zone of one hundred meters from rivers, two hundred meters from ponds, highways, habitations, public parks, and water supply wells, and twenty kilometers from airports. Water quality in a fifty-meter radius must be regularly checked, as well as non-permeable surfaces lining the base and outside of the landfill, to ensure little to no runoff water is detected. SWMR section four outlines that manufacturers are responsible for the usage of proper/sustainable materials and assume responsibility for proper solid waste recycling and disposal. BCAP's SWM goals align with SWMR by explicitly stating the perimeters for resilient waste services and infrastructure that uphold environmental and human health safety regulations.

IV. Implementation gaps & policy recommendations

The effective management of solid waste in Bengaluru is impacted by fragmentation across legislative, regulatory, and operational capacities. This results in systemic inefficiencies, overlapping responsibilities, and a lack of clear accountability. This section provides an in-depth evaluation of these administrative and operational challenges, presenting recommendations listed in descending order of priority.

i. Data inaccuracies and communication challenges

Waste management in Bengaluru is coordinated by several external or contractual agencies, and without a unified oversight mechanism, it can become challenging to ensure proper data quality and monitoring. Data inconsistencies not only hinder research initiatives but also affect program evaluations. The use of inaccurate data can compromise the integrity of policy formulation and potentially reinforce systemic biases within solid waste management across Bengaluru (Subbanarasimha et al. 2024, 350). According to Ahmad et al. (2021, 131520-131541), one way to reduce inaccuracies would be to implement a blockchain-based system, where the current agencies connect through an overseeing agency. By implementing this, the overseeing agency can distribute tasks based on the specialization and size of each current organization. Current organizations would also report through the blockchain to the overseeing organization, which would streamline data sources, ensuring more accurate information. One of the most emphasized difficulties among external contractors under BBMP exists within communication methods and efforts. A significant amount of communication between parties occurs through unmoderated apps like Twitter or LinkedIn. Additionally, as a multilingual city, timely communication and outreach present a considerable challenge. Such barriers can contribute to delays in implementing crucial policies and affect individual and environmental well-being. Furthermore, the scarcity of multilingual documents can hinder collaboration with individuals from marginalized groups and cultural backgrounds (Sharma et al. 2020, 8). One method to address these barriers is to develop a centralized communication platform where all external agencies can directly communicate with BBMP and vice versa. Once this is installed, agencies can work with appointed translators who can ensure accessibility to the major language groups within the city. This centralized communication platform can be founded by the blockchain-based system where resources can be

shared equally between pre-existing agencies (Ahmad et al., 2021, 131520-131541). Implementation to overcome these challenges is medium to long-term in scope and would need to be rolled out in phases. Such initiatives would require moderate investment in IT infrastructure and staff training but could be supported through public-private partnerships. Metrics of success would include reductions in inter-agency communication delays and regular dispersal of SWM performance reports.

Advantages

Improving linguistic abilities across diverse cultural backgrounds could amplify research efforts and increase community participation by improving overall awareness about SWM.

Disadvantages

Organizations will likely oppose being streamlined due to political conflicts, differing priorities, and management styles, which could further delay addressing existing SWM issues.

ii. Challenges in enforcement and monitoring of solid waste management practices

The combined effect of inadequate data and limited monitoring capabilities makes it challenging to assess oversight and enforce responsibilities, especially since the BCAP was published recently and is one of the few city-level adaptation plans to exist in India. Additionally, the influence of political dynamics, such as changes or absence in leadership, can impact long-term planning and collaborations with external contractors. Inadequate monitoring of external contractor activities within Bengaluru's SWM operations can compromise intended outcomes and lead to financial losses (Raj and Rao 2025, 1122–36). Currently, a recent proposal for the reconstruction of mayoral terms to be increased in length is underway for approval, which could allow for more time to address social concerns (Raj and Rao 2025, 1122–36). BCAP could establish an oversight committee to track SWM activities and progress which could hold contractors accountable. By implementing a blockchain-based system, the committee could consist of public, non-political members (from local communities, contractors, and pre-existing agencies) along with trained professionals to separate waste-related issues from politics, which could improve continuity regardless of political beliefs. This committee could also advocate for open data platforms and public reporting systems to ensure full transparency between the committee and the public. These implementations could create a more politically independent system, which in turn would be more effective in waste management by prioritizing environmental needs regardless of politics (Ahmad et al., 2021, 131520-131541). Creating an oversight committee would be a medium-term solution (1-3 years) and would require cross institutional and community support. Metrics of success would include committee performance reports, improvement in SWM enforcement, and continued community participation in this committee.

Advantages

The primary benefit would be the accelerated progress on BCAP's SWM goals due to reduced political challenges and increased community involvement.

Disadvantages

A major drawback would be the risk of inter-party resistance, which could slow down progress or delay essential current SWM practices.

iii. Deficiencies in dumpsite location planning and sustainability

The strategic selection of a dumpsite location is critical to environmental sustainability, infrastructure efficiency, and public health. Improper dumping locations can lead to unsanitary living conditions, blocked roadways, clogged drains that can lead to flooding, and environmental pollution. In a case study by Narayan et al. (2020, 2935-44) in 2013, water quality around seven landfills in Bengaluru was tested, and it was found that almost all the collected samples exceeded the national permissible limits of pH, turbidity, COD, lead, nickel, hydrogen carbonate, nitrates, PO_4, magnesium, sodium, calcium, and alkalinity. Current BCAP SWM goals lack a clear framework for dumpsite location identification. To reduce groundwater contamination future revisions of the plan could include a geographical information systems (GIS) -based site identification framework to map critical SWM infrastructure, health risk information, and suitability analysis using socio-spatial criteria. Dumpsite location planning should be implemented as a medium-term strategy (within 1–3 years)

through collaboration between BBMP's GIS division, the Karnataka State Pollution Control Board, and technical institutions (e.g., Indian Institute of Science or academic collaborators). Similar to a study by Roy et al. (2022, 18), implementation steps would include developing a weighted criteria matrix for site selection for a pilot study that considers environmental, residential, water, and land use data. This would ensure that future dumpsites minimize exposure to sensitive populations and ecosystems. While site planning and implementation can be costly, this effort could be supported through existing Smart City Mission partnerships and help reduce long-term costs associated with public health, flooding, and pollution. Metrics of success may include the number of improper dumpsites located and remediated, creation of publicly available GIS maps/data, and improved water and soil quality near dumpsites.

Advantages

The primary benefit would be the positive long-term impact on environmental and human health by removing and condensing harmful solid waste from populated areas.

Disadvantages

The biggest challenges would be the financial, operational, and time burden necessary to successfully implement and track these complex processes

iv. Lack of standardized waste separation

Failure to implement proper solid waste separation practices can eliminate the opportunity for material recycling. Consequently, more waste is put into local landfills rather than reducing solid waste. Moreover, when organic solid waste ends up in landfills, it produces toxic fumes such as methane and forfeits its potential for biogas or fertilizer generation. Ramachandra et al. (2018, 1129) found that organic waste is the most prominent type of waste generated in Bengaluru, which has an 82% organic recovery potential. To account for the lack of source segregation, BCAP's SWM goals plan to implement waste management cells in every ward and bulk waste generators to manage solid waste in residential and communal areas. BCAP also plans on supporting self-help groups by ensuring safe working conditions and proper training while also promoting and educating the public to favor segregation of solid waste per the three-bin system (e.g., wet, dry, and sanitary solid waste). Currently, the responsibility of proper solid waste separation relies on solid waste generators. To improve the standardization of solid waste separation, BCAP could support a secondary separation procedure at solid waste separation sites led by trained professionals. A secondary separation procedure can ensure that inevitably mis-sorted materials can be recovered, improves quality control, and reduces landfill waste (Esra and Demir 2006, 307-14). Waste separation can be implemented in the short term (6-12 months) and can provide existing workers in this sector with training to sort waste and collect data to improve future waste recovery. Additionally, BCAP SWM's three-bin system activities and education could be enhanced through multilingual campaigns in collaboration with local community or ward-level organizations. Both these strategies are relatively low-cost and can utilize existing labor pools. Metrics of success may include tracking the percentage increase in properly sorted waste after secondary processing, the number of multilingual outreach events conducted, and reduction in contamination rates at waste separation sites.

Advantages

Implementing a secondary separation system will increase the volume of materials available for recycling and divert more hazardous waste from landfills, leading to improved long-term environmental and human health.

Disadvantages

A major drawback is the increased time and effort required for worker training and operational procedures. This could potentially create solid waste backlogs and slow the entire SWM process.

v. Operational inconsistencies in waste collection

The inconsistent timing of solid waste collection services can be an added deterrent to waste separation, leading to less than 60% of solid waste being collected, with only 15% being processed and delivered to landfills (Ramachandra et al. 2018, 1128). This leaves community members with an excess of undisposed solid waste that eventually contributes to environmental pollution (Chanakya, Shwetmala, and Ramachandra 2017, 335). A lack of dependability of solid waste collection schedules diminishes citizen motivation for recycling and

proper waste disposal. This is likely due to the difficulty of coordinating a functioning and reliable pickup system among many stakeholders . BCAP's SWM goals do not specifically aim to combat this issue, which could be a barrier to successful SWM in the future. The implementation of a reliable ward-level solid waste collection calendar with opportunities to integrate community feedback could encourage more citizens to properly dispose of waste. Operational inconsistencies could be tackled in the short term (6-12 months) by creating a system for ward-level SWM officers to interact with residents, understand community needs, and create a collection timetable. A mobile app-based reporting mechanism could be introduced to monitor missed pickups. Cost related to implementation should be minimal due to BBMP contractor capacities and existing ward level oversight.

Advantages

Metrics of success may include an increase in collection coverage rates and a reduction in resident complaints.

Disadvantages

Implementation presents a high risk of inequality, potentially marginalizing certain groups such as low-income, language minorities, less tech-savvy citizens, thus leading to a number of underserved populations.

V. Conclusion

To keep up with rapid urbanization, Bengaluru's Climate Action and Resilience Plan (BCAP) offers a promising roadmap for sustainable solid waste management. However, implementation gaps around SWM monitoring, inter-agency communication, and community participation risk undermining its potential. This brief highlights the need for a clear framework for dumpsite location planning, standardized waste segregation systems, timely and reliable waste collection schedules, multilingual public education, and centralized oversight. By aligning local initiatives such as BCAP's SWM goals with national laws (e.g., SWMR and PWR), Bengaluru has the potential to position itself as a leader in circular economy-driven, climate-resilient urban governance.

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