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WASTE-WISE CITIES

Best practices in municipal solid waste management

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MESSAGE

Vice Chairperson, NITI Aayog

Over the past few years, India's waste management sector has received tremendous attention due to the widespread awareness generated under the flagship Swachh Bharat Mission. The mission touched every citizen in some way or the other and went on to become one of the largest cleanliness drives of the world. With mere 18 per cent waste treatment capacity in 2014, India's waste management efficiency was extremely critical and posed huge challenges towards the environment. From 18 per cent waste processing in 2014 to 70 per cent in 2021, we have come a long way. Exemplary coordination at all levels of government and massive citizen participation in the movement resulted in an environment of Swachhta never achieved earlier in the country.

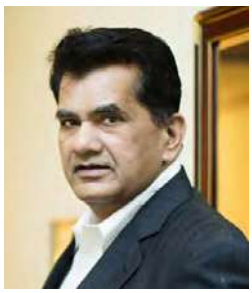
With the launch of Swachh Bharat Mission (Urban) 2.0, the efforts for sustainable waste management are being further strengthened. It is important that we leverage the momentum attained during the first phase of the mission in order to achieve the next set of targets. Under the second phase, it is aimed that cities are made garbage free with efficient waste source segregation, 100 per cent door-to-door collection, and complete remedial treatment of the waste material. As urbanisation expands, the stress of providing quality urban service delivery on ULBs/authorities continues to rise. Therefore, it is crucial that these authorities are supported beyond financial assistance of the mission and their capacities are built to address the service delivery challenges. A comprehensive knowledge resource showcasing best practices of waste management sector will help and guide cities to develop their waste management plans with greater efficiency.

It is with this intent, NITI Aayog and Centre for Science and Environment (CSE) collaborated and developed this publication which showcases best practices for 10 different thematic areas of waste management. Waste management operations in 28 cities from 15 States have been studied and incorporated in the publication. It

aims to create greater capacities among officials of urban local bodies and other relevant stakeholders at the city level for implementation of efficient solid waste management systems. The book discusses multiple areas of waste management including source segregation, material recovery, biodegradable waste management, electronic-waste, construction and demolition waste, etc. I hope that this knowledge resource will guide stakeholders for planning robust waste management systems.

I compliment the efforts of CSE in the sector and their cooperation in the development of this document. I would also like to compliment the Managing Urbanization vertical at NITI Aayog led by Special Secretary, Dr K. Rajeswara Rao for coming up with the idea of developing this crucial knowledge product. His team including Deputy Advisor, Dr Biswanath Bishoi, and Young Professional, Mr Dhiraj Santdasani deserve appreciation for their consistent efforts.

Dr Rajiv Kumar
Vice Chairperson, NITI Aayog



FOREWORD

CEO, NITI Aayog

The government has recently released the second phase of Swachh Bharat Mission (Urban), emphasizing making cities Garbage Free. India has accomplished a significant feat by exponentially increasing the waste processing capacity by four times in the last six years. The announcement of the second phase of the mission will further mainstream the aspects of circular economy in waste management sector of India. While we are moving beyond the targets of ODF and embarking on the journey of making cities garbage free, robust strategies to implement 100 per cent source segregation, door-to-door to collection and complete waste processing need to be adopted by urban local authorities with the active support of urban dwellers.

With rapid population growth in urban areas, the capacities of the local authorities often fall short of achieving the set goals of urban service delivery. Therefore, sector stakeholders must be equipped with adequate knowledge resources to plan efficient waste management systems. Capitalising greater public-private partnerships, involving citizens to form a *Jan Andolon* and leveraging the latest technologies for waste processing can enable India to achieve the next set of goals that focuses on making cities garbage free.

Many Indian cities have shown remarkable progress in waste management by implementing robust models of service delivery coupled with innovative initiatives. To achieve the cleanliness targets in a time-bound manner and with utmost efficiency, Urban Local Bodies across India must have access to strategies and best practices of the waste management sector. With this aim, this publication has been developed, covering best practices of 28 cities categorized into ten thematic areas of the waste management sector. Local authorities can study different models and adapt them as per local conditions for implementation. This compilation of best practices would act as a vital knowledge resource for urban practitioners working in this sector.

I compliment the efforts of Centre for Science and Environment in development of this publication and for working alongside other stakeholders, helping them streamline solid waste management systems. My special appreciation goes to the Special Secretary, NITI Aayog, Dr K. Rajeswara Rao, for conceptualizing this publication and providing commendable leadership in its development. In addition, the team members of the Managing Urbanization vertical of NITI Aayog—Deputy Advisor, Dr Biswanath Bishoi and Young Professional, Mr Dhiraj Santdasani—deserve due recognition for their persistent efforts.

Amitabh Kant
CEO, NITI Aayog

FOREWORD

Special Secretary, NITI Aayog

Showcasing a true testament of *Jan Andolan*, the Swachh Bharat Mission brought significant transformation in India's waste management sector in the past six years. Not only the practices of waste segregation and door-to-door waste collection have come to centre stage, but the waste processing capacity of the country witnessed a steep rise from 18 per cent in 2014 to 70 per cent in 2021. The mission has benefitted the society with its participatory and inclusive approach. The government has recently announced the next phase of Swachh Bharat Mission urban, with an explicit focus on implementing efficient waste management services in the cities across the country.

Although the government at all levels has been diligently working towards achieving complete waste treatment, limited managerial and technical capacities, amid rapid urbanisation, have put pressure on Urban Local Bodies (ULBs) to deliver efficient municipal services. However, multiple cities across the country have implemented ground-breaking, workable, and resource-efficient models of solid waste management. It was felt that ULBs across the country should have access to knowledge resources that present strategies for different components of the waste management service chain. With this intent, this publication "Waste-Wise Cities" was conceptualised, and NITI Aayog collaborated with the Centre for Science and Environment to identify best practices in ten thematic areas of waste management, including material recovery, biodegradable waste, source segregation, construction waste, e-waste, etc.

The book is a knowledge repository compiling success stories of 28 cities across the country that achieved remarkable progress in various areas of waste management. In the process of developing this document, a series of consultations were held with selected ULBs, think tanks, academia, private players, NGOs/CSOs, etc. In addition, the research teams also visited these 28 cities to capture granular details by witnessing on-ground operations.

This publication will enable local authorities and other stakeholders involved in the waste management sector for designing efficient tailored waste management solutions relevant to their local conditions and in alignment with the guidelines. State urban development departments, the key stakeholders, may study this book for relevant initiatives and may also translate the book in regional languages for more effective use of stakeholders as needed.

I would like to compliment to the team of Centre for Science and Environment for their efforts in development of this publication. I would also like to appreciate the team of managing urbanisation vertical, particularly Dr Biswanath Bishoi, Deputy Advisor, and Mr. Sanjay Gupta, Economic Officer, for their efforts. Mr. Dhiraj Santdasani, Young Professional, deserves special appreciation for putting persistent efforts throughout the development of this publication.

Dr K. Rajeswara Rao, IAS
Special Secretary, NITI Aayog

FOREWORD

A paradigm shift is needed in learning and practice for garbage-free and waste-wise cities

Sunita Narain

India's tryst with garbage – the waste from the use of materials in homes, institutions and factories in its cities – is evolving sharply in policy and practice. This change needs to be recognised and disseminated, so that waste does not add to contamination and become a public health menace. Instead, waste should become a resource, to be reworked, reused and upcycled. This will minimise the use of materials in our world, as well as mitigate environmental damage. It is a win-win scenario. This set of case studies on best practices documents what is being done to make this change happen on the ground.

This, when we know that the 'nature' of solid waste changes as societies get richer and more urbanised. Instead of biodegradable (wet) waste, households generate more and more quantities of plastics, paper, metals and other non-biodegradable (dry) waste. The quantity of the waste (on a per capita basis) increases as well, as wealth increases in society. India has crossed the crux of this waste trajectory in many of its urban areas where waste generation has increased exponentially.

It is estimated that urban India generates between 1,30,000 to 1,50,000 metric tonne (MT) of municipal solid waste every day – some 330-550 gramme per urban inhabitant a day. This adds up to roughly 50 million MT per year; at current rates, this will jump to some 125 million MT a year by 2031. What is also of concern is that not only is the quantity increasing, but the composition of waste is changing – from high percentage of biodegradable waste to non-biodegradable waste. The waste characterisation determines the strategy for its management. And then there is the problem of legacy waste lying in dumpyards scattered across cities. It is estimated that some 800 million MT has been 'disposed of' in the 3,159 dumpsites across the country, according to data from the Central Pollution Control Board (CPCB).

But the good news is that there is complete transformation in the policy for waste management in the country. In the year 2000, when the first Municipal Solid Waste Rules were notified, they were based on the idea – prevalent in most countries of the world at that time – that waste had to be collected, transported and then disposed of in secure landfills. The objective was to 'clean' cities of waste by removing it from the vicinity. This policy failed in practice and mountains of waste grew in our cities. What could not be collected or transported because of paucity of municipal services fouled up our streets and neighbourhoods.

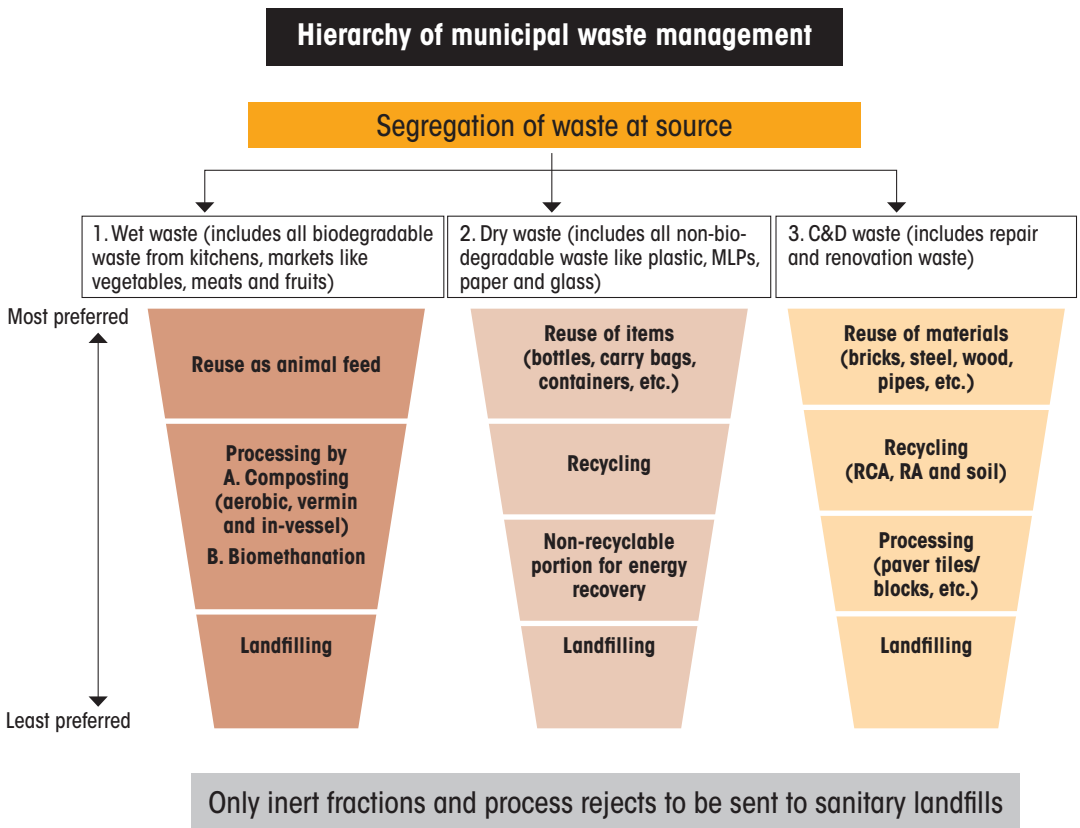
In 2016, Centre for Science and Environment (CSE) published *Not In My Backyard: Solid Waste Management in Indian Cities*; the book was released by then Union minister for urban development and currently the honourable Vice President, Shri M Venkaiah Naidu. This book, which researched the problem of municipal solid waste in the country, brought out the need for a paradigm shift in management. It recommended that India must not use scarce and prized land for disposing of waste. Instead, waste should be treated as a resource and a strategy must be designed for material recovery and reuse.

But what was also clear is that material recovery is not possible without segregation – and that this sorting of waste streams is best done at the household level or at source. The opportunity is to build safe livelihoods from processing of this material wealth. It was also found that whereas in the past, waste could be dumped in the backyards of poor communities as the richer sections of society said '*not in my backyard*'. This scenario was now changing – increasingly and rightly, the poor too were saying '*not in my backyard*'. This essentially meant that it is no longer possible for city planners to find new lands for landfill sites. This was the 'nudge' for correcting policy and practice, as waste needed now to be processed and recycled so that it would no longer be dumped in the backyards of the rich or the poor. We argued that this '*not in my backyard*' of the poor needed to be celebrated so that policy could be reworked.

Over the past few years, there has been a rapid shift in the strategic direction of waste management in the country. The flagship programmes of the Government of India – the Swachh Bharat Mission, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and the Smart Cities programme – have all created an enabling environment to drive this transformation.

The Swachh Bharat Mission (SBM) 2.0, launched on September 1, 2021, is now based on a clear strategy for solid waste management in cities – a strategy that focusses

Components of MSW management – the hierarchy



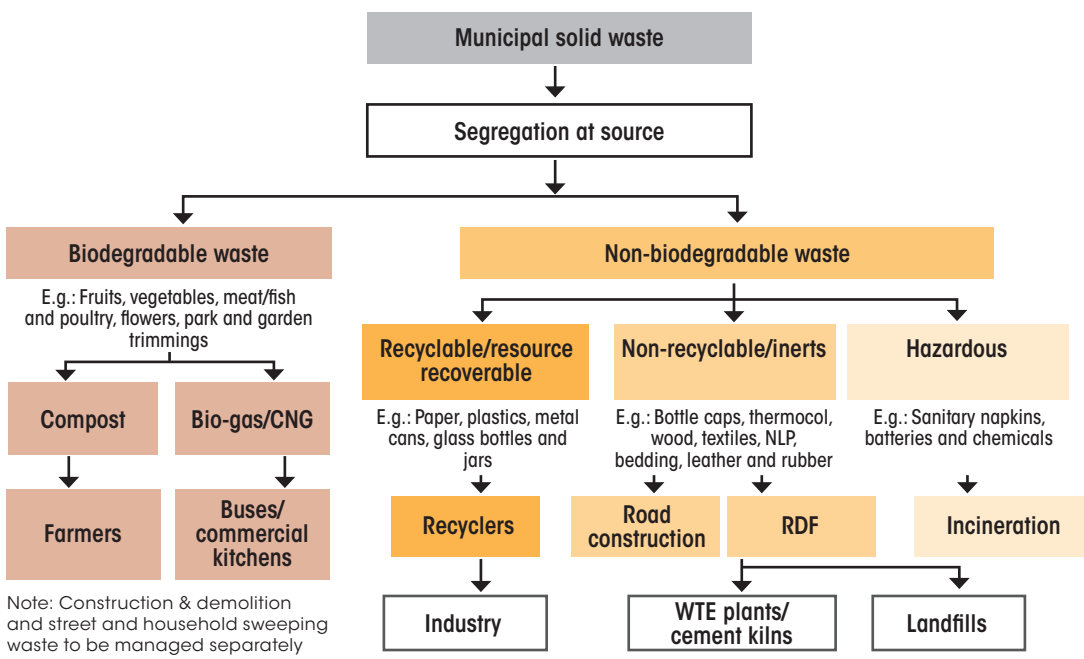
Source: Guidelines for Swachh Bharat Mission (urban) 2.0, 2021

on source segregation, processing of waste (biodegradable and non-biodegradable), and minimising the waste that is sent to landfill sites. According to the guidelines of SBM 2.0, only the inert waste and process rejects – in no case to exceed 20 per cent of the total waste – which are not suitable for either biodegradable and non-biodegradable waste treatment, can be sent to landfill sites. It, therefore, works towards a zero-landfill city concept in the country (see Figure: *Components of MSW management – the hierarchy*).

In terms of management of waste, the guidelines stress that waste-to-energy projects are financially and operationally viable only with assured input of a minimum 150-200 tonne per day of non-recyclable, high calorific value segregated non-biodegradable waste. This has also been our learning as waste-to-energy (WtE) plants are not the silver bullets that they promise to be. The experience in setting up these plants has shown that it is critical that the waste that is sent for incineration for energy generation is high quality; this requires high level of segregation – best done at source. Without this, the plants end up working below their operational capacity and become defunct.

SBM 2.0 also emphasises the need for plastic management – working towards minimising single-use plastic, and operationalising recycling and reuse through processing. This remains an area of further work as it is clear that the scourge of plastic waste needs effective strategies for identification of single-use and non-recyclable plastic. This then needs to be phased out. We also need a better understanding of what recycling of plastic waste entails. This requires cities to provide enabling conditions for safe and environmentally friendly recycling facilities.

Components of MSW management – different types of waste and where they end up



Source: Guidelines for Swachh Bharat Mission (urban) 2.0, 2021

The other big opportunity – but a challenging one – lies in remediating the legacy waste in dumpsites. There is much to learn from city experiences on what is being done and what more is needed to ensure that not only are existing dumpsites cleared of their waste, but also that new dumpsites are not created – these mountains of waste in our cities are unacceptable.

Swachh Survekshan – India's benchmarking and ranking tool – has also evolved to capture the measures that take a city towards source segregation, material reprocessing and zero-landfills.

India's solid waste management strategy is now designed for material recovery and reuse. It is an approach towards a truly circular economy. The fact is that as we learn what we cannot recycle, we will have to work towards minimising its use – this will make policy and practice even more environmentally friendly as it will demand full reutilisation of materials and no waste.

This said, it is clear that while policy has evolved, practice has still to catch up. We need to upscale this paradigm shift across the country: every small or big city and village must be waste-wise.

This needs learning. This needs sharing of experiences on what is working and what is not. Currently, we know that source segregation remains an Achilles' heel – it does not happen at the scale and pace needed. Even if waste is segregated at the household level, it does not get transported in a segregated manner to the processing facilities. In fact, processing happens incidentally, only because there are people who need our waste for their livelihoods – ragpickers, as we call them. City managers are still working through the different options for processing, and to manage these effectively for revenue generation. Worse, plastic waste – particularly much of the packaging waste – is growing and filling our cities. We certainly need a course correction.

The fact also is that we are in an exciting phase of development, where city managers and leaders are indeed learning from ground experience; they are reworking their strategies and implementing change at scale. These cities are our inspiration, as well as our textbooks for learning.

In 2017, CSE started the 'Forum of Cities that Segregate' to create a platform for showcasing city-wide success stories and to develop a knowledge-exchange hub. This then works to build internal capacities, to assess progress, to provide handholding support and to document the best practices to use as an effective instrument for training and exposure.

We are delighted to have had this opportunity to partner with NITI Aayog to take this initiative forward and to ensure that constant learning of best practices and their application will make our cities garbage-free and waste-wise.

Sunita Narain
Director General
Centre for Science and Environment
New Delhi

INTRODUCTION

This book is about the winds of change. Over the past few years, Indian cities have witnessed a steady departure from the traditional practice of managing municipal solid waste to a more environment-friendly and financially sustainable system.

There is greater emphasis on source segregation for sustainable solid waste management and to moving from 'linearity' to 'circularity'. The focus is on:

- Remediation of all legacy dumpsites;
- The well-being of sanitation and informal waste-workers;
- The need to phase out single use plastic;
- The opportunity to introduce technological innovation through digital tracking; and
- Most importantly, on the absolute need for source segregation as the way for material recovery and recycling. Waste is no longer waste for our waste-wise cities.

ABOUT THE STUDY

For driving the change through knowledge and evidence-based learning, NITI Aayog and CSE have collaborated to capture best practices in various facets of municipal solid waste management.

The process of identifying best practices was based on the implementation experience of the flagship Swachh Bharat Mission 1.0 and performance of the cities in the Swachh Survekshan assessment in 2018–20. Through this, 28 cities were identified from 15 states of India in 10 thematic areas of municipal solid waste management. These cities aligned with the current priorities on sanitation and solid waste management as laid out in Swachh

Thematic areas

Priorities/thrust areas for practice and innovation	Cities
Source segregation	Indore, Alappuzha, Panaji
Biodegradable waste management	Mysuru, Vengurla, Bobbili
Material processing	Bhopal, Surat, Jamshedpur, Dhenkanal
Plastic waste management	Gangtok, Bicholim, Kumbakonam
C&D waste management	North Delhi, Gurugram
Sanitary waste management	Pune, Karad
Landfill	Taliparamb, Chandrapur, Ambikapur
Technological innovation	Bengaluru, Leh, Vijaywada, Keonjhar, Kakinada
Innovative model	Paradeep, Thiruvananthapuram, Panchgani
E-waste	Jamshedpur

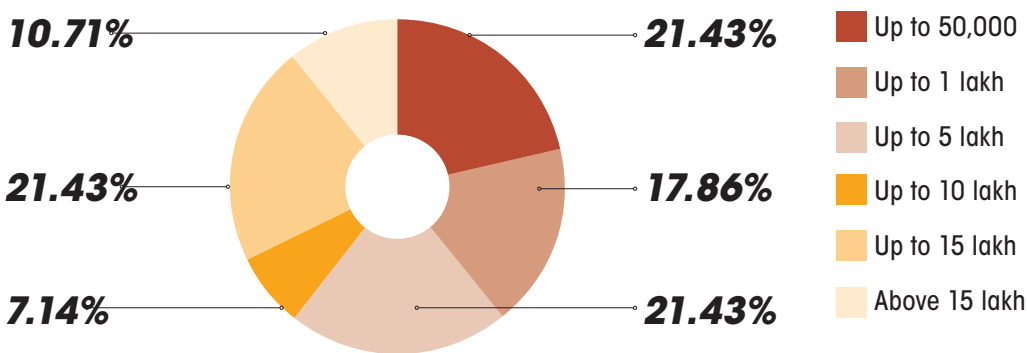
Source: CSE

Bharat Mission (SBM) 2.0, Atal Mission for Rejuvenation and Urban Transformation 2.0 (AMRUT) and Swachh Survekshan 2022 Toolkit. Key thematic areas were picked up for this exercise (see Table: *Thematic areas*).

While each city has been identified on the basis of a specific thematic area, the following is a snapshot of the key solid waste management parameters in the cities selected for the study.

The 28 cities selected for this study have populations in the range of 50,000 to above 5 million (see Graph: *Population-wise distribution of cities*).

Population-wise distribution of cities

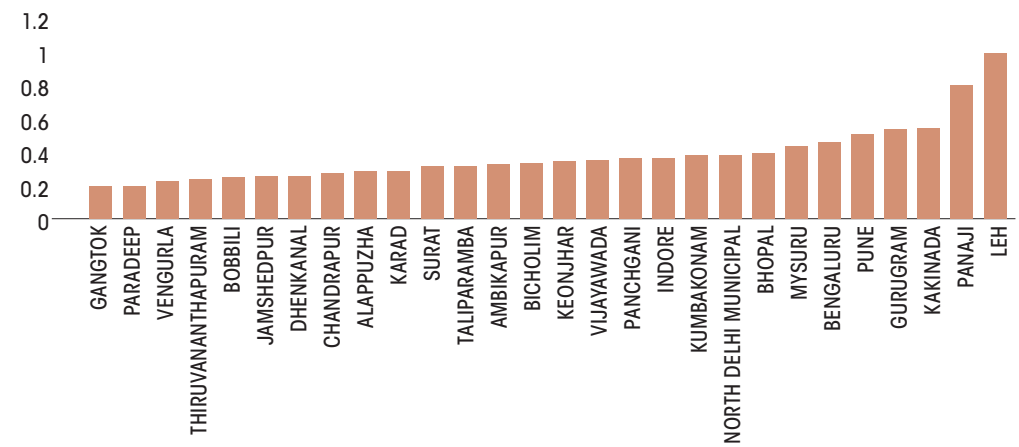


Source: CSE compilation

1. Per capita per day generation of municipal solid waste

The per capita per day solid waste generation has been estimated using the current (2021) estimated population and daily floating population. The per capita per day solid waste generation in the 28 cities is in the range of 0.19–0.99 kg and the average for all 28 cities is 0.39 kg. This is representative of the country-wide per capita waste generation, with bigger and more affluent cities adding more waste per day. For instance, Leh and Panaji, both tourist towns, have a much higher waste generation footprint than the country's average of 0.3–0.5 kg/day/person.

Per capita per day generation (in kg) of municipal solid waste



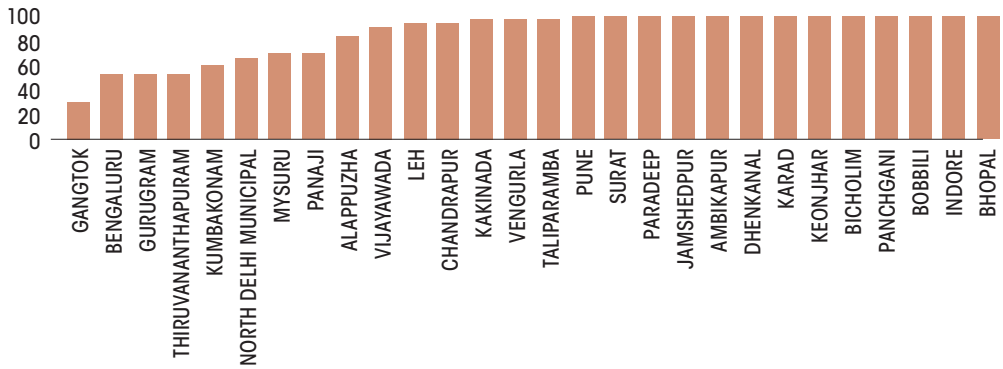
Source: CSE compilation from data provided by ULBs

In the 28 cities, deployment of sanitation workers for managing one tonne of municipal solid waste was in the range of 0.04–0.9. Significantly, cities with a decentralized system in place needed significantly lesser humanpower for managing their solid waste.

2. Processing rate of municipal solid waste

The 28 selected cities are working to close the gap to achieve 100 per cent waste processing efficiency. But it is a work in progress and cities like Gangtok, Bengaluru, Gurugram, Kumbakonam and North Delhi are in the process of improving their processing efficiency.

Percentage of waste processed by cities



STRUCTURE FOR DOCUMENTATION

The report for each city has focused on the thematic area while presenting the overall state of municipal solid waste management. The structure of the report comprises the following key elements:

TRANSFORMATION	The section speaks about what triggered the change in the city to ameliorate solid waste management by adopting appropriate measures for addressing the challenges.
HOW THE SYSTEM WORKS	This section has covered the implementation strategy and operational elements that has helped the city to emerge as a model on the thematic area.
WHAT HAS WORKED	This section has highlighted the specific actions taken by city government in line with the adopted strategy and plan that has been pivotal to drive the change.
LESSONS LEARNT	The section focuses on the key learnings emerged from the study in terms of inclusivity, strategy, plan and implementation model for practitioners to improve their waste management systems.
REPLICABILITY	This section highlighted the elements to substantiate whether the model instituted by the city is replicable – what are the prerequisites to replicate the model in any city.

BEST PRACTICES: HIGHLIGHTS

The documentation focusses on each city's strengths so that learning is based on best practice, its experience and its innovation.

Source segregation

Allappuzha (Kerala), Indore (Madhya Pradesh) and Panaji (Goa)

Source segregation is a fundamental and non-negotiable condition for a sustainable waste management ecosystem. Mixing waste at source creates a myriad of problems. Mixed waste also increases the risk of contamination of recyclables and significantly reduces their economic potential. Even if waste is to be incinerated to generate energy, segregation is key. It has been proven time and again that cities that segregate their solid waste have been able to realise the actual value of waste.

Alappuzha: Alappuzha embarked on a project called Clean Home Clean City that focussed on source segregation as the first and foremost step towards effective waste management. This decreased the operational cost of dealing with waste as well as created a source of revenue. Awareness campaigns by the city government to promote source segregation led to remarkable changes in the attitude and practices of the citizens. This involved all the stakeholders to work for a common cause to improve the overall solid waste management in the city.

Indore: The city had a robust communications strategy to bring about behavioural change at the mass level. The aim was to motivate citizens to embrace segregation. This was followed by a robust monitoring system and enforcement through a series of by-laws. Once segregation was achieved, the city undertook a study to ascertain the population and the amount of waste generated in each ward, based on which a route plan was developed. Vehicle and staff demand was arrived at to meet the waste collection demand of each ward. Through source segregation, participation of all stakeholders and good governance, Indore has become a champion and number one city in the waste management sector in India.

Panaji: Panaji has worked over the last 15 years to achieve 99 per cent segregation. Primary segregation was done in two or four bins by the households. In 2021, the city implemented 16-way segregation at source – this was done along with adopting several technologies and initiatives for waste management. The model provides significantly higher revenue from the sale of recovered goods, increasing the income of the workers involved in the value chain.

Biodegradable waste management

Bobbili (Andhra Pradesh), Mysuru (Karnataka) and Vengurla (Maharashtra)

On an average, organic waste consists of more than half of the solid waste that we generate as a country. This means that if we take care of our organic waste, half of our

waste woes will go away. Moreover, three quarters of the organic waste is water. Indian cities have been known to spend most of their budget on collection and transportation of solid waste. This means that we are spending our tax payers' money and burning fossil fuels to transport water from one point to another. This calls for the need to manage our organic waste as close to the source as possible. That is exactly what these cities have been able to achieve.

Bobbili: Bobbili's municipal administration decided to overhaul the town's solid waste management system, and immediately and rightly turned their focus to source segregation as the lynch-pin of the whole exercise. Over the years, they have been able to make good use of the information, education and communication (IEC) programme and the Andhra Pradesh government's real-time monitoring system to improve source segregation to 100 per cent. The town produces a substantial quantity of wet waste, and composting, whether at the household level or at scale in the form of windrow and vermicomposting, has worked well in Bobbili. In tandem with the biogas plant, the various means of composting have proved adequate to process all of the town's organic waste.

Mysuru: The game changer for Mysuru was the zero-waste management plants in each zone that received segregated biodegradable fractions of solid waste from five wards on an average. The city is the torchbearer in the field of biodegradable waste processing. Collected biodegradable waste is converted to compost by means of scientific methods. Appropriate infrastructure has been developed for proper processing of biodegradable waste. The compost is then packaged and sold to nearby farmers and the horticulture department.

Vengurla: Vengurla adopted a two bins-two bags – green for biodegradable waste and blue for non-biodegradable waste – approach for source segregation. Sanitary waste and domestic hazardous waste were collected separately. The council's choice of technologies and systems – from vermicomposting and bio-biomethanation for kitchen waste and organic waste converter for fish or meat and fibrous wastes, to briquetting for biomass and green foliage waste – can be easily incorporated in any kind of urban centre, irrespective of the size of the population or the area. The city processes 100 per cent of the organic waste that is generated.

Material processing

Bhopal (Madhya Pradesh), Surat (Gujarat), Jamshedpur (Jharkhand) and Dhenkanal (Odisha)

Municipal solid waste comprised a wide variety of materials that we use in our daily lives. Materials in our solid waste range from biodegradables to plastics, papers, metals, glass etc. The value of these materials is a function that is inversely proportionate to the degree of mixing of waste. Solid waste usually leaves our homes in not more than three fractions – biodegradable, non-biodegradable and domestic hazardous waste as mandated by the rule, but at the secondary sorting-cum-material recovery facility, the collected three fractions have been proven to contain over 50 different materials that need to be channelised to specific facilities for scientific processing and converted to new products.

Bhopal: The change happened due to the cooperation of citizens who had to manage their waste properly and hand it over to the municipal workers who provided daily waste collection

services. This was made possible by several initiatives focussing on behaviour change. With an array of well-designed systems, the city has achieved 100 per cent source segregation, 100 per cent collection and 99.6 per cent treatment facility. The 85 municipal wards have been divided into 19 zones with each having four to six wards for ease of planning, monitoring and implementation. With efficient integration of the informal sector and setting up a robust monitoring system, the city has made a complete transformation to count among the best 10 cities in the country.

Surat: Surat doubled in size between 1981 and 1991, and faced a massive challenge to manage their solid waste to keep pace with the increased population. It adopted a multi-pronged approach of achieving 100 per cent source segregation, investment for construction, operation and maintenance, channelization of recyclables and refuse-derived fuels to achieve a high material processing efficiency. This resulted in substantial reduction of the waste received in the landfill.

Jamshedpur: Jamshedpur has proved to be a model of material recovery by establishing Dry Waste Collection Centres (DWCCs) to manage its non-biodegradable waste, where the waste is further segregated into paper, metal, wood, cloth, non-recyclables and packaging materials. Nearly 1,400 ragpickers are employed at the DWCCs as they are expert in extracting recyclables and reusable materials from waste, and act as a critical workforce in managing recyclables. In addition, the decentralised biodegradable waste processing units complement this system. In addition, Jamshedpur has constructed more than 20 km of roads using non-recyclable plastic waste collected from plastic from the DWCCs. The concept of eco-bricks has been popularised in schools and residential societies in Jamshedpur to promote the storage of non-recyclables at the household level.

Dhenkanal: The Odisha state government took a leap towards implementation of decentralised waste management and made it mandatory for all the urban local bodies in the state. Following the directive, the Department of Housing and Urban Development shared a standard operating procedure as a guideline to develop decentralised waste management units. The city councils then involved the local self-help groups, who were trained. They in turn built capacity of every household, resulting in behaviour change amongst the citizens. By political will, realising the importance of public awareness, involvement of the local community and importance of converting waste to resource, Dhenkanal achieved 100 per cent material processing.

Plastic waste management

Bicholim (Goa), Gangtok (Sikkim) and Kumbakonam (Tamil Nadu)

Over the last few decades, plastics have become an inherent part of our lives. They have replaced all conventional materials because they are cheap, lightweight, durable and versatile. Unfortunately, these properties also turned the wonder substance into a cause for concern for most urban local bodies. Management of plastic waste has turned out to be a massive challenge due to its versatility and low awareness among consumers and authorities alike. This means that we don't know what type of plastic goes to which kind of facility and how it gets – if at all it does – recycled. A handful of Indian cities have shown the way ahead to face this challenge head-on.

Bicholim: Bicholim is especially focussing on managing non-biodegradable waste and continues to act proactively to reduce the impact of plastics on the environment and human health. Bicholim has not only managed to process its own waste but is also accepting waste from neighbouring urban local bodies, hence dealing with the non-biodegradable fraction of the entire taluka.

Gangtok: Gangtok adopted an alternate strategy to minimise the environmental and health hazard of plastic waste pollution. Sikkim was the first Indian state to ban disposable plastic bags as early as June 1998. In 2016, the city also banned the use of packaged drinking water in government offices and offices. This was in addition to the ban on disposable plastic plates and cutlery. The ban was effective because the city government followed it up with awareness and enforcement activities on the ground. All the stakeholders were capacitated to understand the impacts of plastic waste on their city and were thus able to effectively contribute to curbing the use of plastic.

Kumbakonam: Kumbakonam recognised and mandated source segregation as the most important step to creating a city free of plastic waste. Following the ban on plastic by the state government in 2019, the city was quick to set up a resource recovery facility. While the recyclable fractions were being sent to the recycling industries, non-recyclable plastic was converted to refuse-derived fuel and channelized to cement factories for co-processing. In its endeavour to become a bin-free and a garbage-free town, Kumbakonam has not resorted to any shortcuts focussing on a holistic model of waste management instead.

Construction and demolition (C&D) waste management

North Delhi (Delhi) and Gurugram (Haryana)

India generates an estimated 150 million tonne of construction and demolition (C&D) waste every year out of which it is being able to recycle merely about 1 per cent. C&D waste is bulky in nature and a significant proportion of this waste stream can be potentially recycled and reused and brought back to construction to replace the dependence on virgin raw material. In addition, recycling C&D waste can help reduce the environmental footprints of buildings and infrastructure.

North Delhi: Delhi produces nearly 5,000 tonne of construction and demolition (C&D) waste out of which North Delhi region generates nearly 2,000 TPD daily. The illegal dumping of C&D waste leads to choking of water drains and polluting Yamuna River. Nearly, 37,000 m^3 of debris was found lying near the eastern bank of Yamuna and 53,000 m^3 of debris on the western Yamuna bank. To address the issue, a C&D processing plant with a capacity of 2,000 TPD was established in Burari, Delhi in 2009. The plant is currently scientifically processing 2,000 TPD of mixed C&D waste and converting it into aggregates, which in turn is converted to ready mix concrete, cement bricks, hollow bricks, pavement blocks, kerbstones, concrete bricks, and manufactured sand, thereby reducing the consumption of virgin construction raw material and minimizing the environmental hazard due to C&D wastes. Over 16 lakh recycled concrete blocks from the plant have been utilized in the new Supreme Court annex building.

Gurugram: Gurugram generates approximately 1,200 TPD of C&D waste. Additionally, the areas governed under the Haryana Urban Development Authority (HUDA) also generate a substantial quantity of C&D waste. In order to address the hazards due to dumping C&D waste, a C&D waste processing facility with a capacity of 300 TPD was established. This became functional in 2019, ensuring proper collection, transportation, processing and disposal of C&D waste. Gradually, the processing capacity of the plant has increased to 1,500 TPD. Due to this initiative, nearly 12 lakh tonne of C&D waste has been collected from unclaimed dumpsites and transported so far through doorstep collection and enforcement activities. Out of this, nearly 3.5 lakh tonne has been processed.

Sanitary waste management

Karad (Maharashtra) and Pune (Maharashtra)

Sanitary waste management has been the least explored and debated of all the streams of solid waste that is generated at the household level. As per the Solid Waste Management Rules, 2016, sanitary waste has to be handed over along with the dry waste bin. The handling and channelisation of this stream of waste involves occupational hazards and is a matter of concern for most cities.

The following two cities of India are showing the way to deal with this stream of waste:

Karad: Karad struggled initially to manage its sanitary waste due to a number of social and technical issues. By managing to break the taboo around sanitary waste, the city administration has achieved a 100 per cent sanitary waste collection rate. The city also ensures that sanitary waste is transported and processed separately in the local Common Biomedical Waste Treatment Facility (CBWTF). All this was achieved through minimal investment on infrastructure and higher accountability amongst citizens and city government through a combination of communication and enforcement strategy.

Pune: The city introduced the Red Dot campaign, a one-of-its-kind initiative, where citizens, workers and administration unanimously accepted their responsibility, making it a lesson for other cities in India. This was achieved through a well-planned mechanism of collection, channelisation and disposal. The city administration is in the process of exploring a state-of-the-art technology to make value added products from their sanitary waste.

Zero-landfill city model

Ambikapur (Chhattisgarh), Chandrapur (Maharashtra) and Taliparamba (Kerala)

A zero-landfill model offers a technically appropriate, environmentally and economically sustainable and socially acceptable model that is based on resource recovery and principles of circular economy. It advocates the need for continuous effort to phase out the dependency on landfills for waste disposal. A zero-landfill city ensures that maximum quantities of waste is subjected to scientific treatment and recycling measures and negligible waste is generated as residual solid waste or rejects, thereby minimising the need to construct new landfills. It is a holistic and multi-stakeholder approach that ensures that waste is segregated at the source itself, recyclables are extracted and channelized to the recycling industries for various gainful applications, and biodegradable waste is treated in a decentralised manner.

Ambikapur: Before 2015, Ambikapur displayed the usual manifestations of a town – overflowing community bins and waste dumped indiscriminately near roads, streets and a garbage mountain containing legacy waste. With the intervention of the local administration and women self-help groups and inspired by the concept of the Garbage Clinic Model, the city is now able to achieve 100 per cent segregation, collection and processing of waste. The waste is brought to the Solid and Liquid Resource Management (SLRM) Centre, where the recyclables are first extracted into 20 inorganic fractions by secondary segregation, followed by 156 categories in the tertiary segregation. The legacy waste dumpsite is cleared by the urban local bodies and now being used as waste recycling centre.

Chandrapur: The city, even five years ago, collected mixed waste and dumped it indiscriminately in the Ballarpur dumping ground. There were 800 garbage-vulnerable points and 110 community bins haphazardly receiving mixed waste. In 2016, Chandrapur achieved 85 per cent source segregation and nearly 95 per cent waste processing by sensitising all the stakeholders through extensive Information, Education and Communication (IEC), capacity-building programmes and awareness campaigns. Parallelly, the existing dumpsite containing 68,593 cubic metre of legacy waste is also remediated by biomining. The land recovered has been converted into an integrated waste treatment facility with a sanitary landfill constructed only for receiving the rejects generated from various waste treatment units ensuring that only negligible waste fraction is disposed of in the landfill.

Taliparamba: Till 2012, the town was sending all its waste to a 2.5-acre dumpsite, affecting the local population and environment. The city reinvented its waste management practices and adapted a decentralised system after 2012, with the help of women self-help groups. Today, 85 per cent of Taliparamba's households adhere to the door-to-door collection process and almost 99 per cent of waste is processed in a scientific manner. The city has also reclaimed the dumpsite land which is now the town's material recovery facility. In addition, the city has provided bio-bins to about 9,500 households for practicing home composting thereby ensuring that wet waste is treated in decentralized manner significantly reducing the transportation cost and burden on landfills.

Technological innovation

Kakinada (Andhra Pradesh), Leh (Ladakh), Bengaluru (Karnataka), Keonjhar (Odisha) and Vijaywada (Andhra Pradesh)

Application of innovative technologies in waste management is essential in order to make the system more sustainable by ensuring efficient collection and transportation of waste enhancing recycling efficiency, minimising energy and resource requirement in waste treatment and most importantly monitoring of waste management-related activities. Technological innovation in waste management and treatment in India is currently mostly in the nascent phase. The transformation of the waste management sector in India should be aligned with innovative technology options which can be replicated all across the country to recover wealth from waste. The cities selected under these segment have made efficient use of technologies like global positioning system, radio frequency identification, global system for mobile communications, machine-to-machine communication and

internet of things, along with innovative mobile and web-based applications to improve and smoothen ground-level mechanism for collection and efficient processing and recycling of waste.

Kakinada: In July 2020, when the city reopened after a prolonged lockdown due to the Covid pandemic, the streets and roads were full of garbage. The city was struggling with complaints in connection with waste management from all corners. After a series of deliberations to deal with the situation, the city introduced advanced Information, Communication, and Technology (ICT) solutions such as Radio Frequency Identification (RFID)-based technology to improve the city's door-to-door waste collection efficiency and GPS technology to track the movements of its waste collection vehicles. Concurrently, several awareness campaigns were conducted across the city to sensitize citizens on the need for source segregation and no littering. Within a year, the city achieved 100 per cent door-to-door collection, 60 per cent waste segregation, and 51 per cent of waste processing.

Leh: Till 2019, Leh did not have a proper mechanism for the treatment and scientific disposal of waste generated in the city. Waste remained untreated because of lack of funds for a treatment facility and to buy machinery to segregate and treat waste as well as to pay for the electricity needed to run the machinery. Due to a constant influx of tourists, Leh faced a growing problem of waste disposal. However, in 2020, with the help of Ladakh Autonomous Hill Development Council (LAHDC) the municipal committee installed a 30 tonne per day capacity solar power-based solid waste management plant which is running successfully. Leh has achieved 100 per cent source segregation and 90 per cent material recovery at the facility to generate revenue from recyclables and compost have been successful and the system works efficiently.

Bengaluru: Monitoring of waste management practices has been one of the significant challenges in Bengaluru for the past few years. In 2020, to monitor the services and synchronise coordination among different waste management concessionaires, Bruhat Bengaluru Mahanagara Palike (BBMP) employed several Information, Communication, and Technology (ICT) solutions, including an RFID-based attendance system and geotagging of collection routes to monitor the waste management services. In addition, a mobile-based application called Ezetap has been designed to monitor garbage-vulnerable points and impose penalties on offenders. With the intervention of these ICT-based technology solutions, BBMP has achieved 100 per cent door-to-door garbage collection and has made the entire city completely free from garbage-vulnerable points.

Vijaywada: The city adopted a decentralised waste management system with state-of-the-art technologies for treating various fractions of waste and a real-time monitoring system, which significantly contributed in achieving 100 per cent source segregation and more than 90 per cent processing efficiency. In addition, 52 out of 64 wards in the city have been declared bin-free. The remaining 12 wards consisting of bins are closely monitored through closed-circuit cameras that are connected to the Command Control Centre in the Corporation. The city also adopted QR (Quick Reference) Code-enabled RFID tags for monitoring the waste collection. At various locations, 45 smart bins and 32 smart semi-underground garbage collection bins are also installed that sends alerts to authorities as