

soon as they are full. Waste from these bins are collected and cleaned as soon as they are filled. In addition, mechanised sweeping is also introduced to avoid spilling of garbage and for saving time. The collection vehicles are fitted with GPS devices for effective route monitoring.

Keonjhar: To make Keonjhar garbage-free and promote source segregation with the help of women's self-help groups, the city adopted several innovative technological measures to improve its waste management system. GPS-enabled vehicles and transportation has been introduced for monitoring waste collection and segregation. The city has made the system more robust and transparent by putting details of fees and fines collected and the finances of micro-composting centres and material recovery facilities on a publicly accessible mobile-based app (Ama Sahara app). Littering is monitored, and penalties are imposed through CCTV cameras installed at public places. The city has achieved 100 per cent source segregation and processing with no garbage-vulnerable points largely due to technological and policy-related interventions.

Innovative models

Paradeep (Odisha), Panchgani (Maharashtra) and Thiruvananthapuram (Kerala)

Paradeep: Paradeep has adopted a decentralised and community-driven model with micro-composting centres and material recovery facilities. With active involvement of women groups, third-gender groups and ragpickers' associations, the city has shown a new waste management model that is inclusive as well as economically sustainable. The model for this initiative is based on economic sustainability. The revenue generated or collected from user fees and from selling of recycled product is always higher than the budget expenditure. The total expenditure incurred in waste management (February–July 2021) was found to be Rs 20.5 lakh while the revenue generated was found to be Rs 23.3 lakh, reflecting a net profit of Rs 2.8 lakh. The major source of revenue is user fee collection, fines, selling of recyclables from material recovery facilities and compost. The city successfully processes 100 per cent of its waste generated.

Panchgani: In 2001, after the declaration of Panchgani as an 'eco-sensitive zone' by the Central government, it became mandatory for the Municipal Council to ensure source segregation and processing of the waste generated in the city. The city conducted extensive information, education and communication (IEC) programmes to sensitise citizens. This has helped them to secure 100 per cent source segregation and processing. The town has invested in constructing material processing and recovery systems, using the pollution tax levied on tourists to create and operate these systems. The city's waste infrastructure has matured to gain the ability to process almost all of the city's waste. The centralised organic waste processing unit works along with decentralised composting at the household and bulk waste generator levels. The total revenue generated is Rs 17.2 lakh. Capital investment for the processing centre was either through corporate social responsibility (CSR) or local donations accounts for Rs 16.2 lakh, thereby leaving a difference between expenditure and revenue for about Rs 1 lakh per month. The council however hopes to plug this gap going forward.

Thiruvananthapuram: TMC adopted a sustainable economic model and supported long-term economic growth without adverse social, environmental or cultural impacts on the community. Segregated wet waste such as chicken or meat waste is turned into fertiliser and has a reasonable market value. It also has a service charge – the agencies provide fees to the municipality. Like biodegradable waste, non-biodegradable waste that is segregated and recycled is sold. Income is thus generated from proper management of both biodegradable waste and non-biodegradable waste. Expenditure on collection and transportation is nil. Expenditure is incurred only for disposal. Revenue is generated from selling recyclables and non-biodegradable waste.

E-waste management

Jamshedpur (Jharkhand)

The use of electrical and electronic equipment has witnessed an explosive growth and so is e-waste. The UN has termed this phenomenon a “tsunami” of e-waste. While e-waste is a problem, it can easily be moulded into a solution. It is the most valuable of wastes, as it contains many rare and precious metals and materials. E-waste typically does not feature in the list of municipal solid waste and therefore not a direct mandate for the cities to collect, transport and manage. However, looking at its exponential growth, it is now time to rethink the policy framework and recognise the city government as one of the key institution to spearhead e-waste management. While most of the cities are not considering e-waste in their solid waste management portfolio, some cities did walk the extra distance to create an example.

Jamshedpur: Before 2018, hundreds of local kabadiwalas and recyclers in Jamshedpur collected e-waste and burnt it to obtain valuable metals from it. During the process, they would expose themselves and the environment to toxic fumes and chemicals. As is the case with other cities in India, this was an unsustainable situation. The city administration decided to step up and take the initiative to deal with e-waste challenges. The city embarked into engaging a company as the producer responsibility organization (PRO) to manage its e-waste. The city has been able to establish a very efficient e-waste collection mechanism already. Out of the 230 tonne of e-waste collected so far, 95.5 tonne have collected in 2021 alone. The collected waste is channelized to the authorized e-waste recycler. The cost of collection, transportation and channelisation is entirely borne by the hired agency thereby leaving no financial burden on the city government.

The compendium of the best practices is a good resource book for the developing cities to get new ideas, learn about the strategies, institutional arrangement, technologies and implementation modalities that has made things possible for the best cities to emerge as a stand out performer. These cities could well be a learning laboratory through exposure visit and the evidences needs to be showcased at appropriate forum and scale to reach the masses. One of the better ways to build capacities of the city government in managing municipal solid waste management is to, going forward, showcase these models in a way that they get replicated all over the country.

WASTE-WISE MAP

28 cities from 15 states of India in 10 thematic areas of municipal solid waste management

(The figures in brackets indicate the population of the respective cities)



SANITARY WASTE MANAGEMENT

PUNE (4.29 million)
KARAD (86,000)



SOURCE SEGREGATION

INDORE (2.6 million)
ALAPPUZHA (0.18 million)
PANAJI (45,800)



LANDFILL MANAGEMENT

TALIPARAMBA (45,600)
CHANDRAPUR (0.41 million)
AMBIKAPUR (0.14 million)





MATERIAL PROCESSING

BHOPAL (2.1 million)
SURAT (5.73 million)
JAMSHEDPUR (0.78 million)
DHENKANAL (83,200)



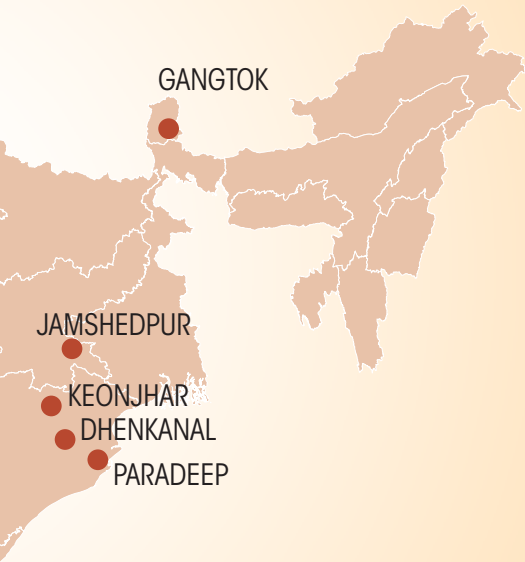
PLASTIC WASTE MANAGEMENT

GANGTOK (0.26 million)
BICHOLIM (18,700)
KUMBakonAM (0.14 million)



BIODEGRADABLE WASTE MANAGEMENT

MYSURU (0.98 million)
VENGURLA (12,400)
BOBBILI (67,500)



TECHNOLOGICAL INNOVATION

BENGALURU (13.48 million)
LEH (43,500)
VIJAYAWADA (1.19 million)
KEONJHAR (67,000)
KAKINADA (0.38 million)



E-WASTE MANAGEMENT

JAMSHEDPUR (0.78 million)



C&D WASTE MANAGEMENT

NORTH DELHI (10.89 million)
GURUGRAM (1.9 million)



INNOVATIVE MODEL

PARADEEP (82,000)
THIRUVANANTHAPURAM (1.34 million)
PANCHGANI (18,000)

*Map is not to scale



SOURCE SEGREGATION

Source segregation is a fundamental and non-negotiable condition for sustainable waste management.

Only through efficient source segregation have cities been able to treat their waste scientifically and reduce dumping in landfills; prevent land, water and air pollution; and realise economic benefits from processing waste.

Alappuzha: The city embarked on the 'Clean Home Clean City' project focussed on source segregation.

Indore: Through source segregation, participation of a wide array of stakeholders and good governance, the city has become a champion of waste management.

Panaji: A true pioneer in solid waste management with its sheer focus on source segregation, the city has achieved 99 per cent source segregation.

ALAPPUZHA

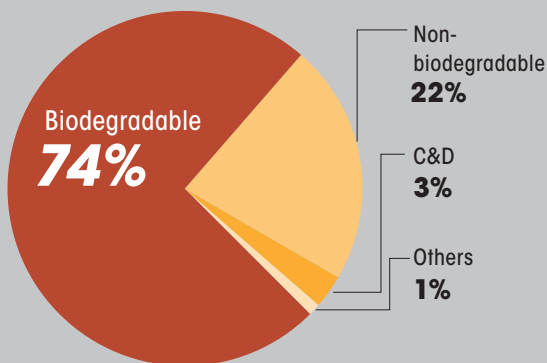
Alappuzha saves its water bodies from clogging up with waste by practicing source segregation



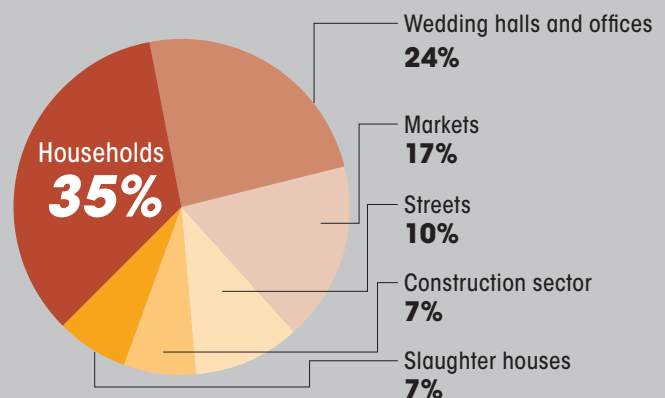
Alappuzha, a city with an extensive network of canals, is quite densely populated. It generates about 56 tonne of waste daily (311 g per person per day). While clogging of water bodies due to excessive dumping of waste is a problem across India, it was particularly accentuated here. The Alappuzha Municipal Council (AMC) has distinguished itself by its success in source-level segregation coupled with decentralised waste management. For its sustainable waste management practices, Alappuzha received recognition from the United Nations Environment Programme in 2017.

Waste composition in Alappuzha

Total waste **56.5 TPD**



Sources of waste





Population (in million, as per 2011 Census)

0.17



Estimated current population (in million)

0.18



Estimated floating population (daily)

20,000



Area (sq km)

46.77



Number of households (2021)

48,000



Number of wards

52



Number of zones

5



Municipal solid waste generation

(in tonne per day or TPD, excluding C&D waste and inerts)

56



Number of sanitation workers

214



Number of community bins

0*



Number of garbage-vulnerable points

0*



Waste management vehicle fleet size

57



Percentage of households covered under door-to-door waste collection

76



Percentage of households segregating waste

100



Percentage of waste processed

84

THE TRANSFORMATION

Before 2011, Alappuzha was in severe distress because of mismanagement of waste. The municipal corporation used to dump waste in a six-hectare plot it owns in Sarvodayapuram, a village located in the nearby Mararikkulam panchayat. There were no centralised or decentralised waste treatment plants in the city. Rotten garbage had piled up on roadsides, and canals and drains were clogged with bags of stinking waste from hotels, markets and meat shops. Dirt used to spread everywhere in the heavy rains. Swarms of mosquitoes and flies invaded the city every year spreading chikungunya and dengue.

To deal with its mounting waste problem, the city embarked on a project called 'Clean Home Clean City' under the guidance of the then MLA of Alappuzha. This project focused on source-level segregation as the first and foremost step towards effective waste management. Initially, the project was implemented in 12 wards. After achieving positive results in those, it was extended to all 52 wards. Nearly 100 per cent of the waste is now segregated at source. That has decreased the cost of dealing with waste as well as created a source of revenue.

Alappuzha Municipal Council has received national as well as global recognition for its performance in waste management. Some of the awards are mentioned below:

- Kerala State Government Energy Conservation Award – 2013-14, 2014-15
- Kerala State Pollution Control Board Award – 2014-2015, 2015-2016, 2016-2017
- CSE award for Clean City 2016
- Kerala State Pollution Control Board Award for Best Waste Management Practice, 2018
- First position in Kerala in Swachh Survekshan Survey 2019
- Award for the best small city in 'innovation & best practices' in Swachh Survekshan Survey 2020

* According to the Swachh Survekshan ranking (Star Rating for Garbage-Free Cities) parameter, zero community bins and zero garbage-vulnerable points are strong indicators of an efficient solid waste management system.

Source: Alappuzha Municipal Council

To achieve source segregation, the municipality recognised that it needed the active participation of citizens. Thus, it undertook massive awareness drives explaining how the city's waterbodies would not survive without successful segregation of waste at source. Through different Information, Education and Communication (IEC) methods adopted to reach different strata of the society, the importance of scientific waste disposal strategies reached everyone. Both households and institutions enrolled with the project and brought about major changes that led to the rejuvenation of Alappuzha's waterbodies and its tourism sector. The Alappuzha model of waste management received recognition in Kerala, then nationally, and finally in global circles.

HOW THE SYSTEM WORKS

To begin with, AMC targeted unnecessary generation of waste at source. Fines and penalties were implemented to make citizens careful about their waste practices. Awareness programmes have been launched to both reduce and segregate waste at the household and institutional levels.

AMC has ensured citizen participation in the project: 48,000 households from 52 wards were issued notices mentioning the importance and need for the project. Ward-level health sanitation committees have been formed which hold monthly meetings. At the zonal level, a meeting is held every two months. The municipality has conducted 44 programmes in educational institutions, 1,600 programmes for SHG members, 12 programmes for drivers of sanitation vehicles, 16 programmes for arts and sports clubs, 22 programmes for Student Police Cadets (SPC) and National Service Scheme (NSS) volunteers, and more than 50 programmes as part of Canal Rejuvenation Program (CANALY). Groups like Kerala Shastra Sahithya Parishadh (KSSP) have also played a significant role in increasing public awareness by conducting upwards of 100 programmes.

Door-to-door collection of waste in all 52 wards is done by a women-run self-help group (SHG) called Haritha Karma Sena. About 76 per cent households participate in this initiative by segregating non-biodegradable waste and paying user fees. The SHG only collects non-biodegradable waste while biodegradable waste is handed over to the community aerobic bins by people who don't have bins in their households. Non-biodegradable waste is collected once a month from households and once a week from commercial establishments. Fifty mechanised vehicles and seven non-mechanised vehicles are engaged in transportation of waste. Of the mechanised vehicles, three are auto-tippers and four are covered tippers. Six vehicles have compartments for collecting segregated waste.

Non-biodegradable waste is collected at 32 mini-material collection facilities (MCFs), each with a capacity of 1.5 tonne. From the MCFs, the waste goes to four centralised material recovery facilities (MRFs), each with a capacity of 13 tonne. There are three plastic shredding units and one baling unit to process non-biodegradable waste. At the MRFs, Haritha Karma Sena members segregate plastics into eight categories and sell recyclables to an organisation called Green Worms.

There are 36 aerobic composting units with 426 bins where people can deposit their biodegradable waste. At full capacity, the units are able to treat about 80 per cent of the biodegradable waste generated in Alappuzha, producing 9 tonne of compost daily.



Biodegradable waste disposal center at Alappuzha district collectorate

Bio-waste generated from hospitals, clinics, laboratories, etc. is being handled by Indian Medical Association Goes Ecofriendly (IMAGE), the biomedical waste treatment and disposal project of the Indian Medical Association's Kerala branch. They have established a state-of-the-art common biomedical waste treatment and disposal facility at Palakkad.

WHAT HAS WORKED

Awareness campaigns to promote source-level segregation led to remarkable changes in the attitude of citizens. Waste is not seen as someone else's problem but as the problem of the entire community which requires everyone to come together. Barriers of caste, class, etc. have been broken under the concept of 'unity in fraternity' so that change can be made and sustained.

This environment of communal togetherness has led to an increase in social entrepreneurship as people are more willing to trust each other and start new initiatives. Many people have been able to find jobs and improve their quality of life. Through scientific treatment of biodegradable waste, about 9,000 households have also been able to make fertiliser at home, which has led to improvements in agriculture.

With this initiative, AMC was not only able to control and reduce unnecessary expenditure caused by improper waste management but also generate additional revenue. This allowed some aspects of the waste management to become self-sustaining.

The most important step in waste management is source-level segregation, as that makes it easier to handle the waste in the later stages. Scientific management of waste is necessary to prevent pollution but it is the responsible handling of garbage at source that plays a vital role in the holistic development of a cleaner and healthier environment.

LESSONS LEARNT

Creating awareness about source segregation: The core element of proper recycling is segregation which gradually grows into effective waste management. The only way to achieve source-level segregation is to adopt effective communication strategies to inform and educate people about the costs of disposing unsegregated waste and the benefits to the environment and to public health that accrue from segregating waste. Till the people actually understand this and adopt it in their daily lives, no waste management strategy can be successful.

Involving the community: Participatory Rural Appraisal (PRA) has been very effective in getting to know people's needs and addressing them. The community has to be involved in the whole process so that they have a sense of ownership over the waste management system. Involvement also brings about changes in attitudes towards waste management and a willingness to take up ever larger portions of responsibility to conserve the habitat. Vulnerable members of the community are able to find means of livelihood in the waste management process if their involvement is encouraged, and this also provides them with additional incentives to make the system sustainable.

Plastic shredding unit, Alushi



Bottle booth centre, near the urban local body office



Impacts

- The informal sector engaged in waste picking has been integrated into the new waste management system. It started with 15 SHG members but has now reached 93 SHG members.
- Through extended producer responsibility (EPR) initiatives, multilayered plastics are disposed of in a way that SHG members could earn an income by selling them. They are making around Rs 300–500 per day from user fees and by selling the recyclables to Green Worms.
- Through source-level segregation, the amount of waste dumped in the water bodies has decreased remarkably, thus polluted water bodies have been rejuvenated.
- By reducing pollution, the spread of water-borne diseases has been controlled and the overall health of the community has improved.
- Generated compost is being given to local farmers free-of-cost.

Importance of leadership and organisation: The whole project originated under the leadership and guidance of the local government. The initial push provided by the authorities was much needed to get the process off the ground. After that, their guidance proved invaluable to take the project over significant hurdles. With this organisation the government set up and made sustainable, waste management became a source of income for many. Political will coupled with a methodological approach can change the face of any city.

REPLICABILITY

Source-level segregation and decentralisation waste management are the lynchpins of Alappuzha's solid waste management system. The success of Alappuzha's solid waste management system was recognised and these two aspects were picked up by many municipalities across the country.

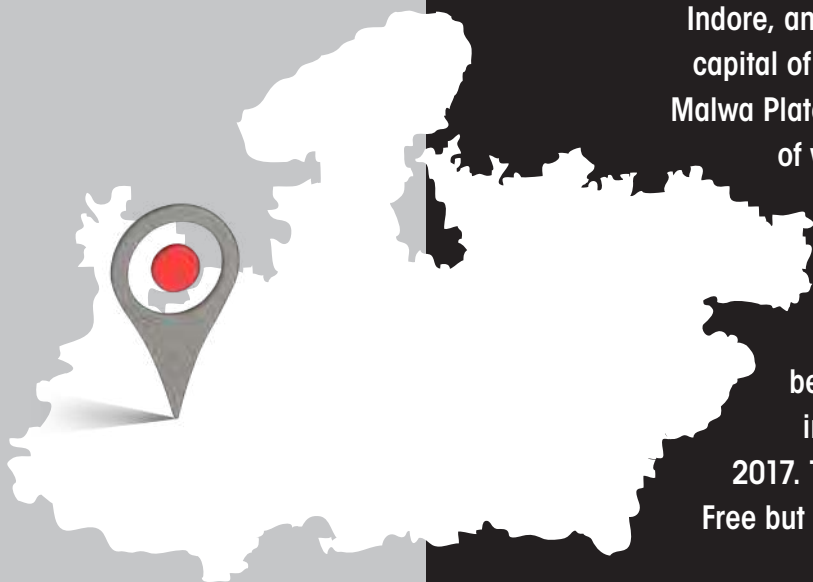
For source-level segregation, local SHGs should be recruited. This is very important as it allows community members to work within the community. Access to households is much higher for local SHGs as residents trust them. Workers are better motivated to make the project a success as it affects their lives. It is also a step towards poverty eradication as the most vulnerable people in the community can find gainful work in waste management.

Mini-material collection facilities have been adopted by various local self-governmental institutions in Kerala. The aerobic compost unit has also become a model followed throughout Kerala. The state government has made a policy for the implementation of decentralised waste management across Kerala. This can be taken up by other state governments as well.

MADHYA PRADESH

INDORE

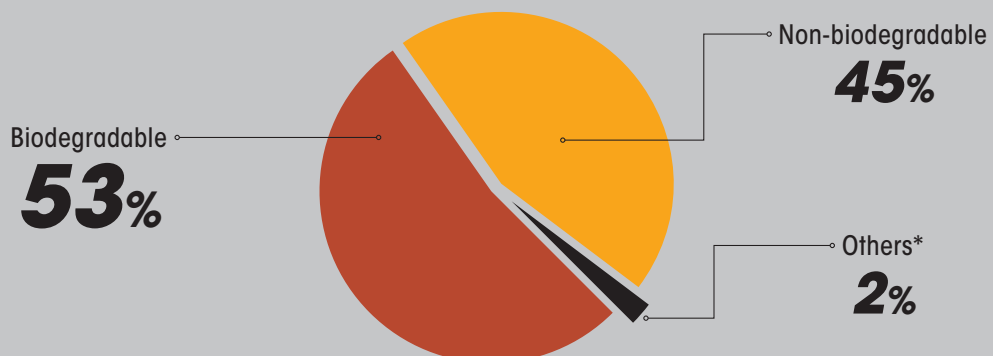
Indore has become the cleanest city in India by mastering segregation at source and subsequent steps in the waste management chain



Indore, an education hub and the commercial capital of Madhya Pradesh, is situated on the Malwa Plateau. It generates about 1,029 tonne of waste daily (392.4 g per person per day). The city, which was already famous for its food and bangles, has now earned the 5-star garbage-free city tag. Indore has been ranked the cleanest city of India in Swachh Survekshan surveys since 2017. The city is not only Open Defecation Free but has also earned the first Water Plus Certification in the country.

Waste composition in Indore

Total waste **1,029 TPD**



* Others includes domestic hazardous waste, sanitary waste, C&D waste and inerts.

Source: Indore Municipal Corporation



Population (in million, as per 2011 Census)

1.9



Estimated current population (in million)

2.6



Estimated floating population (in million, daily)

0.26



Area (sq km)

276



Number of households (in million, 2021)

0.49



Number of wards

85



Number of zones

19



Municipal solid waste generation

(in tonne per day or TPD, excluding C&D waste and inerts)

1,029



Number of sanitation workers

2,854



Number of community bins

0*



Number of garbage-vulnerable points

0*



Waste management vehicle fleet size

829



Percentage of households covered under door-to-door waste collection

100



Percentage of households segregating waste

100



Percentage of waste processed

100

* According to the Swachh Survekshan ranking (Star Rating for Garbage-Free Cities) parameter, zero community bins and zero garbage-vulnerable points are strong indicators of an efficient solid waste management system.

Source: Indore Municipal Corporation

THE TRANSFORMATION

Indore's waste management system used to be nothing special. There were over a thousand garbage-vulnerable points in the city. Segregation of waste at source was almost nil. Mixed waste was dumped in the Devguradiya trenching ground and even in open areas and public land, leading to many health and environmental problems. Domestic hazardous waste dumped together with other household waste posed a threat to waste pickers and animals. The river Kahn, which flows through Indore, had become a sewer. Roads were littered with garbage which smelled and attracted stray dogs, cattle and insects. Although Indore Municipal Corporation (IMC) had hired a concessionaire for transportation, processing, and disposal of garbage, the waste management system was extremely inefficient due to a lack of funds, dearth of monitoring and unavailability of institutional capacity to bring change.

Finally, in 2015, things started to change as the mayor expressed her concern about the lack of cleanliness in the city. IMC terminated its contract with the concessionaire after having communicated its apprehensions many times. In December 2015, IMC started door-to-door collection as a pilot project in Wards 42 and 71. IMC also undertook awareness programmes in these wards to motivate residents to segregate their waste into biodegradable and non-biodegradable fractions. It was observed that people were ready to do their part as long as they were assured of regular and reliable garbage collection services. IMC ran another pilot in two other wards but with a different objective – to check whether tricycles or auto-tippers are better for door-to-door collection. In one of the wards, tricycles were used for door-to-door collection while auto-tippers were used to transport garbage from the primary collection points. In the other ward, the use of tricycles was eschewed completely and auto-tippers were used directly for door-to-door collection. The cost of door-to-door collection with tricycles came out to be Rs 2,886 per tonne while the cost with auto-tippers came out to Rs 1,662 per tonne. IMC adopted the cheaper auto-tippers city-wide.

In February 2016, door-to-door collection was extended to ten wards and by October 2016, IMC started door-to-door collection of garbage in the entire city, along with a campaign to promote source

segregation. Initially, a two-bin system was used for segregation as per the guidelines of Swacch Bharat Mission – green bins for biodegradable waste and blue bins for non-biodegradable waste. In 2017, Indore adopted the use of separate bins for sanitary and hazardous waste, as per the new Swacch Survekshan toolkit. Most citizens happily embraced this as well due to the frequent knowledge and trust building sessions the municipality was holding with them. The more intractable of the citizens were forced to change their ways as door-to-door collection vehicles stopped accepting unsegregated waste completely. As time went by, the administration felt confident enough to ask citizens to segregate waste into even more categories in order to maximise the value of waste processing. Presently, the city is segregating its waste into six categories: 1. Biodegradable, 2. Non-biodegradable (excluding plastic), 3. Plastic, 4. Sanitary, 5. Domestic hazardous and 6. Electronic. IMC had originally installed two sets of litter bins across the entire city. During the pandemic, it also installed a set of third bins (yellow) in which people could put their masks and gloves.

HOW THE SYSTEM WORKS

IMC collects waste from different sources, including households, commercial areas, and establishments like shopping complexes, hospitals and institutes. Those generating less than 50 kg of garbage daily are covered under door-to-door collection whereas bulk waste generators (BWGs) are served by a separate dedicated mechanism. BWGs have to manage their biodegradable waste on-site or they can hire private concessionaires to manage it on their behalf.

In order to implement 100 per cent door-to-door collection of segregated waste, an identification study was carried out to find the amount of waste generated in each ward and the population of each ward. On the basis of the data collected, a detailed route plan was prepared to cover all wards. Based on the route plan, an extensive vehicle and staff deployment plan was implemented.

Door-to-door collection is done in partitioned vehicles. There are six separate spaces for biodegradable, non-biodegradable, plastic, sanitary, domestic hazardous and electronic waste in each tipper. These tippers carry waste from households to transfer stations. GPS has been installed in all waste collection and transportation vehicles. A special cell monitors the GPS. Penalties are imposed on drivers for route deviations and multiple deviations can result in their termination.

Indore is running a successful material recovery facility where waste is segregated according to its recyclability value. The city segregates non-recyclable fractions according to their calorific value so that only waste with high calorific value gets used as refuse-derived fuel (RDF).

Source segregation and scientific treatment of biodegradable waste through aerobic composting and anaerobic digestion has helped Indore prevent as much as 630 tonne of biodegradable waste from reaching the dumpsite every day, where it would have been responsible for emitting greenhouse gases into the atmosphere. Carbon credits earned through this process have been efficiently used by the city to generate about Rs 52 lakh. This has been possible due to the following projects:



Compartmentalised vehicle for collection of biodegradable, non-biodegradable, domestic hazardous, electronic and sanitary wastes

- Composting, Devguradiya – 600 TPD
- Biomethanation, Choithram Mandi – 20 TPD
- Biomethanation, Kabitkhedi – 15 TPD

The money flow

The total expenditure made by IMC to run the waste management system is about Rs 879 crore per year. The city collects about Rs 27 crore per year as user charges, and the remaining expenses are met with property taxes. Households pay up to Rs 60 and shops pay up to Rs 150 a month for waste collection. Businesses, offices, etc. pay Rs 3 for every kg of waste collected from them.

WHAT HAS WORKED

Bringing behavioural change at a mass level is not an easy task. IMC took multiple steps to spread awareness among people and motivate them to embrace segregation. Vehicles used for door-to-door collection of garbage were utilised to promote the campaign ‘Do Bin Har Din’ (two bins everyday). The campaign was carried out in all residential and commercial areas, including public places. Social media was used extensively, along with *nukkad nataks*, wall paintings, radio jingles, etc. Schools were engaged to promote segregation among students through competitions focused on cleanliness, and through oath taking ceremonies in the morning assembly.

The mayor and the ward councillor got actively involved in the campaign. Municipal officials and public representatives conducted joint visits and road shows to convince citizens to segregate waste. Religious and community leaders have a strong hold on the people, so they were convinced to become *swachhagrahis* and brought on a common platform. They talked about the importance of cleanliness as mentioned in religious books and participated in mass road-sweeping exercises to spread awareness.

IMC has engaged more than 800 self-help groups (SHGs), comprising more than 8,000 women, to spread awareness about source segregation in the nooks and crannies of the city. SHGs have also been recruited to provide workers for the material recovery facilities. This has ensured that SHG members are gainfully employed as integral members of the waste management system. This is really useful in making the system sustainable in the long-term.

Zero-waste tags are awarded to those markets and colonies which excel at waste management. These tags can be used as a marketing tool by these markets and colonies to attract customers and charge higher rents. This motivates other markets and colonies to also take steps to earn these tags. Households and other establishments were also given dustbins at subsidised rates to promote segregation.

IMC deploys one resource person with each garbage collection vehicle in order to spread awareness and to ensure that everyone is giving segregated waste. If a resource person fails to convince any household, then they can bring in the assistant health officer and ward *daroga* to penalise the offender. This is cost intensive but IMC knows that it is necessary to ensure 100 per cent segregation of waste and so it is willing to bear the cost.

It is one thing to have good laws and another thing altogether to implement them. In India, this is an especially big problem. To deal with this issue, IMC levies penalties and fines for people who litter in public spaces and do not segregate at home. Officials at the ward level have been given yellow enforcement vehicles and walkie-talkies to connect to other officials. All officials, including the municipal commissioner, are connected with the walkie-talkies. This gives a sense of confidence to officials, and promotes responsible behaviour among them as the municipal commissioner might be listening to their communications with each other.

LESSONS LEARNT

Participation of all, development for all: Without the participation of all citizens and governing bodies, it is impossible to build and sustainably operate the kind of efficient and reliable waste management system for which Indore has become known. Development of any sort is not a top-down exercise but a participatory exercise. Indore has shown us the wonders that can be achieved when we all come together with a single goal.

Segregate, segregate, segregate: It cannot be stressed enough that Indore's model has only been so successful because Indore focused on achieving 100 per cent segregation at source before it proceeded to the other aspects of waste management. Without segregation, all subsequent steps in the waste management chain fall apart. No matter how good a waste processing centre a city has, or how good its composting plan is, without segregation none of it can work at its full potential.

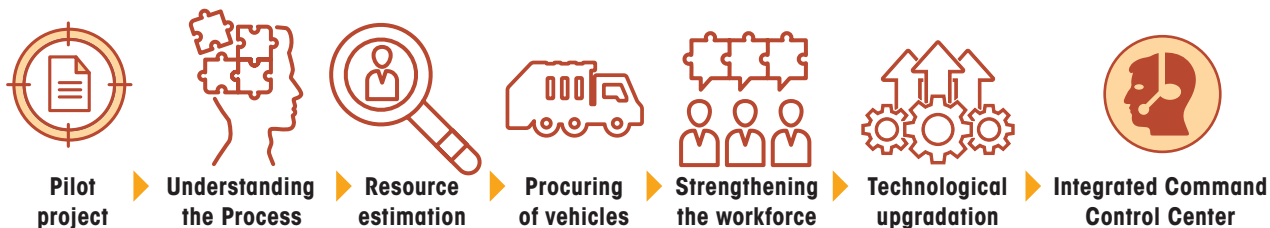
Impacts

- Indore has been named the cleanest city of India in every Swachh Survekshan survey since 2017.
- Indore has earned the 5-star garbage-free city tag along with five other cities.
- Indore is the first city in the country to earn the Water Plus Certification.
- More than 8,000 women from marginalised communities have been given gainful employment.
- Due to efficient segregation and subsequent processing of waste, almost no waste ends up being dumped in the landfill.
- Illegal collection and dumping activities have been reduced almost to nil.
- Indore has become Open Defecation Free.

REPLICABILITY

The process outlined below was followed by Indore and can inform other such efforts as well:

Steps taken by IMC to reform its waste management system



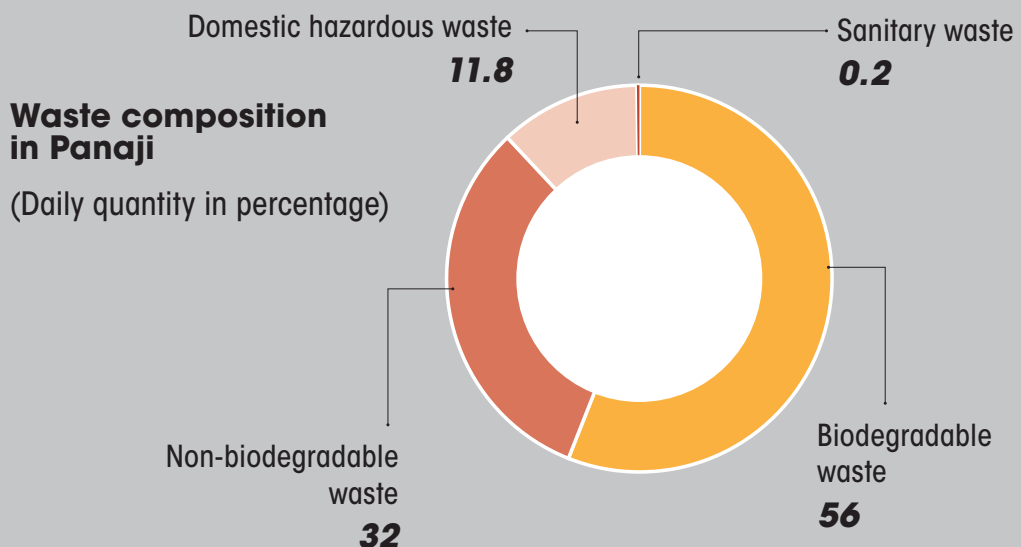
Considering the fact that Indore was rated 25th in the first Swachh Survekshan survey of 2016 and turned itself around to achieve first rank the very next year, it should be clear that cleaning up is within the reach of every city. The success of Indore's waste management derives first and foremost from its success in achieving 100 per cent segregation of waste at source into six categories. Door-to-door collection of segregated waste is possible in every city, town and village of India as long as the local governing bodies are committed to it. It has to be noted that Indore has been successful because the municipal authority showed the willingness to earn the trust of citizens and make them active participants in cleaning up of their city. Community engagement is absolutely necessary to replicate this model.

PANAJI

Panaji turns its trash into cash by adopting source segregation



Panaji is a popular tourist destination, blessed with beaches and heritage buildings. Its waste is managed by the Corporation of the City of Panaji (CCP). By extensive information, education and communication (IEC) as well as continuous monitoring, the city has achieved 99 per cent source segregation and changed the way solid waste management was tackled.





Population (as per 2011 Census)

40,017



Estimated current population

45,800



Estimated floating population (daily)

16,700



Area (sq. km)

8.12



Number of households (2021)

16,000



Number of wards

30



Number of zones

7



Municipal solid waste generation

(in tonne per day or TPD, excluding C&D waste and inerts)

50



Number of sanitation workers

474



Number of community bins

0*



Number of garbage-vulnerable points

7*



Waste management vehicle fleet size

35



Percentage of households covered under door-to-door waste collection

99



Percentage of households segregating waste

99



Percentage of waste processed

80

THE TRANSFORMATION

In 2001, around 1,200–1,500 garbage bins were placed across the city. But these community bins became points of disposal for every kind of unsegregated waste. Eventually, the waste generated from the bins formed a hill. Subsequently, the heap mounted in a nearby village, Curca, and resulted in the formation of leachates, followed by a landslide.

Improper and unorganised disposal in open areas and landfills resulted in the spread of communicable and non-communicable diseases, and affected the welfare, livelihood and economic productivity of the local population. It also diminished the value of the surrounding real estate. Further, the leachates contaminated the soil, polluting the groundwater. With no options, the Corporation of the City of Panaji (CCP) tried for more scientific and innovative alternatives.

Panaji city's solid waste management programme – managing segregation, sorting and recycling of the city's waste – has been successful because CCP worked consistently over the last 15 years at improving methods and involving citizens in its endeavours.

Of the waste CCP collects, 99 per cent is segregated at source (four-way or two-way). Eighty per cent of the waste is processed, 90 per cent of the roads are swept efficiently and 99 per cent of stand-alone houses have door-to-door collection. Aerobic composting in masonry units and the crate system set up at decentralised facilities have an existing capacity of 20 TPD. Waste going to the landfill is 23 TPD, comprising 5 tonne of street sweepings, 10 tonne construction debris and 8 tonne horticultural waste such as tree branches.

There is currently no sanitary landfill. Waste is disposed of at temporary waste sites identified on a need basis.

CCP recognises the fact that waste collected should be treated locally. But it faces opposition from local sources. It is the same story with making clusters to treat waste – no one wants them in their area.

* According to the Swachh Survekshan ranking (Star Rating for Garbage-Free Cities) parameter, zero community bins and zero garbage-vulnerable points are strong indicators of an efficient solid waste management system.

Source: CCP



Women workers segregating waste manually

HOW THE SYSTEM WORKS

The Corporation of the City of Panaji (CCP) developed door-to-door collection of waste indigenously, initially approaching 100 houses to segregate their waste into two separate bins. Panaji was envisioned as the first landfill- and bin-free city in Goa. This was accomplished by 2020.

Way back in 1995, the city had introduced a project called Solid Waste and Resource Management (SWARM). The government of Goa was responsible for technical assistance. The project was undertaken by the Regional Water and Sanitation Group, South Asia (RWSG-SA) at the Ministry of Urban Development, Government of India. Subsequently, in 2000, the Ministry of Environment and Forests (MoEF) set new rules for managing and handling municipal solid waste.

In 2003, the Panaji Municipal Corporation (PMC) was upgraded to the Corporation of City of Panaji (CCP). In 2004–05, CCP targeted training schoolchildren and designed a Panjim Chakachak movement, which led to the TRASH (Thinking Reflecting and Acting for a Sustainable Habitat) festivals, campaigns, and awareness sessions with media. It highlighted why segregation of biodegradable and non-biodegradable waste was important.

In 2010–11, after implementing four-way segregation, an improvement over the earlier two-way segregation, CCP created collection points and recycling stations for

non-biodegradable waste at different junctures in the city. By means of adequate information, resources and efficient management practices, they changed the way solid waste was tackled. They trained volunteers, mostly students, who visited individual households to demonstrate waste segregation. Hotels, hospitals and nursing homes were provided with leaflets and pamphlets with segregation information at the source as well as garbage-lifting schedules.

The CCP procured 10 compactors, two tractors and 16 tipper trucks after successfully encouraging waste generators to recycle their waste. The newly acquired tipping trucks consisted of four bin bags. Each bin was emptied into separate collection bags and sent to the sorting centre. Green and black bins specially designed by CCP were sold at subsidised rates. The bins came with a locking system, which eliminated the chances of waste tipping.

In 2020–21 CCP implemented segregation of waste into 16 fractions. Residential colonies in Panaji were encouraged to collect 16 types of waste in separate bins. CCP made it compulsory for builders and promoters to create a composting pit in each colony so that biodegradable waste was separated at source or their license would be cancelled. Besides, community pits were made near market areas to collect and treat around nine TPD of leaf-waste.

Biomedical waste is stored in and collected from separate bins and sent to Goa Medical College. Hospitals and clinics follow the two-way segregation process. Infectious waste is stored in yellow bins lined with a yellow bag. Sharps (needles and scalpels) are put in blue bins lined with blue bags. To improve sanitary waste management, CCP also procured vending machines for sanitary napkins and incinerators to dispose of sanitary napkins.

The Corporation treated waste, made Panaji a zero-landfill capital, sent more than 10,000 tonne of refuse-derived fuel (RDF) to Karnataka, and helped the cement industry by limiting its usage of fossil fuels (coal).

Mechanism of waste collection

- **Collection of segregated waste:** Waste that has been segregated into four streams (paper, plastic, metal and non-recyclable materials such as thermocole) is put in a black bin. Each of the four bins has a sticker – in different colours – to identify the stream of waste.
- **Designated days:** CCP has assigned designated days for collection of waste. Biodegradable waste from residential colonies, hotels and restaurants is collected daily and non-biodegradable waste is collected twice a week.
- **Designated routes and vehicles:** CCP has assigned designated vehicles and routes for waste collection. The routes are devised based on traffic and quantum of waste generated. During the Covid pandemic, two trucks were assigned for collection of waste from the homes of Covid patients. They were coloured white and designed so that workers did not come in contact with patients.

Source: CCP



Waste is segregated in 16 separate bins and bags

Non-biodegradable waste from bulk waste generators (BWG) is taken to 14 sorting centres, including mini-centres. Sanitation workers divide the waste here depending on the value of the items. Plastic and paper are sub-segregated into different fractions based on quality, colour, etc. After sorting, bales of non-recyclable waste – separate bales of paper, plastic, tetra packs, and cloth – are made using baling machines. The Corporation earns about Rs 1 lakh per month from the sale of recyclable items. Inert waste is carried to a dumpsite for disposal.

The Corporation initiated the campaign Shop with Your Waste (SWYW) where three designated shops were asked to collect pet bottles, cardboards, milk packets, metals etc. from the consumers and provide them with valuables such as a notebooks, pens or erasers. By adopting this strategy, CCP has collected clean, non-biodegradable waste and helped to increase footfalls in the designated shops.

CCP has also launched the app “I Can Change My City”, which helps bridge the gap between communities and the Corporation.

Mural paintings and initiatives such as the campaign Seeti Bajao, City Bachao, in which authorized volunteers blew whistles every time they saw anyone litter, have received a huge response during the International Film Festival (IFFI).

The money flow

According to CCP, over Rs 7 lakh is collected every year as property tax towards sanitation and Rs 9 lakh is generated by selling compost. Operators earn Rs 10 lakh per year by selling recyclables and refuse-derived fuel (RDF). Expenditure on municipal solid waste collection and transportation is over Rs 14 lakh per month, and for processing is Rs 2.5 lakh per month. Total annual revenue generated by CCP is about Rs 27 crore.

WHAT HAS WORKED IN PANAJI

The CCP adopted several new technologies and initiatives for waste management, including:

- **Introduction of mini sorting stations:** There are five mini-sorting stations (KTC, Bhatlem, Caranzalem, Market and EDC Patto) and one large sorting station at St Inez in Panaji city. In case of operational issues at any one station, other facilities can be used so that work is not affected.
- **Aerated pit composting:** By 2006, CCP made it mandatory that every building permit issued for new projects in the city included its composting unit or biodegradable waste processing facility within the premises. The city has implemented aerated static pit composting.
- **Promoting biomethanation:** Bio-digestors of 20, 75, 150, 300, 500 and 1,000 kg are installed for processing biodegradable waste. Further, biogas produced is utilised by local canteens and five-star hotels. The conversion of waste to energy is engineered and used by locals.
- **Segregation through conveyor belts:** The earlier method for segregation of waste was very tedious. The introduction of conveyor belts has brought ease in working, helping sanitation workers in manual segregation.
- **Design of vehicles was consciously customised:** Compartmentalised vehicles were designed for collecting biodegradable and non-biodegradable waste to prevent waste from falling on roads while it is transported. The newly introduced vehicles have leachate tanks that collect leachate from the waste. The vehicles have a hydraulic system that helps to hold two dustbins together and drop the waste inside the vehicle without the need for manual labour. The vehicles are BH-VI compliant, and follow all government norms.
- **Tubelight waste and hazardous waste more efficiently handled:** Hundreds of tube lights are stacked every day, and they get treated by a pollution board-certified agency scientifically. So far, 17,000 tubelights have been treated.

The agency has a gobbler machine that crushes glass tubelights separating by-products such as mercury and other metals. The drum is sealed and disposed of in a sanitary landfill in Maharashtra.

- **Promotion of eco-friendly products:** Tomato-sauce pumps, steel plates and cloth bags are promoted while use of sauce sachets, plastic straws and polyethylene bags are discouraged.
- **Specially designed street bins were placed across the city, replacing community bins:** Digital litter-bins have been designed by CCP to segregate paper, metal, glass, mobile batteries and plastic for Panjim streets. When the button placed on the bin turns from green to red, the alert



An aerated compost pit near the main Panaji market area

automatically goes to CCP, conveying the message to clear the bin. The bin is also used as an advertisement board, where companies can display digital advertisements across the city.

LESSONS LEARNT

The city has adopted a zero-waste and zero-landfill model by implementing decentralised waste management and treating waste at the source. Space constraints along with large quantum of waste in the city made the municipal city officials look into means such as innovative technologies, continuous information, education and communication (IEC), treating waste at source, waste reduction etc. to manage waste. The city has also looked into alternative mechanisms for channelising non-recyclable waste. Awareness campaigns have helped to promote source segregation of waste in the city.

Despite CCP's initiative, a few places still require continuous monitoring and regulation to ensure longevity of the zero-waste management initiative.