AGRA

CIRCULARITY IN ACTION

Research direction: Atin Biswas

Authors: Kuldeep Choudhary and Subhasish Parida

Editor: Arif Ayaz Parrey

Design and cover: Ajit Bajaj

Graphics: Mukesh Kumar Singh

Production: Rakesh Shrivastava and Gundhar Das

Norwegian Embassy
New Delhi

We are grateful to the Norwegian Ministry of Foreign Affairs for its support.

Maps used in this document are not to scale.

Citation: Kuldeep Choudhary and Subhasish Parida 2021, *Agra: Circularity in Action*, New Delhi

Published by
Centre for Science and Environment
41, Tughlakabad Institutional Area
New Delhi 110 062
Phones: 91-11-40616000
Fax: 91-11-29955879
E-mail: sales@cseinida.org
Website: www.cseindia.org

AGRA

CIRCULARITY IN ACTION

Contents

Introduction

Agra is located on the banks of the Yamuna River, around 200 km southeast of Delhi, in western Uttar Pradesh of northern India. Sultan Sikandar of the Lodi dynasty founded the city in 1504. Agra has also been mentioned in the *Mahabharata* as 'Agravan'. The city is known worldwide for the Taj Mahal. It is home to other famous monuments like the tomb of Itmat-ud-Daula, and the forts of Agra (also known as Red Fort), Sikandra and Fatehpur Sikri. The city is also famous for 'Agra ka petha', leather products, pietra dura (marble inlay) and rugs.

The city has a population of 1.58 million (as per the 2011 Census), with a floating population of 0.3 million. Agra hosts 1.15 million tourists every year, which is 17 per cent of the total international tourists visiting India. Taj Mahal alone receives seven–eight million domestic and foreign tourists every year, which is the highest in the country. Agra Municipal Corporation (AMC) is responsible for civic infrastructure and administration of the city and provides basic services like sanitation, healthcare, education, housing, roads, transport, etc. AMC engages the private sector and makes use of innovative mechanisms in the efficient management of municipal services.

Table 1: Agra—city profile

Total area of the city	141 sq. km
Population (2020 estimate)	2,087,006
Number of households	0.44 million
Number of bulk waste generators	2,352
Number of commercial entities	29,081
Number of wards	100
Number of zones	4
Waste generation (2017)	712 TPD

Source: Agra: Roadmap for a Zero Waste City, Centre for Science and Environment

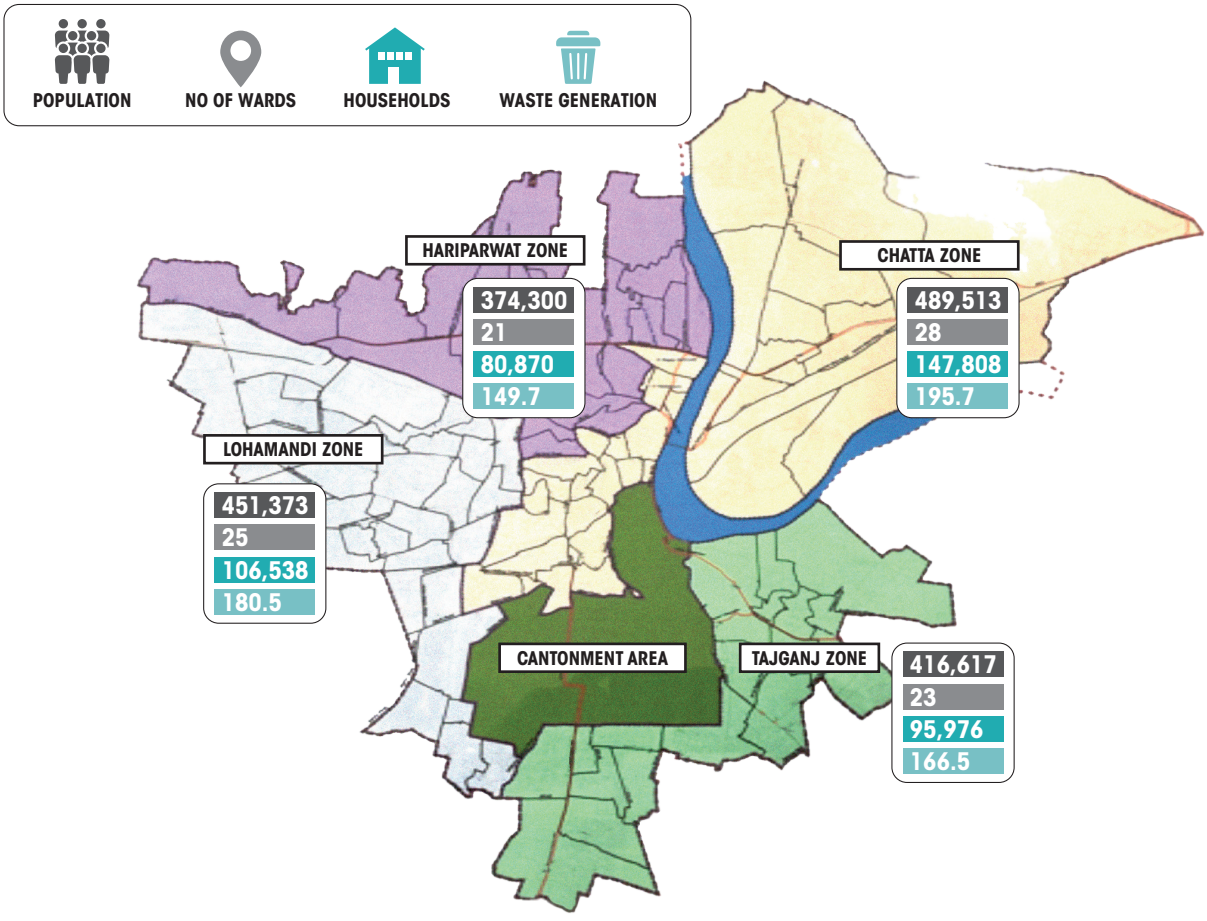
Backstory

AMC has 100 wards divided into four zones (Hariparvat, Tajganj, Lohamandi and Chatta) for smooth operation of solid waste management services. The city generates close to 712 TPD of municipal solid waste (excluding street sweeping and drain silt) at the rate of 0.4 kg per capita per day. Zone-wise waste generation details are provided in *Map 1*.

Each zone has an average of 24 wards, and the average solid waste generation in each zone is approximately 173 TPD. The average waste generation per ward is around 7.1 TPD. Till 2019, it was the responsibility of the door-to-door

Map 1: Agra zone map

TOTAL WARDS: **100**	NOT MAPPED: **3**
POPULATION: **1,779,973**	POPULATION: **48,170**
HOUSEHOLDS: **439,398**	HOUSEHOLDS: **8,206**
WASTE GENERATION: **711.7**	WASTE GENERATION: **19.3**



Source: Agra: Roadmap for a Zero Waste City, Centre for Science and Environment

collection agencies to collect municipal solid waste primarily from households, commercial establishments and other institutions. However, secondary collection and disposal was done by AMC itself. The system for managing municipal solid waste in Agra was suffering from the following challenges:

Quantification of waste generation

The quantity of solid waste generated in Agra is uncertain as the waste generation data varies from source to source. As per data provided by AMC, 680 TPD of solid waste was generated in 2001; AMC's Action Plan reported that waste generation had increased to 750 TPD in 2011 and currently stands at 712 TPD, whereas the City Sanitation Plan Report, jointly prepared by AMC, Ministry of Urban Development and Administrative Staff College of India (ASCI) states that the city generates 824 TPD of waste at present. The total waste generation reported by different sources varies substantially. Therefore, it is essential to estimate actual waste generation.

Segregation

AMC claims that they are practising 40 per cent source segregation. However, it has been observed that the average source segregation is a meagre 9 per cent. Only a few bulk waste generators (BWGs) and commercial establishments segregate their waste; most of them are not practising source segregation. Only segregation of PET bottles, metals and cardboard boxes with a high resalable value is taking place in primary collection vehicles.

Collection

Collection is one aspect in which Agra has shown remarkable progress. As per the Action Plan Report, the city's average door-to-door collection percentage was 91.66 per cent. Door-to-door collection is very efficient in certain pockets. However, it can be improved further to achieve 100 per cent waste collection from all kinds of establishments to ensure no illegal dumping and littering on the streets.

Primary transportation

Primary transportation is carried out by AMC's fleet of 114 motorized vehicles and 1,500 tricycles. Waste collected from different establishments is bought to the *dhalaoghars* or community bins from where it is taken to transfer stations. The waste is then transferred to secondary transport vehicles, which take it to the dumpsite. AMC is trying to end the culture of using community bins to dump waste. All primary collection vehicles have been equipped with two sets of three colour-coded bins (green, blue and red), but the intended purpose of collecting segregated waste is not fulfilled because of negligible source segregation.

Secondary transportation

Secondary transportation is carried out in 93 secondary collection vehicles. Tajganj zone transfer station is functional. The transfer station at Transport Nagar, designed to receive waste from Lohamandi and Hariparvat zone, does not receive waste regularly. Chatta zone does not have a transfer station but it needs one to reduce fuel consumption and labour costs of transporting waste as a significant portion of the zone lies across the Yamuna from existing transfer stations. Almost all transfer stations receive mixed waste.

Processing capacity

There are three decentralized biodegradable waste processing facilities in the city, altogether with a processing capacity of 9 TPD. The 2 TPD processing facility near ISBT, and 2 TPD and 1 TPD processing facilities at Raj Nagar are owned by AMC. Flower waste and waste received from vegetable markets is treated at them. However, the 4 TPD processing facility for BWGs in Dhandoopura, which Nationwide Waste Management Services (NWMS) owns, is not functional yet. There is also a 325 TPD centralized treatment facility located at the Kuberpur dumpsite. Waste that reaches the dumpsite is mixed, which first goes through pre-sorting and then for windrow composting. The current processing capacity of the dry waste processing centre at Tedibaghiya, owned and operated by NWMS, is 120 TPD. This plant is more like a transit point than a recycling plant as only sorting and bailing of dry waste takes place at it.

Informal sector

There has been a solid presence of the informal sector in the waste management sector in Agra. As per the 2019 Action Plan, 273 rag pickers are operating in the city. There is a pressing need to identify all informal hotspots in the city and integrate informal rag pickers into AMC's current solid waste management operations.

Financial sustainability

AMC spends a massive amount of money on overall solid waste management, which is limited to unsegregated waste collection, transportation, unscientific processing and disposal. Hence, the whole system has become financially unsustainable. To make the entire system economically viable, the city needs to focus on source segregation, minimize transportation costs, and extract valuables from possible waste resources.

Story of change

In 2020, the contracts of all agencies for door-to-door collection were terminated because of non-performance. The city decided to manage municipal solid waste on its own until improved systems were developed and put in place. With 3,890 sanitation workers and a fleet of 200 vehicles, the city was somewhat managing its waste with a very high percentage of door-to-door collection. Still, with limited segregation coupled with inadequate processing, the larger share of the generated waste was ending up in the dumpsite. A sustainable solid waste management system demands a lot more than efficient collection, transportation and disposal; therefore, AMC decided to make a paradigm shift from its traditional waste management system to one attuned to the principles of circular economy.

At this juncture, Centre for Science and Environment, Delhi-based environment advocacy and research non-profit, partnered with AMC to offer technical support through a formalized long-term commitment to improve the overall solid waste management ecosystem in Agra. To address the challenges associated with current solid waste management system and practices, a formal memorandum of understanding was signed between AMC and CSE on 21 December 2020 to shift from linearity to circularity systematically. Following the agreement, CSE undertook a comprehensive analysis of the city's waste management portfolio with ground-level data and research around the existing challenges and

Release of CSE's Agra: Roadmap for a Zero Waste City

opportunities. During this period, CSE's team carefully assessed the existing system right from collection, transportation, treatment and disposal, while also analysing data for meaningful interpretation. Upon completing the on-ground research, CSE submitted a detailed report to AMC, titled *Agra: Roadmap for a Zero Waste City* with key findings and specific recommendations, including a roadmap for a systematic approach to improve the waste management system in the city. The report specifically came up with the following diagnostics and activity mapping with a tentative timeline:

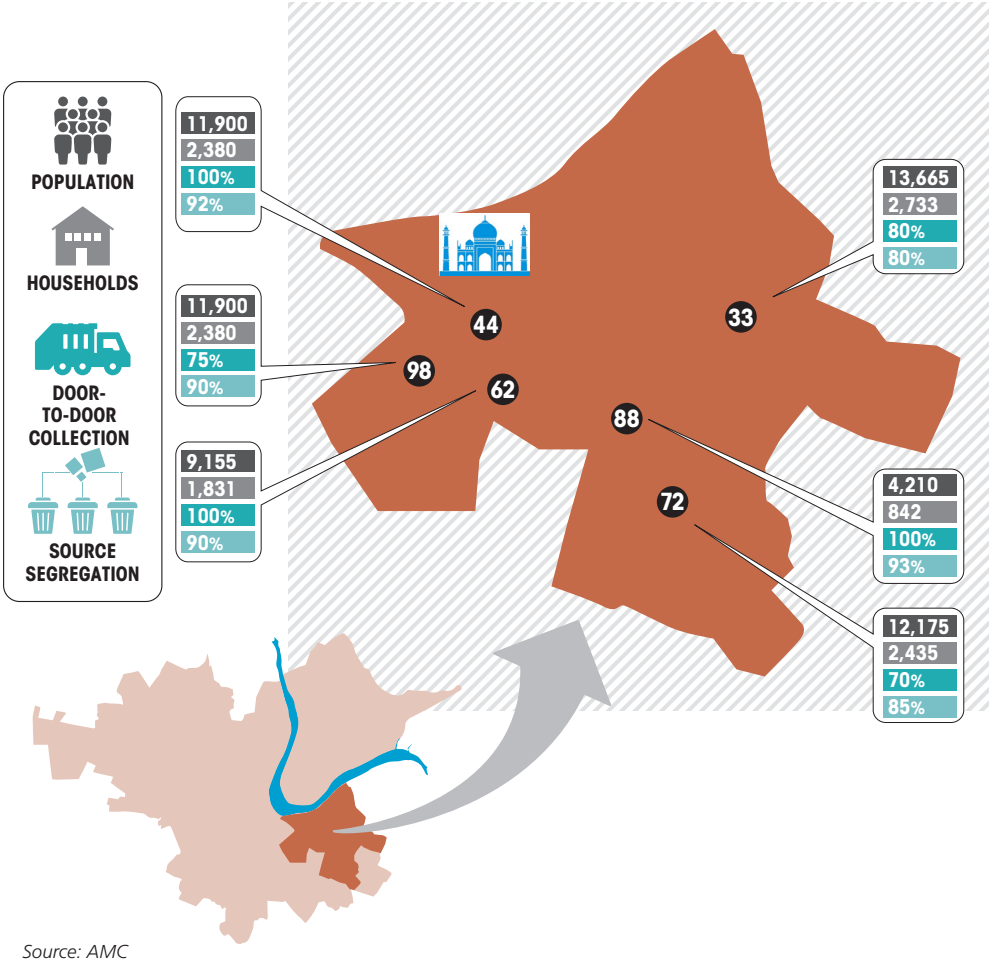
- Ensuring 100 per cent source segregation
- Decentralized management of organic waste
- Decentralized management of dry waste
- Decentralized management of domestic hazardous waste
- Redesigning the concessionaire agreement
- Integration of the informal sector
- Capacity building of the AMC officials on integrated solid waste management
- Financial sustainability
- Managing petha waste
- Managing leather waste
- Managing drain silt and sludge
- Institutional arrangements

How it all began

Considering the critical focus points mentioned in *Agra: Roadmap for a Zero Waste City*, AMC decided to start their journey towards the zero waste goal with the first and most important aspect of solid waste management, i.e., source segregation. AMC floated a tender for the Taj Trapezium Zone (TTZ), consisting of six municipal wards, on 19 January 2021 for 'Conducting solid waste management IEC activities within 2 km periphery of Taj Mahal to make it a garbage-free area'. Ward numbers 33, 44, 62, 72, 88, and 98, spread within a 2 km radius of the Taj Mahal, were selected as the catchment area for the pilot initiative. All these wards come under the Tajganj zone, and the total waste generated from these six wards is around 40.5 TPD.

Subsequently, a professional agency called 'Feedback Foundation' was deployed on the ground from 25 February 2021 to engage with communities and institutions to educate them about the benefits of source segregation.

Map 2: The six wards in the vicinity of Taj Mahal



Source: AMC

The agency started surveying households, commercial and institutional establishments in these six wards. A team of 24 mobilizers, two supervisors, and one project head started creating awareness in the six wards through a door-to-door awareness campaign. During the campaign, the group of mobilizers visited every household, teaching them the advantages of source segregation of waste and how to segregate waste into four different categories: wet, dry, domestic hazardous and sanitary. The team also interacted with other establishments in these six wards and trained them on source segregation as well. Through rigorous door-to-door awareness campaigns, ward meetings and street plays, citizens were made aware of the benefits of source segregation, which also started reflecting on the ground. CSE reinforced the source segregation campaign with Information, Education and Communication (IEC) material used to instruct waste generators during the awareness campaign activities regarding the importance of following social distancing norms during the pandemic. With efficient use of the IEC material, and other informative

IEC leaflet distribution to households and commercial establishments

tools and techniques, the team of volunteers from Feedback Foundation guided citizens about mapping various types of waste with colour-coded bins. In time, the citizens of these wards started developing a habit of practising segregation of waste at source.

While the source segregation campaign in Agra was gaining momentum, AMC felt that segregated waste collection needed to be complemented by an efficient primary collection system and invited bids for door-to-door collection of segregated waste and transportation from the entire catchment area under the pilot initiative. Lions Services Limited won the contract and deployed 37 waste collectors for door-to-door collection and three supervisors for overall monitoring. To facilitate the process of collection and transportation and navigate the narrower roads within the wards, they have deployed 13 tricycles and 12 auto-tippers. Each auto-tipper is operated by a driver, who is accompanied by a helper. One sanitation worker operates each tricycle. Tricycles used for door-to-door collection contain colour-coded bins to collect segregated waste.

Four-way segregation follows a uniform colour code for collection and transportation: green bins for wet waste, blue bins for dry waste, black bins for domestic hazardous waste, and red bins for sanitary waste. While auto-tippers have partitions for collecting wet and dry waste separately with larger

Segregated waste collection from households

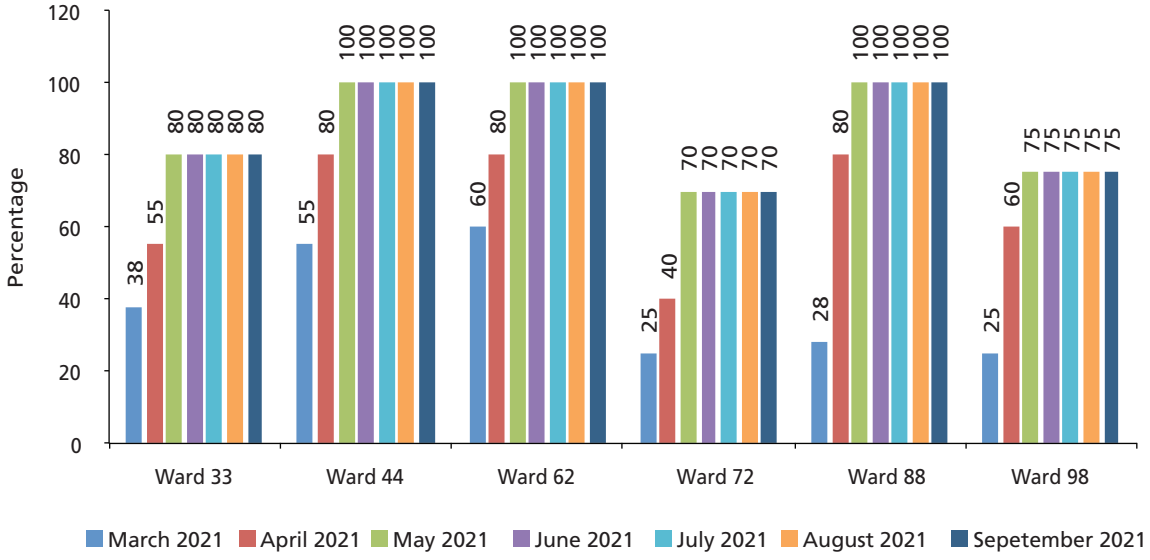
Community awareness campaign on source segregation using IEC tools

Awareness campaign at a school

Awareness rally by school students on source segregation

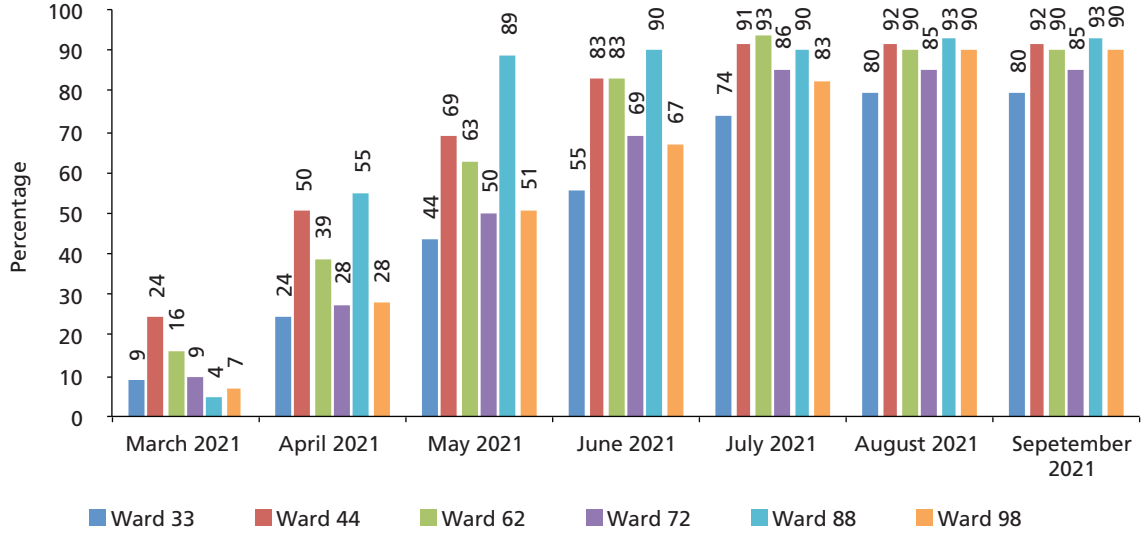
containers, the other two streams of waste are contained in two different bags hung at the back of the auto-tipper. As the campaign started gaining momentum, the agency deployed for collection and primary transportation of the segregated waste began operations in the catchment area of the six wards to transport waste to designated transfer station for secondary transportation by the fleet of AMC for processing and final disposal.

Graph 1: Door-to-door collection percentage in the selected wards



Source: AMC

Graph 2: Source segregation percentage in the selected wards



Source: AMC

Decentralized management

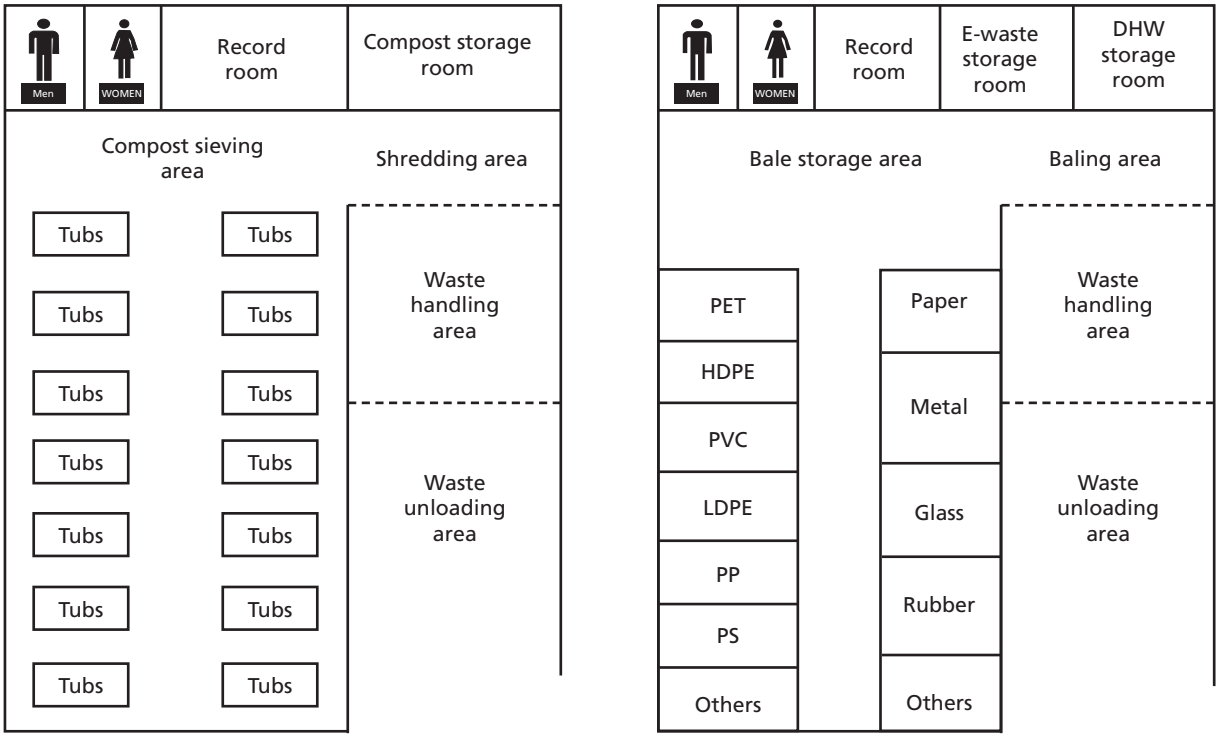
Micro-composting centre-cum-material recovery facility at Tajganj

The value of waste gets compromised to a large extent the moment food waste is mixed with dry (non-biodegradable) waste like plastic, paper, metal and glass at its very source of generation. The same practice is repeated at the intermediate waste transfer station if the transportation system does not store various fractions of waste separately. The best possible way to deal with the problem is to treat waste at a location as close to the point of generation as possible, to keep the cost of transportation at a minimum and maximize the revenue from the processed waste. While food waste can be a rich source of manure full of plant nutrients, dry fractions can be an excellent source of revenue generation if appropriately managed.

The six month-long campaign in Agra, coupled with segregated collection, has helped the city government achieve as much as 86 segregation and collection efficiency. Currently, segregated waste is being transported to centralized waste processing and disposal facilities in Kuberpur, about 9 km from the city limit. The pilot initiative's objective remains incomplete in the absence of decentralized facilities within the catchment of TTZ to treat waste at the nearest possible point and cut down the cost of secondary transportation and, thus, significantly reduce the operational cost. To walk this last mile of decentralization, AMC has decided to set up a micro-composting-cum-material recovery facility (MCC-MRF).

The MCC-MRF facility will also be used for further sub-segregation of dry wastes like plastic, paper, metal or glass for further processing. Recovered materials can be channelized to proper buyers to create a business model and ensure sustainability. Setting up such facilities will help treat segregated waste in a decentralized manner so that the city can institute a revenue model that can be replicated in the rest of the town—this way the benefits of getting segregated waste can be leveraged optimally. Suitable land for setting up the MCC-MRF has been identified, and AMC has initiated the establishment of the unit. Once the MCC-MRF is operational, it would be a huge leap forward for the city to mark a new beginning towards decentralization to complement the policy directive and move towards being a zero-waste city.

Figure 1: Typical structure of an MCC and MRF



Source: CSE

Working mechanism of the MCC

a. The MCC will have 14 tubs in two trains of seven tubs each. Each tub may have dimensions as indicated in *Table 2*.

Table 2: Requirements of processing units

Processing capacity of bio-degradable waste in tonne per day	Size of each tub	Required area for the processing centre in square metre
5	3.9m x 1.8m x 1.0m	600
4	3.0m x 2.0m x 1.0m	410
3	3.0m x 1.5m x 1.0m	360
2	2.4m x 1.2m x 1.0m	260
1.5	2.0m x 1.2m x 1.0m	200

Source: CSE

b. Unload the biodegradable waste in the waste receiving yard after noting down the weight.

c. Transfer the waste to the conveyor belt and segregate it further to ensure all non-biodegradable components are removed.

d. Sprinkle effective microorganisms (EM) solution evenly on top of the waste and feed the waste into the shredder.

e. Collect shredded waste that is ready to be put inside composting tubs and repeat the process for the next tub on the next day.

f. The sequence of putting waste in the tubs is: 1st day: 1st tub, 2nd day: 2nd tub, 3rd day: 3rd tub, 4th day: 4th tub, 5th day: 5th tub, 6th day: 6th tub, 7th day: 7th tub.

g. Rake the waste well once in every five days for better aeration.

h. With each passing day, the waste will degrade due to bacterial activity and there will be reduction in its volume. The colour of the waste will slowly turn brown and ultimately become black in the final stage.

i. On the 8th day, the waste in 1st tub would have degraded with considerable reduction in its volume. Put the freshly shredded waste mixed with prepared media again in the 1st tub, on top of the seven day-old waste.

j. The sequence of putting waste in tubs is: 8th day: 1st tub, 9th day: 2nd tub, 10th day: 3rd tub, 11th day: 4th tub, 12th day: 5th tub, 13th day: 6th tub, 14th day: 7th tub.

k. This method is to be continued till the 21st day, on which the shredded waste mixed with prepared media will be put in the 7th tub. The sequence is: 15th day: 1st tub, 16th day: 2nd tub, 17th day: 3rd tub, 18th day: 4th tub, 19th day: 5th tub, 20th day: 6th tub, 21st day: 7th tub.

l. After the 21st day, the 2nd train of seven tubs will be put to use in the same manner. The sequence of putting waste in tubs is: 22nd day: 8th tub, 23rd day: 9th tub, 24th day: 10th tub, 25th day: 11th tub, 26th day: 12th tub, 27th day: 13th tub, 28th day: 14th tub, 28th day: 14th tub, 29th day: 8th tub, 30th day: 9th tub, 31st day: 10th tub, 32nd day: 11th tub, 33rd day: 12th tub, 34th day: 13th tub, 35th day: 14th tub, 36th day: 8th tub, 37th day: 9th tub, 38th day: 10th tub, 39th day: 11th tub, 40th day: 12th tub, 41st day: 13th tub, 42nd day: 14th tub.

m. During these 21 days, from the 22nd day to the 42nd day, the waste in all seven tubs in the 1st train will be raked for aeration but no fresh waste will be added.

n. Matured compost shall be removed from the tub and sieved for uniform size. The rejects from the sieving shall be put again in the tub for further decomposition.

o. Screened compost shall be kept for seven days for stabilization.

Working mechanism of the MRF

a. Unload inorganic waste in waste-receiving yard.

b. Segregate inorganic waste into different fractions such as plastic, paper, metal, glass and non-recyclable fractions.

c. Segregate plastic further into seven categories, weigh it and then stored it in the specific storage compartments.

d. Recyclable materials can be sold to recyclers from which the urban local body (ULB) can earn revenue.

e. Non-recyclable materials are baled and stored in a designated area until a certain quantity has been accumulated. Then the bales can be send to cement plants or waste-to-energy plants or thermal plants to be used as refused-derived fuel (RDF).

f. Collected e-waste and domestic hazardous waste can also be stored in designated rooms. E-waste can be sold to registered recyclers, whereas domestic hazardous waste should be sent to a hazardous waste storage, treatment and disposal facility.

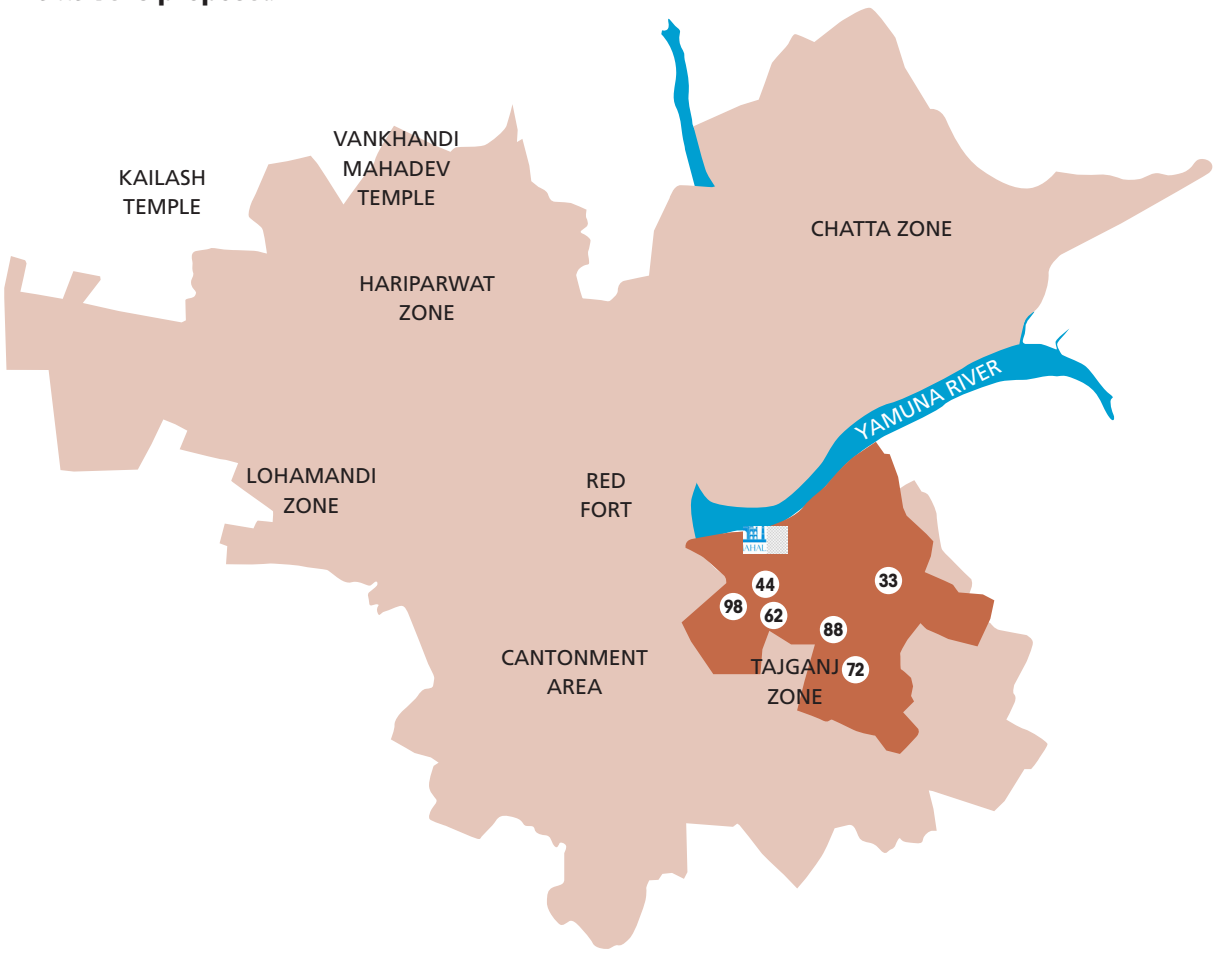
g. At no point should e-waste and domestic hazardous waste be mixed with other recyclable and non-recyclable waste.

Replication of the TTZ model

As the pilot initiative to promote source segregation and segregated collection continued to gain momentum, the city started gearing up to replicate the learnings from the pilot to the rest of the town, encompassing 94 municipal wards (see *Map 3*).

In an effort to scale up the model being developed in the area around the iconic Taj Mahal, the city government will enforce source segregation first, followed by the creation of a set up for recovery, recycling and reuse of collected waste. The scaling-up process would also involve heavy investment in the inclusive approach with learning from the pilot initiative and engaging with citizens to promote source segregation. The city has planned to hire a professional agency for the campaign. At the same time, the actual concessionaire will be responsible for door-to-door collection of segregated waste for further treatment and processing in the respective facilities according to the specific stream of waste. The city government has already initiated the procurement process to scale up

Map 3: Area under the pilot initiative and the remaining 94 wards where source segregation initiative is proposed



Source: AMC

the learning from the pilot to the remaining 94 municipal wards. CSE would provide all possible technical and capacity-building support to AMC while scaling up the initiative. The existing fleet of vehicles and workforce available with the city authority would be utilized for secondary transportation, treatment and final disposal. The critical elements considered for the procurement are given in the following section.

Salient features

- Door-to-door collection of solid waste in a segregated manner in the project area and transportation to secondary storage points in a scientific manner as per the Central Public Health and Environmental Engineering Organization (CPHEEO) Manual, 2016 and Swachh Bharat Mission (SBM) guidelines.

- No waste collected shall be dumped or ground anywhere in the open. It must be scientifically transferred to designated transfer station or RC compacters, as decided by AMC.

Table 3: Penalty provisions for non-compliance with bye-laws

Activity	Penalty
Non-collection of solid waste (garbage) from households during door-to-door collection	Rs 25 per day per house or shop or establishment to a maximum accumulated value of Rs 2,500 per vehicle per day
Collection in non-segregated form	Rs 25 per day per house or shop or establishment to a maximum accumulated value of Rs 2,500 per vehicle per day
If non-collection of solid waste results in dumping of solid waste on ground	Rs 500 per incident per heap
Waste transported in unscientific manner (not covered, or is overflowing, or is dripping, or is unsegregated, etc.)	Rs 5,000 per vehicle per day per default
If waste is dumped at a non-designated place	Rs 10,000 per day per default
If monthly zone-wise collection in the segregated form is below a certain specified percentage	The specified percentage is decucted in payments to concessionaire for the month.

Source: AMC

- Designing and implementing public awareness campaigns to promote the best response from the public in practising source segregation, door-to-door collection and restraining people from traditional practices of dumping waste into drains, and littering on roads or any other space.

Recommendations

The current pilot initiative in the TTZ area, which has already made significant progress, needs to be strengthened with the following measures:

1. The transfer station in the Tajganj area needs to be equipped with facilities for dealing with segregated stream of waste to ensure that segregated waste is optimally utilized through resource recovery and recycling.

2. Bags used in primary collection vehicles for door-to-door collection must be properly labelled to ensure ease of identification at the transfer station and subsequent treatment facilities.

3. The source segregation campaign, which is very heavily focused on behavioural change, needs to continue for a few months even after the achievement of 100 per cent segregation at source.

4. The monitoring system that has evolved during the pilot initiative in the TTZ area needs to be expanded when the initiative is scaled up in the rest of the city.

5. The existing fleet management unit and functionaries deployed at the municipal ward, zone and corporation levels need to be equipped with the required skill and knowledge through a well-designed capacity building programme to take the plan forward.

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Phones: 91-11-40616000 Fax: 91-11-29955879
E-mail: subhasish.parida@cseindia.org Website: www.cseindia.org