Baseline Report on Solid Waste Management – Vijayawada

Project – International Urban Cooperation: Sustainable and Innovative Cities and Regions

February, 2021

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1 ACKNOWLEDGEMENT

The baseline study for the solid waste management system project has been commissioned as part of the Vijayawada-Hamburg strategic collaboration under the European Union International Urban Cooperation (IUC)-India program. The study represents the key deliverable of the Urban Cooperation Local Action Plan for the city of Vijayawada. The report has been prepared by Ashish Verma (JNKE, IUC India project) based on secondary research, stakeholder consultations, case studies and review of recommendations.

I am grateful for the support, expertise and insights provided by Ms. U. Sarada (Additional Commissioner – Projects, Vijayawada Municipal Corporation) as well as her team. The discussions held with these stakeholders and the information provided by them was instrumental to the completion of this report.

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2 EXECUTIVE SUMMARY

The baseline report on Solid Waste Management for Vijayawada city has been conceptualised after appropriate discussions with the concerned authority at Vijayawada Municipal Corporation (VMC). This report is an outcome of secondary research, stakeholder consultations and data collection both at the virtual level as well as with support from VMC. The report endeavours to present the current status of solid waste management (SWM) activities in Vijayawada including total solid waste generation, waste characteristics, waste collection and handling practices, waste treatment and disposal facilities. Further the report identifies the key challenges, potential gaps in terms of lack of manpower, infrastructure facilities needed to handle the waste in an efficient manner, etc. The report then presents potential solutions along with national and international case studies. Finally, the way forward in terms of potential next steps is suggested.

Chapter 2 contains the background of the assignment, city profile of Vijayawada and the objectives of this baseline study. It also briefly explains the methodology followed in preparation of this study and the limitations of this exercise.

Chapter 3 captures the existing arrangement of SWM in the city of Vijayawada, covering the entire SWM value chain, including waste generation, segregation, collection, transportation, disposal and waste treatment processes and technologies. The coverage of SWM activities within the city, prevailing waste types and sources of waste have been further explained. It also covers the roles and responsibilities of key stakeholders of the SWM system, policy and legal framework applicable to Vijayawada SWM, and future plans of VMC, related to SWM. Environmental concerns related to SWM activities are also illustrated

Chapter 4 presents demographic and macroeconomic trends in Vijayawada and solid waste generation estimates looking at a 20-year horizon.

Chapter 5 provides potential challenges detrimental to the solid waste value chain in Vijayawada, including the processes of solid waste collection, transportation, disposal and processing/treatment. The chapter also provides possible solutions to such challenges.

Chapter 6 analyses six cases studies, one each from Indore (Madhya Pradesh), Muzaffarpur (Uttar Pradesh), Mexico (Brazil), Bogota (Colombia), Vilnius (Lithuania) and Stockholm (Sweden) in order to assess the best practices and processes in solid waste management. The chapter also seeks to explain how the key learnings from national and international best practices and case studies can help shape an efficient solid waste management in Vijayawada city.

Chapter 7 summarizes the need for an efficient SWM in Vijayawada and lists out important points as a way forward for relevant stakeholders

3 INTRODUCTION

This chapter contains the background of the assignment, city profile of Vijayawada and the objectives of this baseline study. It also briefly explains the methodology followed in preparation of this study and the limitations of this exercise

3.1 Background Information

3.1.1 International Urban Cooperation (IUC) Program

The IUC program's overall objective is to contribute to improved international urban policy diplomacy and increased decentralized cooperation on sustainable urban development and climate change. The program has two components:

a) City/Sub-national cooperation on sustainable urban development to strengthen European Union (EU) - India cooperation among selected city/sub-national governments as well as between the national level and the EU, on sustainable urban development while contributing to India's Smart Cities Mission, AMRUT and other national and international sustainable urbanization processes; and

b) Cooperation on sustainable energy and climate adaptation and mitigation, and access to clean and affordable energy, through building upon the Global Covenant of Mayors (GCoM) initiative in line with existing India-EU commitments.

3.1.2 Vijayawada and Hamburg Partnership

VMC and Hamburg City have joined IUC India and chose to work together on sustainable urban development. Both cities have signed an agreement with IUC India respectively on September 19th 2018 and 7th December 2018 and have decided to cooperate on SWM issues. IUC India is supporting the Vijayawada-Hamburg partnership through exchange visits, technical assistance and the development of an Urban Cooperation Action Plan (UCAP) for the efficient, sustainable and climate friendly waste management practices at VMC. The exchange visits between Vijayawada and Hamburg have taken place between December-2018 to March-2019.

This report is the key outcome of the cooperation between Vijayawada and Hamburg which is valid until April 2021. The report may potentially constitute the basis of a future more detailed feasibility assessment and a concrete pilot project in Vijayawada in the next phase of the project scheduled to be implemented during 2021-23. The baseline study will also draw insights related to SWM best practices in India and EU cities (including Hamburg). The next stage of the project will attempt to address the key challenges identified in the baseline report in a phase wise manner. The modalities, timeline and other key deliverables could be finalised mutually between VMC and IUC-India.

3.1.3 Baseline Report on SWM

The baseline report encapsulates the current status of SWM activities in Vijayawada, roles and responsibilities of various stakeholders involved in the process, future demand and plans. The report is prepared based on secondary research, stakeholder consultations, national and international best practices. The report endeavours to propose certain recommendations to Vijayawada city in the area of SWM.

3.1.3.1 Objectives of the Baseline Report

3.1.3.1.1 Baseline on Current Solid Waste Handling Practices

The main objective of the study is to prepare a baseline with regards to the current SWM practices being followed in Vijayawada city. The report carefully examines the current practices employed by VMC to handle the solid waste generated in the city. It includes activities relating to door-to-door waste collection, transport to main transfer stations, waste processing activities that may include composting, waste to energy, bio methanation, recycling and finally disposal to the landfill sites. The report attempts to understand the basis of current waste handling practices employed by VMC as per the various rules and regulations prescribed by the national and state level governments.

3.1.3.1.2 Main Challenges and Relevant Stakeholders

In the following sections, it is targeted to identify the main challenges faced by the VMC in handling the waste management in the city. The suitability and applications of various guidelines prescribed by the higher levels of governance are examined to identify the gaps so that appropriate recommendations could be provided to the city governance either in the form of technical interventions or policy level changes. The roles and responsibilities of various stakeholders is also been observed so as to identify the resource gaps and propose suitable recommendations.

3.1.3.1.3 Potential Solutions and Impacts

As per the current level of SWM practices, prevailing rules and guidelines, role of various levels of stakeholders, key challenges and gaps are identified and potential solutions are recommended to the city of Vijayawada. These solutions are recommended in the form of case studies and best practices both at national and international level. The impacts of such recommendations are also established so that the city may take a decision based on the suitability and adaptability of certain solutions

3.1.3.1.4 Key Learnings and Way Forward

Key learning in various areas of interventions such as policy level intervention, technological interventions and resource level interventions were provided to the city to choose from based on the need and requirements of Vijayawada city. The next way forward including preparation of detailed feasibility report, implementation of pilot projects, replication and upscaling of pilot activities were also recommended to Vijayawada city.

3.1.3.2 Methodology Employed

The report is prepared after employing a mix of secondary research and stakeholder consultation. A lot of secondary information was collected from the relevant departments in VMC. In addition, information is also collected based on online research, review of reports and provision of information both at the VMC and other relevant departments in Vijayawada city. The respective sources of information are provided at the end of the report in bibliography section. The study was conceptualised during September 2020 and the first draft report was prepared in October 2020 which was later on revised to incorporate some additional information and revisions. The final draft report was prepared and sent to VMC in December-2020.

3.1.3.2.1 Secondary Research

Information is collected based on online research, review of various published reports, case studies, journals, articles etc. In addition to this, a lot of information is also collected from VMC website. For all the information collected from various online platforms, relevant reference has been made within

the report itself. The respective source of information collected from various platforms – websites, research papers, presentations, newspapers etc. have been given in bibliography section of the report.

3.1.3.2.2 Stakeholder Consultation

Several online consultations were conducted with the relevant departments within VMC. It involved consultations mainly with the Engineering and Public Health departments of VMC. Information from VMC[1] has been received through discussion over phone, exchange of emails and other convenient tools useful for the preparation of the report. In addition, local NGOs involved in certain SWM activities at Vijayawada were also consulted to reach at the required level of assurance regarding current SWM practices followed in Vijayawada city. All the relevant stakeholders have very generously provided all the available information required for the completion of this report.

3.1.3.3 Limitation of the Study

The report aims to provide a comprehensive analysis of the current waste management scenario in the city of Vijayawada, the future outlook for SWM services and to highlight the best practices related to SWM, followed across India and abroad. However, the study is limited in the sense that it is only a baseline study to assess the as-is situation of the SWM lifecycle in Vijayawada, in addition to the assessment of existing facilities and practices for waste treatment. Additionally, this study relies heavily on secondary sources of information and data collection through stakeholder consultations. In the wake of Covid-19 and the subsequent restrictions laid out by the Government of India, on-ground verification of data and site visits were not feasible.

3.2 Vijayawada City

Vijayawada city is one of the thirty-five metropolitan cities in the country and the second largest city in the State of Andhra Pradesh after Visakhapatnam. It is located on the banks of river Krishna. Vijayawada has considerable historical importance and cultural heritage. It is considered as the agricultural and commercial capital of Andhra Pradesh. VMC is more than a century old and has been constituted as a municipality in 1888 with an area of 30 sq. km. It was upgraded as a Municipal Corporation in 1981. As per the population of the year 2011 census, Vijayawada City with an extent of 61.88 sq.km of area and dwellings of 2,72,457 households has more than 10,34,358 (2011) population which constitute 3.9% of total urban population of the State of Andhra Pradesh.[2] The estimated population for the year 2020 is 13,55,510 and for 2021, it is estimated to be 13,96,853

Figure 1: Vijayawada City

[1] *E.E. - VII CIRCLE - VII vmcee7@gmail.com and Solid Waste Department of VMC*
[2] *http://www.vmcdm.org/city_profile.html*

The landscape of city is marked by undulating small and medium sized hillocks with extensive plain lands between them. The Krishna River is a dominant part of the geography of City and runs through it. Although the hills here are a continuation of the Eastern Ghat chains, they, in general have a low elevation compared to the rest of the Ghats. The city also has three canals – Bandar, Eluru and Ryves. The average ground water depth is 10 meters. The City falls under Earth Quake Zone-III declared by Government of India reports. With the natural vulnerability, Vijayawada City is exposed to multi hazard risk profile and considered most vulnerable in terms of Natural and Man-made disasters. As per a report carried out by USAID-UNDP, the city is exposed and vulnerable at varying degrees to various natural hazards including cyclonic wind, flood, heat wave, and rock fall. In addition to this, the city has history of outbreak of malaria epidemics. The city also experiences wide spread vector borne and water borne diseases

3.2.1 Geography and Climate

Vijayawada is located at 16.5193°N 80.6305°E and has an altitude of 11 m (36 ft). It lies on the banks of Krishna River and is also surrounded on the north by Budameru River. The northern, north-western, and southwestern parts of the city are covered by a low range of hills, while the central, southwestern and north western parts are covered by rich and fertile agriculture lands with three major irrigation canals. The topography of Vijayawada is flat, with a few small to medium-sized hills. These hills are part of the Eastern Ghats cut through by the Krishna river. Three canals originating from the north side of the Prakasham barrage reservoir, Eluru, Bandar and Ryves, run through the city.

Figure 2: Maps of Vijayawada City

Vijayawada lies on 27m above sea level. The climate here is tropical wet and dry. When compared with winter, the summers have much more rainfall. The average annual temperature in Vijayawada is 28.5 °C, while the annual rainfall is 42 inches[3].

3.2.2 Demographics

As of 2011 Census of India, the city had a population of 10,34,358. The total population constitute, 5,17,956 males and 5,16,402 females —a sex ratio of 997 females per 1,000 males, higher than the national average of 940 per 1,000. 92,848 children are in the age group of 0–6 years, of which 47,582 are boys and 45,266 are girls—a ratio of 951 per 1,000. The average literacy rate stands at 82.59% (male 86.25%; female 78.94%) with 858,538 literates, significantly higher than the national average of 73.00%.

Table 1: Demographics of Vijayawada City

Population as per 2011 Census	10,34,358
Male Population	5,17,956
Female Population	5,16,402
Estimated population (2020)	13,55,510
Projected population (2031)	18,86,387
Projected population (2041)	25,47,480

3.2.3 Land Use Pattern

The area of the municipal corporation has increased from 30 sq kms. In 1996 to about 61.88 sq kms in 2020. The corporation's administrative area comprises of 64 administrative divisions inclusive of the extension areas. A detailed land use structure of the corporation area has been enumerated in table and figure below:

Table 2: Proposed Land Use in VMC for 2021

S.N.	Land Use	Within VMC Area	
		Area in Hectares	%
1	Residential including mixed residential	3,330.50	53.82
2	Commercial	273.71	4.42
3	Industrial	151.02	2.44
4	Public and Semi Public including Institutional	405.29	6.55
5	Recreational Including Parks and play grounds	176.67	2.86
6	Transport & Communication Including Railways	799.97	12.93
7	Water Bodies	717.15	1.59
8	Hills	333.69	5.39
	Total	**6,188.00**	**100**

[3] *https://en.climate-data.org/asia/india/andhra-pradesh/vijayawada-715084/*

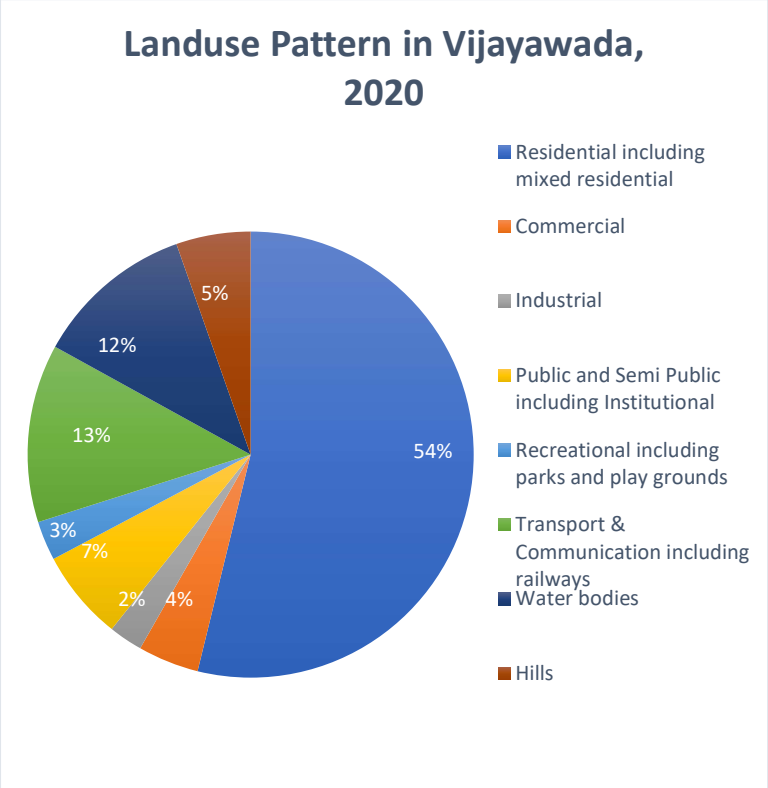


Figure 3: Land Use Pattern in Vijayawada City

3.2.4 Economy:

Vijayawada is the second largest city in the state of Andhra Pradesh of India in terms of its population. Visakhapatnam is the only city ahead of it in terms of population. Vijayawada is one of the Tier-II cities and is categorized under the B-1 graded cities of India. Factors contributing to its economic growth include agricultural exports, tourism, resources, industries and transportation etc. The economy depends largely on trade and commerce, which provides entrepreneurial growth. About 70% of working people are involved in tertiary activities. As per the historical data and future trends, the GDP of the city in 2010 was $3 billion (Rs. 18,000 crore) and is expected to grow up to $17 billion (Rs. 1,02,000 crore) by 2025. According to Oxford Economics report carried out by Oxford Economics Institution, the GDP of the city in 2018 was $5.8 billion and is expected to grow up to $21 billion by 2035[4][5]. The generation of SWM also depends on advancement of economic activities in any city therefore it needs to be looked at in a holistic perspective.

The city of Vijayawada is traditionally the main agricultural market centre for Krishna basin and act as a major commercial centre to a host of wholesale and retail activity, dealing in consumer goods, textiles, automobiles and industrial products etc. It is also a major trading place for processed Virginia tobacco, cotton and turmeric. The agricultural commodities produced in this part of Andhra find its

[4] *https://www.financialexpress.com/economy/worlds-top-10-fastest-growing-cities-are-all-from-india-check-which-cities-made-it-to-oxford-list/1585498/*
[5] *https://en.wikipedia.org/wiki/Economy_of_Vijayawada*

market in Vijayawada both local consumption and export. Vijayawada is also known for its mango exports, generating crores worth turnover annually.

Andhra Pradesh has recorded 8.16% growth rate in GSDP at the constant price for 2019-20 financial year. The GSDP of Andhra Pradesh at Current Prices for the year 2018-19 (Advance Estimates) is estimated at Rs. 9,33,402 Crores as against Rs. 8,09,548 crores for 2017-18 (First Revised Estimates). As per the Advance Estimates, the GSDP at constant (2011-12) prices for the year 2018-19 is estimated at Rs.6,80,332 crores as against Rs.6,12,793 Crores for 2017-18 (FRE) indicating a growth of 11.02 percent in comparison with the All India GDP growth rate of 7.0% for 2018-19 as per Advance Estimates. The sectoral growth rates of GVA of Andhra Pradesh for 2018-19 at constant (2011-12) prices are Agriculture: 10.78%, Industry: 10.24% and Services sector: 11.09%. The Per Capita Income (NSDP) of Andhra Pradesh at current prices has registered a growth of 13.96 percent as it increased from Rs.1,43,935 in 2017-18 (FRE) to Rs.1,64,025 in 2018-19, as compared to the Per Capita Income of All India which has increased from Rs. 1,14,958 in 2017-18 to Rs. 1,26,699 (AE) in 2018-19. According to one study, the GDP of the city in 2010 was $3 billion (Rs. 18,000 crore) and is expected to grow up to $17 billion (Rs. 1,02,000 crore) by 2025. According to another by Oxford the GDP of the city in 2018 was $5.8 billion and is expected to grow up to $21 billion by 2035

3.2.5 Transportation

The city is well connected to the rest of the country by National Highways and Railways, boosting trade. Vijayawada railway station with A-1 status, is one of the important railway junctions in India contributing the highest revenues to the South-Central Railway. It also has a domestic airport at Gannavaram.

3.2.6 Tourism

Vijayawada is the second important tourism city of Andhra Pradesh state after Visakhapatnam. It has certain landmarks and visitor attractions in and around the city such as Prakasam barrage, parks, museums, caves, river island and religious sites etc. Andhra Pradesh tourism has reached new heights with a 130 per cent growth in adventure tourism economy. These are based on the result of a survey done by adventure travel association. It has been noted that adventure sports in Krishna and Godavari Rivers are drawing large number of tourists to the state[6].

3.3 Vijayawada Municipal Corporation

The Municipality of Vijayawada (Bezawada) was constituted on 1st April, 1888 and was upgraded as a selection grade municipality in the year 1960. The municipality was upgraded to a corporation in 1981. As of now, the total area of the corporation has increased to 61.88 Sq.kms. with the merger of Gunadala, Patamata and Bhavanipuram village panchayats and two villages payakapuram and Kundavari kandrika in the corporation in 1985.

The city is divided into 64 political wards. An elected body headed by the Mayor performs the administration of the Corporation. The Commissioner acts as the executive head, and oversees the day to day functioning of the local body. The staff strength of the corporation is just over 5,000.

[6] *https://timesofindia.indiatimes.com/travel/destinations/andhra-pradesh-adventure-tourism-records-massive-growth/as68081336.cms*

4 CURRENT STATUS OF SWM IN VIJAYAWADA CITY

This chapter captures the existing arrangement of SWM in the city of Vijayawada, covering the entire SWM value chain, including waste generation, segregation, collection, transportation, disposal and waste treatment processes and technologies. The coverage of SWM activities within the city, prevailing waste types and sources of waste have been further explained. It also covers the roles and responsibilities of key stakeholders of the SWM system, policy and legal framework applicable to Vijayawada SWM, and future plans of VMC, related to SWM. Environmental concerns related to SWM activities are also illustrated

4.1 Total Solid Waste Generation in Vijayawada

Vijayawada City is spread across 61.88 km2 and is divided into 64 sanitary divisions and 64 municipal wards for the purpose of SWM. The city had a population of 10,34,358 as per census 2011. The current population for the year 2020 is estimated to be 13,55,510 with an annual growth rate of 3.05% per year.

The total waste generated is around 550 metric tons per day of which, approximately 265 metric tons is wet waste and 285 metric tons is dry waste. The wet waste comprises of discarded vegetables, fruits and flowers and is composted at waste treatment plants and composting units located across the city to produce organic manure, while dry waste comprising of construction and demolition waste, silt, etc. is transferred to the dumping yards. The city is processing 240 metric tons of wet waste and 229 metric tons of dry waste to produce compost and other material of commercial value through various service providers like waste composting units, waste recycling units, Bio methanization etc. The rest of the waste i.e. 81 metric tons is sent it to the land fill site for final disposal. Vijayawada is the only city in India to completely use the waste generated for these purposes[7]. Please note below some of the salient features of SWM activities in Vijayawada city[8]

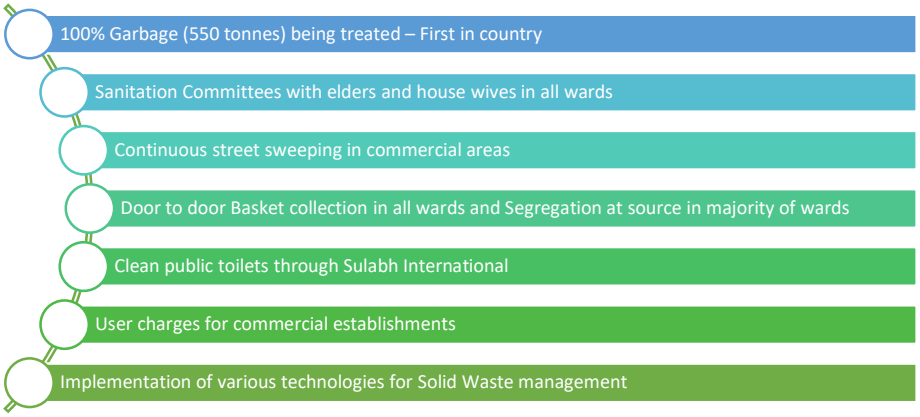


Figure 4: Salient Features of SWM Activities in Vijayawada City

[7] http://www.ourvmc.org/#/aboutvmc
[8] http://www.ourvmc.org/#/adminactivities

4.2 Sources of Waste in Vijayawada[9]

Waste quantities as well as composition are inextricably linked to the vibrancy of economic activity and resource consumption pattern of the society which generates the waste. Of the total municipal solid waste, 370 tons is collected from residential sector, 100 tons is collected from commercial sector, 10 tons is collected from industrial sector, hospitals in the city generate approximately 20 tons of waste, construction and demolition waste contributes approximately 50 tons to the total city waste.

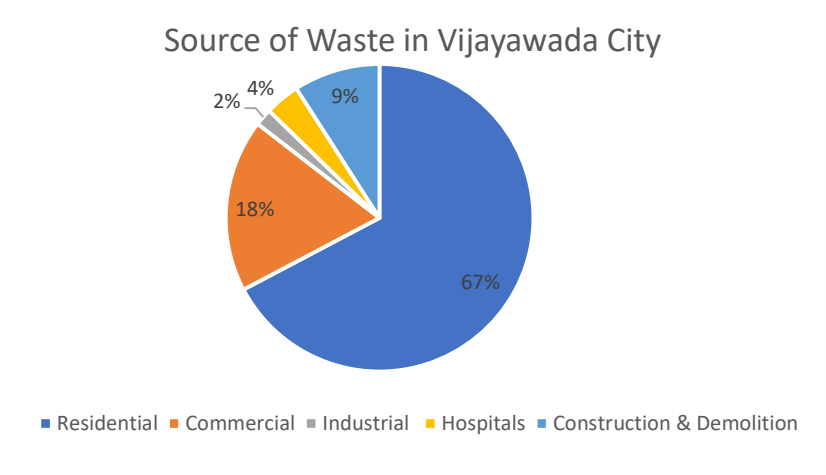


Figure 5: Source of Waste Generation in Vijayawada City

4.3 Types of Waste in Vijayawada

As per an assessment carried out by Department of Environmental Sciences, Acharya Nagarjuna University, Guntur, Krishna in the year 2015, the average organic percentage of waste in MSW was 55%, combustibles were 35% and recyclables were 10%. The physio-chemical parameters of the solid waste collected from disposal sites were found in moderate range and the waste was very much suitable for composting practices.

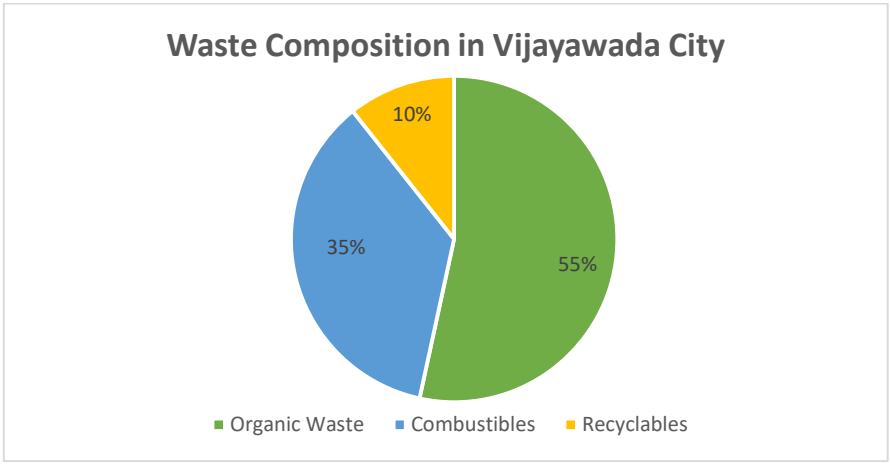


Figure 6: Waste Composition in Vijayawada City

[9] *Information collected from Vijayawada Municipal Corporation (VMC)*

4.4 Prevailing Waste Handling Practices

The city is divided into 64 sanitary divisions for primary collection of waste generated in the municipal limits. There is house to house hold collection covering all the 64 wards in the city. VMC has divided the entire road length in the city into 1256 numbers of micro pockets with each micro pocket having different road length. The wet and dry waste is collected separately. The city has about 3919 sanitary staff, of which 3284 are from Development of Women and Children in Urban Areas (DWCUA) groups and have taken up the task of cleaning the roads every day and the rest 635 workers are P.H. workers for sanitation.

VMC transports the wet and dry waste through closed compacted vehicles separately to the compost plants, energy generation plant, bio-mining plan, bio-methanation plant, construction and demolition plant, plastic recycling plants for processing of the waste and finally to the landfill site. At the storage place at community location, the system of community bin is followed. Of the 64 wards in Vijayawada city, 52 wards are bin-free wards whereas the rest of them are non bin-free wards. There is a total of 315 loader points throughout the city of which 241 lies in bin-free wards and 74 lies in bin wards. There are two waste transfer stations situated at – (a) Ajith Singh Nagar Area and (b) Auto Nagar transfer station. The final disposable waste is transferred by 9 big tippers to the landfill site situated at Pathapadu.

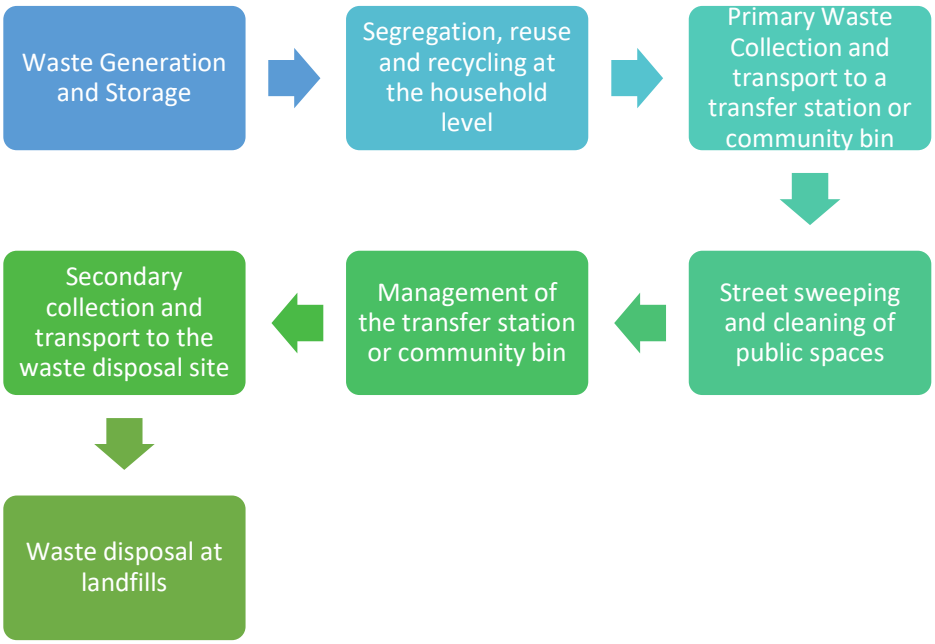


Figure 7:SWM Process Followed in Vijayawada city

VMC uses various convenient vehicles for the transport of waste from one place to other. There are various types of vehicles being used by VMC for waste collection, transportation and other waste management practices in the city.

Table 3: Type of Vehicles Used by VMC for SWM

Type of Vehicles	Numbers
Tractors	2
Big Tippers	9
Small Tippers	15
Dumper Placers	6
Big Compactors	11
Small Compactors	35
Hook Loaders	2
CNG Autos	24
Two Wheelers	2
Big Sweeping Machines	5
Medium Sweeping Machines	2
Small Sweeping Machines	6
Bobcats	3
Hemans (Skit Steer Loaders)	13
Jatayu Vehicles	3
Airtech	9
Super Sucker (De-silting Machine Vehicles)	5
Sweeper Cleaning Power Bucket Machines (Man Hole De-Silting Machines)	6
Four-wheel Vehicle Mounted Mini Jetting Machines:	3

Figure 8:Use of Push carts, Dumper bin, compactor bins at Vijayawada City

VMC uses 168 numbers of garbage bins out of which 48 are dumper bins and the balance 120 are compactor bins. In addition, there are 32 are Smart bins. Out of total 64 wards, 52 wards are bin-free and 12 wards use bin to collect waste. There are 315 loader points in spread across all the wards for collecting the garbage.

VMC has provided 6 numbers of 1.3 Cubic meters, Smart Semi Underground garbage collection bins at 2 locations and 26 numbers of 3.0 Cubic meters, Smart Semi Underground garbage collection bins at 9 various locations in the city in the place of existing dumper bins from Swachh Andhra Corporation funds and the work is in progress.

VMC is having 2 numbers Transfer stations, one at Ajith Singh Nagar and another at Autonagar. The garbage collected around those transfer station areas is being transported to these transfer stations with Autos, small tippers, Compactors, Dumper placers, and Tractors. Further the same is transported to Pathapadu land fill with Big Compactors and Big Tippers.

Vehicle Depot is to maintain vehicles and to provide them in the city of Vijayawada for the collection of garbage from various places to existing transfer stations at Ajith Singhnagar and at Autonagar and for further transportation from these transfer stations to land fill at Pathapadu dumping yard round the clock.

Vehicle depot is also maintaining the vehicles which are being utilizing for sweeping of roads, sewerage purpose as and when required. Procurement of 3 numbers of BS-IV, 4 Cylinder engine with cabin and Chassis for bearing load capacity of 7.4 MT with 6000 litres capacity Tanker with water sprinkler to Vijayawada Municipal Corporation. (NCAP Funds of MoEF & CC, GOI through APPCB)

VMC has also conducted the procurement, operation and maintenance of 3 numbers of Heavy-duty industrial road sweeper machine, mounting on 6 tonnes GVW/LCV Chassis to Vijayawada Municipal Corporation (NCAP Funds of MoEF & CC, GOI through APPCB). In addition, VMC has procured 25 numbers of CNG 3 Cubic meters capacity closed box tipper / Autos for garbage collection from 1st to 27th divisions in Vijayawada Municipal Corporation (General Funds). VMC has also procured 3 numbers of Roadside Rescue Open Drain Desilting Machine for removal of Silt/Grit in Open Drains (NALA Machines). VMC has procured 3 numbers of Vehicle Mounted Jetting, Grabbing and Roding Machine for Maintenance of Sewer System in Vijayawada Municipal Corporation to be supplied by contractor.

Online Waste Management System – (OWMS)

In VMC there are total number of RFID Tagged gates are 1,08,357 at present 90,602 Tags were Scanned. and in MDFRS total employees registered are 3,343 in this 2,707 employees were taken attendance due to technical problem balance employees and gates scanning updating is under process.

Figure 9: Use of Refuse compactors at Vijayawada City

4.5 Technologies, Treatment Process and System Description[10]

VMC is using multi-pronged strategy to dispose the waste collected from different parts in the city. The city is doing onsite composting, recycling of dry waste material and energy recovery from organic waste. The use of various technologies is summarised below:

- **Wet Waste processing Plants**
  - 5 Centralised Composting Units – 40 TPD
  - 1 Windrow Composting Unit – 150 TPD
  - 1 Bio – methanization plan – 20 TPD
  - 200 numbers of bulk waste generators - 50 TPD
  - Home Composting - 2 TPD
- **Dry Waste Recycling Plants**
  - 1 VMC Material Recovery Facility – 50 TPD
  - 160 Kabadiwala Retail Shops – 60 TPD
  - 12 Whole Sale Dry Waste Recycling Plants – 67 TPD
  - 1 Plastic waste recycling facility - 25 TPD
- **Garbabge sent to Dumping yard - 81 TPD**
- **Processing of construction and demolition waste (70 TPD)**
- **Biomining plant at Ajith Nagar dumping yard**

Figure 10: Various Technologies used in Vijayawada City

In Vijayawada Municipal Corporation daily 550 Metric Tonnes of Garbage generating. In the 550 Metric Tonnes of garbage Wet garbage 265 and Dry garbage 285 Tonnes. Vijayawada Municipal Corporation having 4 on site compost plants with the in taking capacity of 40 Metric Tonnes and 1

[10] *Information collected from Vijayawada Municipal Corporation (VMC)*

Windrow Compost plant with the in taking capacity of 150 Tonnes per day. Vijayawada Municipal Corporation having 160 Kabadiwala shops for dry waste recycling daily they are recycling 229 Tonnes of Dry garbage

Wet Waste Processing Plants (Composting Plants):

VMC has 4 Nos of Centralized wet waste processing plants at various places as follows:

Table 4: Waste Processing Plants at VMC

S.N.	Location	Daily Wet Waste
1	Kabela	10
2	Urmila Subbarao Nagar	10
3	APIIC Colony	10
4	Ajith Singh Nagar at Excel Plant	10

Figure 11: Various Technologies used in Vijayawada City

VMC installed one windrow compost plant, one bio methanization plant. In addition, there are 200 numbers of bulk waste generators which are practising composting at source of waste generation and some people are also practising home composting with a cumulative capacity of 2 TPD. The onsite compost plants process the organic waste and make organic fertilizers.

Figure 12: Onsite Compost plants at Bhavanipuram Raithu Bazaar in Vijayawada

The civic body has also concentrated on clearing the 20 tonnes of vegetable waste and animal waste with the help of the bio-methanization plant which is maintained by Arumugam Bio Energy of Tamil Nadu. The project cost is of INR 2.15 crore and the state government is bearing the expenses. The plant produces 1,500 m^3 of methane gas with the combination of nitrogen and hydrogen sulphate. VMC has also installed different dry waste recycling plants at the main dumping site within the city. The VMC has a dry waste recycling plant at Ajith Singh Nagar transfer station with a cumulative capacity of 50 tons per day. The plant is currently managed by Ultratech cement, Jaggayapeta.

Figure 13: Composting Plants in Vijayawada City

VMC has established dry waste collection and recycling centre i.e. Material Recovery Facility (MRF) centre. Construction of Material Recovery Facility sheds & Platforms for Solid Waste management, in Ajith Singh Nagar Excel Plant Area was conducted in phase wise manner.

VMC has also facilitated the supply and delivery of manual sorting conveyors, feeding hooper, magnetic separator & belt conveyors in material recovery facility centre at Ajith Singh Nagar using

VMC general funds. Construction of Platform with raised basement for accommodation of Material Recovery Facility at Ajith Singh Nagar was also undertaken in Vijayawada Municipal Corporation.

The VMC authorities faced several problems to dispose the plastic generated in the city therefore, it was decided to recycle it. The Corporation started doing so by establishing the 'Material Recovery Facility Centre' at Ajith Singh Nagar. With the financial support of the Coca-Cola company, the VMC started processing plastic waste. As of now it recycles 25 tonnes of plastic waste by turning it into many types of pellets and granules which is further utilised as raw material for various plastic products. The plant is maintained by the E - Sree Foundation of Hyderabad. VMC has taken various initiatives in order to eliminate single-use plastic. For example, a ban on single use plastic is being enforced in the city since June 2020. Besides that, the collected plastic waste is being shifted to recycling units for producing bricks and also supplied to cement manufacturing companies in Jaggaiahpet area, where it is being utilised it as an alternative fuel to coal[11]

The VMC has established the construction debris processing plant at Ajith Singh Nagar in November 2018. The plant is being jointly operated by Pro Enviro C&D Waste Management Company and the VMC. The capacity of the unit is about 200 tonnes and it processes nearly 70 tonnes of debris every day. The debris is processed into 40 mm, 20 mm and 6 mm metal filling sand and is used directly for construction as a fill material and also in manufacture of downstream products like RMC, bricks, blocks, tiles, pavers, etc.

VMC has recently adopted numerous measures to improve SWM activities such as implementation of quick response code (QR Code)-enabled radio frequency identification (RFID) tags for waste collection[12]. In other words, the civic body has introduced an online waste management system allowing sanitation workers to use QR code scanners while collecting garbage bins from houses that could be, in turn, monitored in real time through the commissioner's dashboard. Following the change, as many as 52 wards out of 64 have been declared as bin free. VMC also installed 45 smart bins at various locations that sends alerts to authorities as soon as they are full[13].

[11] https://www.newindianexpress.com/cities/vijayawada/2019/dec/11/experts-review-vijayawada-municipal-corporations-waste-management-2074412.html

[12] https://www.newindianexpress.com/cities/vijayawada/2020/feb/14/vijayawada-municipal-corporation-steps-up-efforts-for-participation-in-ease-of-living-survey-2103264.html

[13] https://timesofindia.indiatimes.com/city/vijayawada/vmc-spends-year-harnessing-tech-for-effective-solid-waste-management-eliminating-plastic/articleshow/73051399.cms

Besides this, the concerned authorities within VMC has shared the details[14] regarding the current waste handling practices like community participation on ban on plastic use, awareness rallies that are conducted to address the information gaps and raise awareness amongst the citizens as well as other relevant staff within VMC. VMC has also promoted the distribution of cloth and jute bags by resident welfare associations and other volunteers to discourage the use of plastic bags in the city. In addition, the city has various waste recycling and material recovery facilities at different places within the city and depicted in the following pictures.

Figure 14: Waste Recycling and Material Recovery Facility

[14] *Information collected from Vijayawada Municipal Corporation (VMC)*

VMC has also established a biomining plant to treat 2.5 lakh tonnes of waste accumulated at Ajith Singh Nagar dump yard[15]. The biomining plant was installed and the 45-acre land was utilised to

Figure 15: Biomining Plant at Ajith Singh Nagar Dumping yard

construct social housing buildings in the area. The project involves segregation of collected waste into separate sections. The project involves clearing of waste accumulated in 45 acres of land. The contract was allotted to Zigma Global Environ Solutions of Erode in Tamil Nadu.

The Vijayawada Municipal Corporation (VMC) entered in to a "DESIGN-BUILD OPERATE" (DBO) contract with above said Private Service Provider to implement the project on "Remediation of Ajith Singh Nagar dump site through Bio-mining process in VMC". The project would involve Design, Construction, Operation and Maintenance of the Bio-mining and Reclamation of existing solid waste dump site in the said process in a scientific manner at Ajith Singh Nagar dump site in VMC area. The work was completed (TREATED QTY OF WASTE: 3.05 Lakhs M Tons of waste is treated as on 30-06-2020). The cleared site was under process parks development.

VMC Land Fill (Dump yard):

- VMC is having land fill measuring an extent of area Acres 2.75 at Pathapadu village which is 20 kms away from Vijayawada city.
- This quarry pit is already exhausted. In this connection VMC is searching for another suitable site for scientific land fill on lease basis up to completion of waste energy which is establishing at Naidupeta, Guntur District by Government of A.P.

[15] https://www.newindianexpress.com/cities/vijayawada/2020/feb/14/vijayawada-municipal-corporation-steps-up-efforts-for-participation-in-ease-of-living-survey-2103264.html

- The Pathapadu village public has frequently stopping our VMC garbage carrying vehicles to dump the city garbage in the above quarry pit.

Figure 16: Waste Dump Site at Pathapadu Dump

The final disposable waste is dumped at Pathapadu in Vijayawada rural. The daily waste that is dumped at Pathapadu is 100 tons.

Figure 17: Waste Dump Site at Pathapadu Dump

Vijayawada won the 'cleanest big city' award in the category for cities with over 10 lakh people. It had earlier received this distinction in 2018. In the 2019 edition of the Swachh survey, Vijayawada was ranked 12th, Greater Vizag 23rd and Tirupati eighth. While Vijayawada and Greater Vizag improved their rankings, Tirupati slipped to the 12th rank this year. Out of the total of 6,000 marks, Vijayawada secured 5,270.32, which included 1,329.09 for 'service-level progress', 1,100 for 'certification', 1,493 for 'direct observation' and 1,348.23 for 'citizen feedback and Swachhata mobile application.

4.6 Organizational Setup

The solid waste management activity in Vijayawada city is jointly managed by the Engineering and the Public Health departments of VMC. Both the departments work under the supervision of Municipal

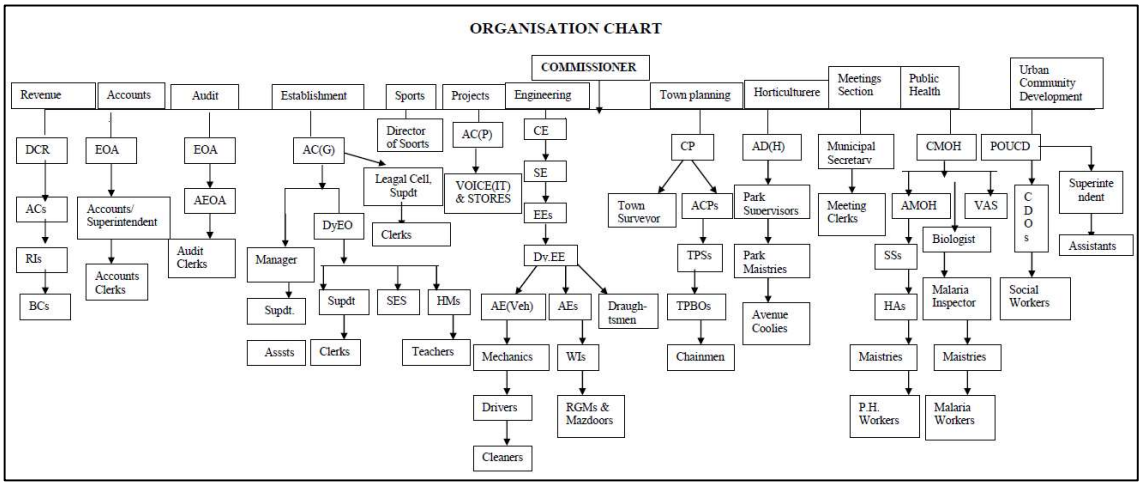


Figure 18: Organization Set up at Vijayawada Municipal Corporation

Commissioner and work towards the implementation of various policies, action plans and other related activities. As described in the organization chart above, the engineering department is headed by the chief engineer and then followed by superintending engineer, executive engineers, divisional executive engineers, assistant engineers, mechanics, drivers and the cleaners in the city. This department works more on the physical side of solid waste management which includes cleaning, implementing policies, action plan implementation. The Public Health department is headed by the chief medical officer and works on the sampling, health and hygiene and other relevant matters related to solid waste and its impact on public health.

4.7 Policy & Legal Framework (National/Regional Policies and Strategies; Overall Goal for VMC) Including Covid-19[16]

The solid waste management in Vijayawada is carried out following the national and state level guidelines. The following rules have been recommended by national government to be followed by the sub-national and local governments to conceive and implement strategy, action plans and concrete projects to manage the solid waste generated in the cities.

[16] *Information collected from Vijayawada Municipal Corporation (VMC)*

Figure 19: National Level Guidelines for Solid Waste Management

4.7.1 Solid Waste Management Rules, 2016

The source segregation of the waste has been mandated to channelize the waste to wealth by recovery, reuse and recycle. Responsibilities of generators have been introduced to segregate waste into three streams – wet, dry and domestic hazardous waste; and handover segregated wastes to authorised rag-pickers or waste collectors or local bodies

Generators will have to pay "user fee" to waste collectors and for "spot fine" for littering non-segregation. The concept of partnership in Swachh Bharat has been introduced. Bulk and institutional generators, market associations, event organizers, hotels and restaurants have been made directly responsible for segregation and sorting the waste and manage in partnership with local bodies.

All resident welfare and market associations, gated communities and institutions within an area 5,000 sq. m. should segregate waste at source – in to valuable dry waste and handover recyclable material either to the authorised waste pickers or the authorised recyclers or to the urban local body.

The bio-degradable waste should be processed, treated and disposed of through composting or bio methanation within the premises as far as possible. The residual waste shall be given to the waste collectors or agency as directed by the local authority

All manufacturers of disposable products who sale or market their products in such packaging material which are non-biodegradable should put in place a system to collect back the packaging waste generated due to their production. The concept of RDF, and types of waste generated and the need of WTF is also mentioned in the Waste Management Rules, 2016

4.7.2 Hazardous Waste Management Rules, 2016

India's environment ministry MoEF & CC has issued its revised hazardous and other wastes (management and transboundary movement) rules 2016. The policy explains the type of waste, which

by reason of its characteristics would be classified as hazardous waste and helps to distinguish between hazardous and other wastes. Hazardous waste classification, identification and storage & labelling requirements of hazardous waste are explained. Management of such waste, problems associated and importance of proper hazardous waste management is also illustrated. Roles, responsibilities and duties of waste generator and various stakeholders as well as environmentally sound management, management hierarchy, co-processing, disposal and recycling of hazardous waste is explained.

4.7.3 Bio Medical Waste Management Rules, 2016

The MoEF&CC notified the bio-medical waste management rules, 2016 to replace the earlier rules, 1998. These protocols define the types of waste which are categorized as bio-medical waste such as human & anatomical waste, treatment equipment such as needles, syringes and other material used in healthcare and in the process of treatment and research. They also explain the waste categories for bio-medical waste and define the ambit of bio-medical waste generators such as blood banks, treatment or immunization processes in hospitals, nursing homes etc. Scientific disposal of such waste for effective disposal by hospitals and other waste generators. The roles and responsibilities of waste generators and producers as well as standards for incinerators and other bio-medical waste handlers are also explained.

4.7.4 Plastic Waste Management Rules, 2016

The MoEF&CC notified the plastic waste management rules, 2016 which will now supersede the plastic waste management rules, 2011. The policy defines plastic, compostable plastics, carry bags, virgin plastics, multi-layered packaging and all types of plastic waste. It also lists the categories of plastics, lists the roles and responsibilities of prescribed authorities for plastic waste management, the roles and responsibilities of plastic waste generators and producers. The set of protocols explain the modalities of plastic waste management, environmental issues and challenges related with plastic waste and to promote the use of plastic waste in various tasks such as road construction, energy recovery etc.

4.7.5 E-Waste Management Rules, 2016

The MoEF & CC notified the e-waste management rules, 2016 in supersession of the e-waste (management and handling) rules, 2011. The policy applies to every consumer, producer, manufacturer, collection centres, dealers, refurbishes, dismantlers and recyclers involved in manufacture, sale, transfer, purchase, storage, collection, and processing of e-waste or electronic & electrical equipment which is listed in Schedule I. It also includes parts, components and spares which make the product operational. The protocols superseded the e-waste management rules of 2011. In EWM rules of 2016, e-waste has been defined as whole or in parts of an electrical and electronic equipment discarded as waste by consumer as well as the rejected material from refurbishment, manufacturing and repair.

4.7.6 Construction and Demolition Rules, 2016

The MoEF & CC notified the Construction and Demolition Waste Management Rules in 2016. The rules are an initiative to effectively tackle the issues of pollution and waste management. The construction and demolition waste generated nationally is about 530 million tonnes annually. The construction and demolition waste management rules, 2016 defines construction and demolition waste. The rules apply to every waste resulting from construction, re-modelling, repair and demolition of any civil structure

of individual, organization or authority who generates construction and demolition waste such as building materials, debris and rubble.

4.7.7 Andhra Pradesh State Sanitation Strategy[17]

Sanitation for the purpose of Andhra Pradesh State Sanitation Strategy (AP SSS) is defined as safe management of human excreta, including its safe confinement treatment, disposal and associated hygiene-related practices. The AP SSS recognizes primacy to integral solutions that covers sub sectors of solid waste, waste water (including septage), storm water drainage and drinking water. The aspect of sustainability is at the core of the strategy by looking at the dimensions of capacity enhancement, finance, technology, inclusiveness, climate change responsiveness, institutional and governance strengthening.

4.7.8 Measures Adopted by VMC Regarding Covid-19

VMC executive authorities appointed special officers in each ward for daily sample collections from symptomatic suspects. They are also sending covid positive people to isolation facilities. In addition, they are carrying out dis-infection with sodium hypochlorite and bleaching powder. The garbage from the containment zones is being collected separately.

VMC is conducting daily surveys to identify symptomatic people with covid-19 symptoms and sending them for swab collection. Information Education and Communication (IEC) activities are being conducted after forming different teams which are designated to do public awareness activities and collection of fines for not wearing mask, practicing social distancing and spitting at public places. So far, VMC has collected fines amounting INR 336.800 with the co-ordination of regional police. Resident Welfare Association (RWA) is conducting door to door distribution of awareness pamphlets regarding covid-19. Announcement using loud speakers, use of printing and electronic media to raise awareness about Covid-19. 8 Autos and 1 Jeep are engaged for Information Education and Communication (IEC) activities. Social Distance, Wearing Masks, Hand Sanitation etc. activities are being practiced. Awareness raising big hoarding are placed at strategic locations in the city, 2000 samples are collected per day through 10 Covid-19 buses.

4.7.9 Key Stakeholders (Role of National / State Governments; Institutions and Stakeholders Involved in the Planning)[18]

Below section gives an overview of the key stakeholders involved in the SWM activities for Vijayawada city:

Table 5: Key Stakeholders and Their Roles and Responsibilities

Level of Governance	Concerned Ministries / Departments
National Level Stakeholders	• Ministry of Environment and Forest (MoEF) • Ministry of Housing Urban Affairs (MoHUA) • Central and State Pollution Control Boards (CPCB)
State Level Stakeholders	• Department of Urban Development • The Directorate of Municipal Administration (DMA)

[17] *http://www.urbansanitation.org/live/hrdpmp/hrdpmaster/hrdp-asem/content/e30293/e31169/e49811/e65195/FINAL_AndhraPradeshSSS-Releasedversion.pdf*

[18] http://www.ourvmc.org/general/struct1.pdf

	• Municipal Administration Department of Government of Andhra Pradesh • Andhra Pradesh Pollution Control Board • Swachha Andhra Corporation[19]
City Level Stakeholders	• Vijayawada Municipal Corporation • Private formal and informal sectors • Local NGOs • The citizens of Vijayawada city

It is quite evident that various stakeholders are actively involved in the management of solid waste. Figure 20 below broadly identifies the roles and responsibilities of different stakeholders.

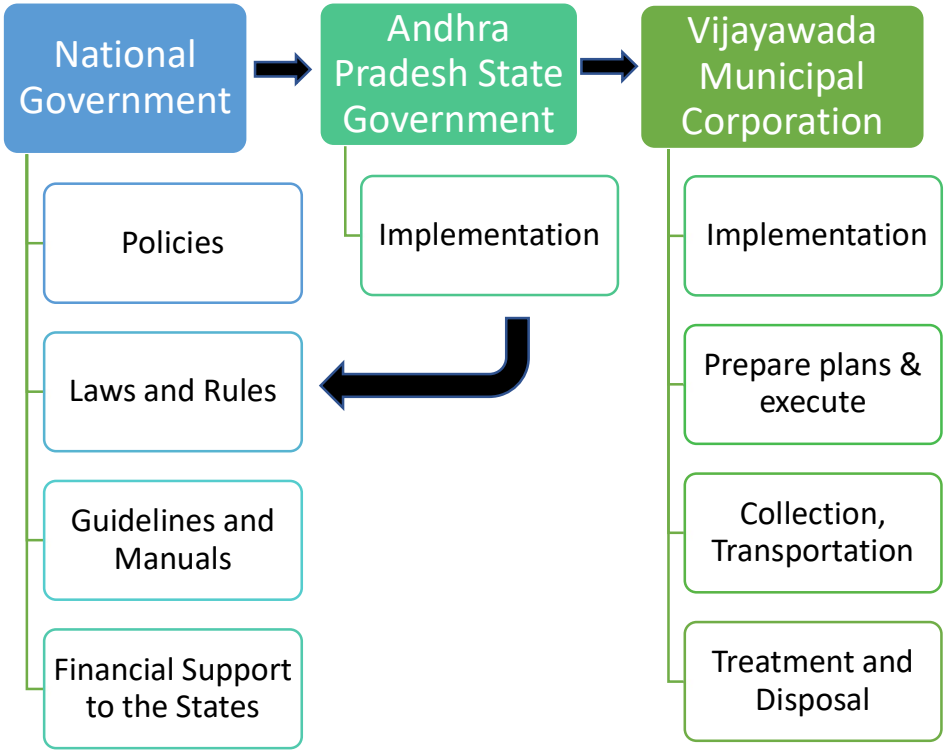


Figure 20: Key Stakeholders, their roles and responsibilities

4.7.10 Future Plans (Expansions, Incorporation of Advance Technology etc.)

VMC intends to provide a holistic waste management service to the citizens of Vijayawada city. The city is able to achieve the desired objectives to some extent by introducing various initiatives like collection efficiency, use of multiple technologies and providing a green and clean city to its citizens. There still are certain bottlenecks which the city target to eradicate by use of advance technologies, ensuring public participation and raising awareness amongst the public. The city intends to establish

[19] *http://sac.ap.gov.in/sac/default.aspx*

a Material Recovery Facility at the landfill including a ballistic separator, belt conveyors, air separator, manual sorting conveyors, feeding hopper, magnetic separator, etc.[20]

The civic body has also decided to renovate the bio methanation plant at Ajit Singh Nagar and set up a new one at Jakkampudi. To streamline the existing system, VMC is planning to improve door-to-door segregation across the city and make Vijayawada garbage free. In addition, the civic body is analysing all possibilities to enforce SWM practices through an Online Waste Management System (OWMS)-Internet of Things (IoT) and Information and Communication Technologies (ICT) tools.

The city government is also in discussion with various bulk waste generators with a daily waste generation of 5 tons or more to treat their own waste by way of installing on-site composting plant where the technical support will be provided by VMC. Establishments like housing societies, big hotels, hospitals, commercial markets, industrial sites etc. fall in this category. Recently, an agency has been empanelled to segregate garbage from bulk waste generators such as marriage halls, convention centres and hotels[21]. Some bulk waste generators have already started decentralised composting at Suryarao peta in Benzcircle area of Vijayawada city. Finally, the city intends to adopt a scientific landfill plant at the new waste dump site identified at Pathapadu[22]

[20] *Information collected from Vijayawada Municipal Corporation (VMC)*
[21] *https://www.newindianexpress.com/cities/vijayawada/2020/feb/17/agency-to-segregate-garbage-from-vijayawada-bwgs-2104524.html*
[22] *Information collected from Vijayawada Municipal Corporation (VMC)*

5 FUTURE PROJECTIONS

This chapter presents demographic and macroeconomic trends in Vijayawada and solid waste generation estimates looking at a 20-year horizon.

5.1 Historical Population

As per provisional reports of Census India, population of Vijayawada in 2011 is 10,34,358; of which male and female are 5,18,590 and 5,15,768 respectively. The urban / metropolitan population is 14,76,931 of which 7,43,267 are males and 7,33,664 are females. The historical data on population is tabulated below:

Table 6: Historical Population Data for Vijayawada

Year	Population	Decadal Growth Rate
1961	2,30,397	
1971	3,15,258	36.83%
1981	4,61,772	46.47%
1991	7,01,827	51.99%
2001	8,45,217	20.43%
2011	10,34,358	22.38%

The city has witnessed a rapid growth over the past five decades with average decennial growth rate of 35.62%. During the period 1981-91 the net growth has been about 51.99% attributed to a large influx of rural population to the city. However, in past two decades, 1991-2001 and 2001-2011, the growth has been stabilized with an increase of approximately 20-22%. The annual growth in the city's population is detailed in table below:

Table 7: Annual Population Growth Rate

Year	Population	Compound Annual Growth Rate (CAGR)
1961	2,30,397	
1971	3,15,258	3.19%
1981	4,61,772	3.89%
1991	7,01,827	4.28%
2001	8,45,217	1.88%
2011	10,34,358	2.04%

5.2 Projected Population:

The growth rate of population of Vijayawada city experienced by Vijayawada urban agglomeration during 1991 and 2001 will continue in future though at a lesser rate. Based upon the historical information on population for 2011, it is projected that in 2021, the agglomeration could house a population of 19.9 lakhs including the population of the city[23]. The Vijayawada urban agglomeration

[23] *http://shodhganga.inflibnet.ac.in/jspui/bitstream/10603/188151/9/09_chapter%202.pdf*

is experiencing population growth rates higher than the state. Based on the historical data and considering an average CAGR24 of 3.05%, the estimated population for the years of 2020, 2021, 2026 and 2031 for the area relating to VMC limits:

Table 8: Population Forecasting for Vijayawada

Years	1961	1971	1981	1991	2001	2011	2016	2020	2021	2026	2031
Population (Lakhs)	2.3	3.1	4.6	7.0	8.5	10.3	12.0	13.6	14.0	16.2	18.9

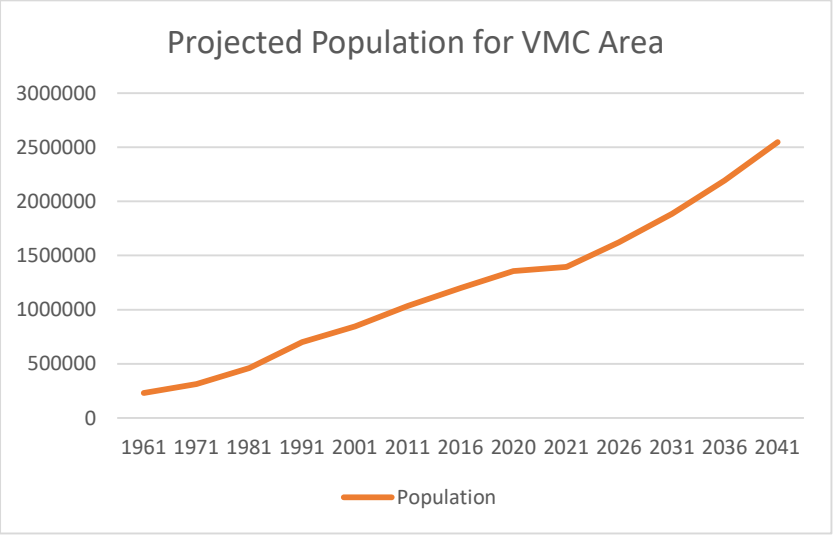


Figure 21: Projected Population for VMC Area

5.3 Projected Solid Waste Generation

Waste generation in urban areas of India will be 0.7 kg per person per day in 2025, approximately four to six times higher than in 1999[25]. The problems associated with waste become more acute as the size of communities increase and this provides opportunities for decentralized waste management by self-help groups and NGOs. The waste produced in urban areas of India is approximately 170 000 tonnes per day, equivalent to about 62 million tonnes per year, and this is expected to increase by 5% per year owing to increases in population and changing lifestyles. The table below shows that urban India generated 31.6 million tonnes of waste in 2001 and is currently generating 47.3 million tonnes. By 2041, waste generation is predicted to be 161 million tonnes, a fivefold increase in four decades. Average per capita waste generation is used to estimate the future waste generation for Vijayawada. The following table and graph present the future waste generation scenario for Vijayawada city. In 2001, the average per capita waste generation was 439 grams which is projected to increase to 569 grams in 2021 and 741 grams in 2041. The projected population for Vijayawada for the year 2021 and

[24] *IUC Analysis*
[25] *https://royalsocietypublishing.org/doi/10.1098/rsos.160764 and https://www.investindia.gov.in/swachh-bharat-unnat-bharat#:~:text=Waste%20generation%20in%20urban%20areas,times%20higher%20than%20in%201999.*

2041 is estimated to be 13,96,853 and 25,47,480 respectively. The total waste generation for these respective years is estimated to be 795 tons per day and 1888 tons per day respectively.

Table 9: Projected Solid Waste Generation in Vijayawada City

Year	Per capita waste generation (kg per day)	Population (Numbers)	Total waste generation (MT per day)
2001	0.439	8,45,217	371
2011	0.498	10,34,358	515
2016	0.498	12,02,018	599
2020	0.498	13,55,510	675
2021	0.569	13,96,853	795
2026	0.596	16,23,270	967
2031	0.649	18,86,387	1224
2036	0.693	21,92,153	1519
2041	0.741	25,47,480	1888

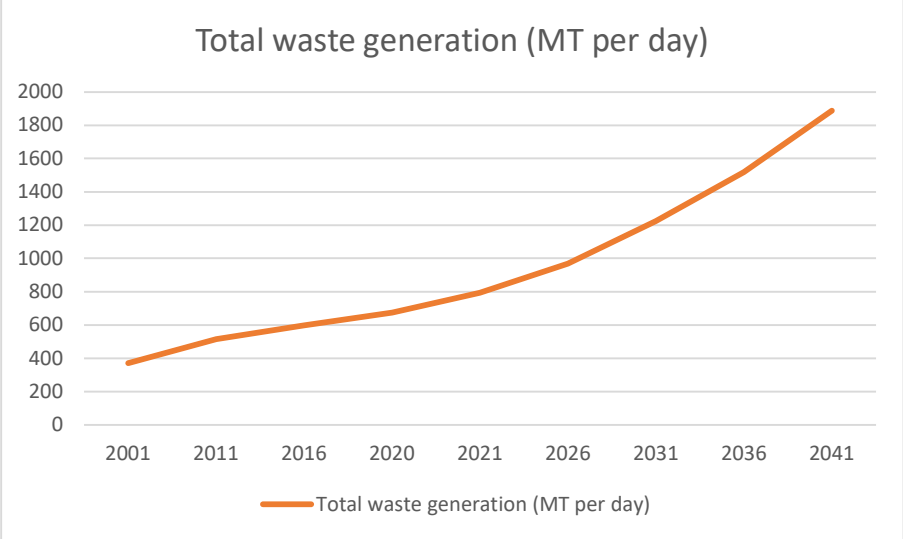


Figure 22: Projected Solid Waste Generation for Vijayawada City

6 KEY CHALLENGES AND POTENTIAL SOLUTIONS

This chapter provides potential challenges detrimental to the solid waste value chain in Vijayawada, including the processes of solid waste collection, transportation, disposal and processing/treatment. The chapter also provides possible solutions to such challenges.

6.1 Key Challenges

There are a number of challenges related to waste management in VMC. Figure 23 lists the key challenges, while the analysis provides more details about these challenges.

Figure 23: Key Challenges Solid Waste Management in Vijayawada City

6.1.1 Source Segregation

Segregation at the source of waste generation is very important. This single intervention if practiced efficiently can solve many other issues. It is observed that the waste generators at various sectors like residential, commercial and industrial are not segregating the waste before disposing it to the door-to-door waste collectors. This further leads to inefficient processing and inadequate landfill site. The municipal corporation should conceptualize and implement programs targeted towards raising awareness amongst the masses about the source segregation. The municipal corporation can use various communication mediums like public rallies, road shows, television, radio, print media etc. to raise awareness about solid waste handling and disposing.

6.1.2 Rapidly Increasing Areas to Be Served and Quantity of Waste

VMC has been expanding its municipal limits. Various surrounding villages have recently been included in the municipal limits which also adds to the existing responsibilities of the municipal corporation. In addition to the increasing areas to be served, the population as well as the lifestyle of people is also changing which puts an additional pressure on the existing limited resources of the city government.

6.1.3 Inadequate Resources

The VMC has limited resources to cover the areas as well as the services to be fulfilled by the local government. The recently added areas as well as the increased population have put an additional burden on the local government for which adequate and trained staff is needed to perform the SWM activities in an efficient manner.

6.1.4 Inappropriate Technology

It is also learnt that the Municipal Corporation does not have appropriate technologies to handle the SWM activities in the city. Right from the beginning of waste collection, transportation, processing and final disposal, it requires advance technology so as to reduce inefficiencies and ensure proper disposal in a scientific manner.

6.1.5 Disproportionately High Cost of Manpower and Low Efficiency

The rising inflation rate has also increased the cost of manpower which puts an additional pressure on municipal budget to carry out the SWM activities. The revenue from SWM activities is not so high compared to the cost and operational expenses. This results in inefficient operations and management practices.

6.1.6 Societal and Management Apathy

The approach of the society as well as the concerned management towards SWM is not so proactive. The people in general do not consider it an individual responsibility therefore, the system is not able to work efficiently and provide quality services to the citizens. In addition, the SWM sector also attract ignorance when compared to other development programs running in the city.

6.1.7 Increase in Demand for Service Level Demand

The increase in population and economic activities in the city will lead to increase in waste generation in all the sectors including residential, commercial & industrial as well as other public activities in the city. The increased generation of waste will require more resource staff as well as advanced technologies to collect, segregate, transport and dispose the waste generated and collected from various parts in the city. This requires proactive planning and execution strategies. In addition to following the rules and regulations mandated by the national and state level government, Vijayawada city should also explore and test the innovative ways and means to handle the future scenarios. It may involve partnering with external experts, involvement of local and regional NGOs, awareness raising at mass scale and adopting innovative technologies to dispose the waste.

6.1.8 Environmental Concerns

As per a survey conducted by UNIDO, it was found that the bio methanation plant established at Ajith Singh Nagar dumping yard uses vegetable waste and waste from slaughterhouses to produce methane gas which in turn is utilised to produce electricity. It was found that the smoke that emanates from the plant is hazardous and may pose health risks to the people living in nearby areas. It is suggested that the concerned team deploy appropriate technology to treat the smoke before releasing it in the atmosphere[26].

[26] https://www.newindianexpress.com/cities/vijayawada/2019/nov/17/vijayawada-civic-body-preparing-plans-for-power-generation-from-waste-material-2062885.html

Vijayawada's automobile hub, Autonagar is turning into a solid waste dumping yard. For more than 30 years, the area is facing the negligence despite the prevalence of many authorities involved in various capacities including VMC. Health issues have become very common in this area[27].

6.2 Potential Solutions

The SWM activities in any city needs to viewed in a comprehensive manner rather than in isolation. Various processes with regards to SWM right from the beginning of its generation, segregation, transport and disposal are linked to each other and should be managed in a holistic manner. In the chart below, various solutions relating to each stage of solid waste generation are mentioned which should be followed and implemented. The discarded waste reaching to the different waste processing facilities and finally to the landfill site should be processed as per the recommendations mentioned in the chart below. There should be focus on reduction of solid waste generation, reuse of waste should be followed, recycling should be largely practiced and then the waste should go to various processing facilities like composting, waste to energy, chemical treatment and final disposal[28].

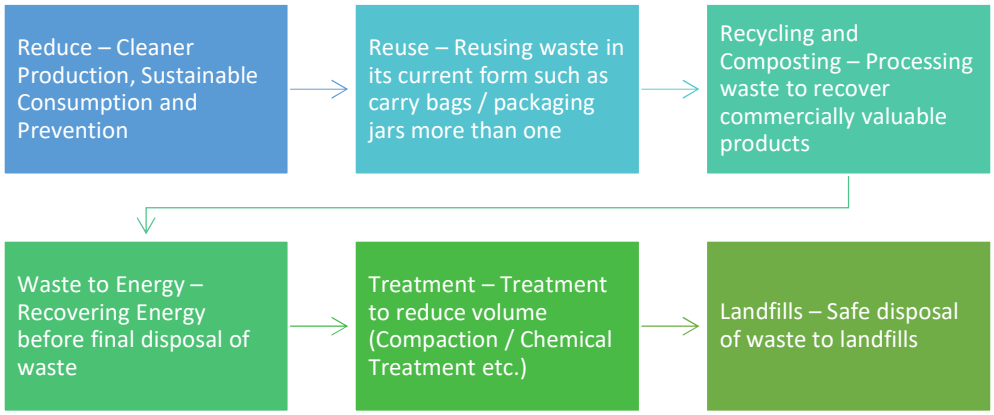


Figure 24: Potential Solutions regarding SWM in Vijayawada City

6.2.1 Reduce

Cleaner Production, Sustainable Consumption and Prevention. Reduce the amount of materials and goods the city consumes. This might mean limiting the amount of purchases the city makes in the first place. To determine the true needs and avoid impulse buys. There are other ways to reduce the consumption without limiting purchases. Buying foods in bulk often means less packaging waste. Buying in bulk is useful if someone is sure about the need the full quantity. Otherwise, it could be wasteful if one can't use all of the goods before they expire.

Budgeting can also help reduce resource consumption. If one is thinking about a new computer, but the old computer works well, save up the money little by little until one can afford a new one without

[27] https://www.newindianexpress.com/cities/vijayawada/2019/dec/03/vijayawadas-automobile-hub-autonagar-turning-into-solid-waste-dumping-yard-2070536.html
[28] https://www.ohiovalleywaste.com/ohio-valley-waste-news/reduce-reuse-recycle-what-does-it-mean-3049

using a credit card or payment plan. By the time one has gotten the money saved up, one may actually need the new computer, or may have realized there's a better use for the saved-up money.

Turning off lights when there is none in the room, unplugging electronics when not in use, and fixing drippy faucets are other ways to reduce consumption of essential resources. It will also lower utility bills - bonus!

6.2.2 Reuse

Reusing waste in its current form such as carry bags / packaging jars more than one. Reusing is the act of taking old items that might consider throwing away and finding a new use for them.

Get the most mileage out of the materials that are encountered. Jars from grocery store foods can be used to store leftovers or to take lunch to work. Use old clothing as cleaning rags.

Sometimes materials can be reused by other people. Working computers and parts can often be donated to community centres or charitable organizations. Clothing can often be donated and given a second life.

6.2.3 Recycling and Composting

Processing waste to recover commercially valuable products. This is probably the most well-known and well-understood of the 3Rs. If there is recycling pick-up services, one will be familiar with recycling paper, plastic and metal materials. These materials are carefully processed at TC Recycling. The separated and processed materials will later be processed into other goods.

Buying recycled goods is another way to participate in this part of the 3 Rs. One may start to notice more and more products with a "Made from Recycled Material" stamp. These products are no different from standard goods; they're just helping to make the most of valuable resources. Composting is a way of harnessing the natural process of decomposition to speed up the decay of waste. Designing successful composting systems requires an understanding of certain biological, chemical, and physical processes such as the movement of air, uptake of carbon and nitrogen, and heat production and transfer.

6.2.4 Waste to Energy

Recovering Energy before final disposal of waste. Waste-to-energy (WtE) or energy-from-waste (EfW) is the process of generating energy in the form of electricity and/or heat from the primary treatment of waste. Waste-to-energy is a form of energy recovery. Most waste-to-energy processes produce electricity and/or heat directly through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels. Most wastes that are generated, find their way into land and water bodies without proper treatment, causing severe water pollution. They also emit greenhouse gases like methane and carbon dioxide, and add to air pollution. Any organic waste from urban and rural areas and industries is a resource due to its ability to get degraded, resulting in energy generation. The problems caused by solid and liquid wastes can be significantly mitigated through the adoption of environment-friendly waste-to-energy technologies that will allow treatment and processing of wastes before their disposal. These measures would reduce the quantity of wastes, generate a substantial quantity of energy from them, and greatly reduce environmental pollution. India’s growing energy deficit is making the government central and state governments become keen

on alternative and renewable energy sources. Waste to energy is one of these, and it is garnering increasing attention from both the central and state governments[29]

6.2.5 Treatment

Treatment to reduce volume (Compaction / Chemical Treatment etc.) Waste compaction is the process of compacting waste, reducing it in size. Garbage compactors and waste collection vehicles compress waste so that more of it can be stored in the same space. Waste is compacted again, more thoroughly, at the landfill to conserve valuable airspace and to extend the landfill's life span

6.2.6 Landfills

Safe disposal of waste to landfills. Waste should be considered as resource which can be utilized to extract energy. This notion can only solve the problem related to landfills. Landfill mining to extract valuable substances for recycling, reuse, and recovery will lead to the proper management of waste. India requires clear regulations and its enforcement to solve problem related to waste management and landfills. Innovation in technology related to manage landfills can only be brought about by strong regulations and funds that can only be directed in this direction. The investment in constructing engineered landfill sites and waste-to-energy facilities is the only option that can help in solving the issues related to landfill. Methane extraction and thermal treatment of waste are the major opportunities for energy generation from landfills, but it requires qualified engineers and professionals having experience in this field which are lacking in India. Resource recovery from waste can be done using existing technologies as an extremely effective recycling tradition exists in India. A well-coordinated network of “scrap dealer” produces around three million tonnes of recycled materials which avoided the emission of 721 Kg CO2 per annum in the environment in India[30]

[29] http://www.gcpcenvis.nic.in/PDF/Waste%20to%20Energy.pdf
[30] https://link.springer.com/referenceworkentry/10.1007%2F978-3-319-58538-3_167-1

7 NATIONAL AND INTERNATIONAL BEST PRACTICES

The following chapter analyses four cases studies, one each from Indore (Madhya Pradesh), Muzaffarpur (Uttar Pradesh), Mexico (Brazil) and Bogota (Colombia) in order to assess the best practices and processes in solid waste management.

7.1 Indore - Waste collection efficiency

7.1.1 Background

Indore has been divided into 19 zones and 85 wards. Each ward has on an average 6,000 households and 600 commercial establishments (part of 88 notified commercial areas). In Indore, waste is generated from various sources including households, commercial areas and other institutions like RWAs, hospitals, hotels among others. The households or residential complexes are covered by the door to door collection system while the semi bulk and bulk generators are covered by the bulk collection system. Indore ensures the 100% coverage of wards through its door to door collection system.

Earlier, household waste collection system prior to 2016 was not so good. SWM was carried out in two stages as explained below:

Primary collection: Household waste was collected in some locations by municipality workers and in others through private arrangement by housing colonies.

Private waste collectors were called “Jagirdars”. They had very poor service quality levels and often dumped the garbage in open government land/ empty plots leading to health hazards for citizens.

In general, the waste collected was put in dustbins along main streets. The city had 1380 dustbins with some of them in very poor shape. These dustbins would often overflow creating an ugly look around the city. Stray animals (cows, pigs and dogs) would feed on this garbage. Some of these animals (cows and pigs) were looked after by the Jagirdars who could get additional income by milking the cows or selling the animals for meat. They had a vested interest in not keeping the localities clean so that the animals could feed on them and reduce their maintenance cost on these animals.

Secondary collection: From the central dustbins, waste was removed by a private contractor and moved to open dumping ground in to Devguradia. The contractor was facing a financial crisis leading to severely affected secondary waste transportation system. Their financial woes were reflected in the poor maintenance of vehicles managed by them and irregular service leading to accumulation and overflowing of dustbins.

The combination of poor collection and transportation of household waste gave a filthy look to the city. In addition, open defecation was prevalent in slum areas as the municipality had not provided enough public toilets for such people to use. Even with the city areas, cleanliness of public toilets was improper leading to open defecation by other citizens as well.

The Mayor expressed her concern about cleanliness to the commissioner and apprehensions about continuing with the private contractor which led to a termination of the contract in August 2015, few months after Mr. Manish Singh joined as Municipal Commissioner of Indore.

7.1.2 Implementation of D2D Collection System

In order to implement a successful door to door collection system, an identification study had to be carried out which helped to figure out the amount of waste generated at each ward and the population of each ward. On that basis, a detailed route plan was prepared to cover all wards. Based on the route plan, a detailed vehicle and staff deployment plan was implemented in order to meet the waste collection demand of each ward.

The door to door collection is done through the use of partitioned vehicles. There are three separate collection bins for wet, dry and domestic hazardous waste in each tipper. These tippers carry the waste from households to the transfer station, from where the waste is transported to the trenching ground in hook loaders. All vehicles used in the collection and transportation system are monitored by a GPS enabled tracking system. The GPS system is constantly monitored by the monitoring cell. Any route deviations by particular drivers are penalized and multiple deviations is also grounds for termination.

Figure 25: Waste Collection at Indore City

The wet waste from the domestic generators is collected through the Door to Door Collection System. The door to door collection system has been deployed by IMC to collect the waste from domestic generators and commercial areas in Indore. The waste is collected through partitioned vehicles known as 'Tippers' and transported to the Garbage Transfer Stations for secondary collection.

The wet waste from semi bulk generators generating 25 to 100 kg of waste is collected through the Bulk Collection System. The bulk collection vehicles consist of a dumper which is used to collect wet waste and a compactor which is used to collect dry waste. These vehicles move in pairs as per a predefined deployment plan. These vehicles on completing their collection route transport the waste straight to the central processing plant.

The bulk generators generating more than 50 kg of waste is comes under the category of bulk garbage generators. As per the GoI guidelines, it is mandatory for these generators to process their wet waste on-site. Hence wet waste is not collected from these generators.

The wet waste collected by the door to door collection vehicles is transported by the tippers to one of the eight transfer stations. At the GTS, the tippers unload the wet waste into dedicated compactors which compress and load the wet waste on dedicated hook loaders. The details of all the incoming waste collection vehicles are logged in the log books at the GTS. The bulk collection vehicles do not travel to the GTS but straight to the processing plant after completing their respective collection routes.

Figure 26: Waste Disposal and Treatment at Indore City

The Weighment Bridge facility is established at the central processing plant. This is the first point of interaction for all the vehicles incoming at the plant. This is a computerized facility where the weight of all the wet waste that is being collected by the door to door collection and the bulk collection system is brought to be weighed before it can move to the processing plant.

The wet waste is processed in two ways i.e. Central Processing Plant & at Decentralized Waste Processing Units. All the wet waste of the bulk generators (50 kg and above) is processed at their premises, so this waste is not processed at the central processing plant. The wet waste from the GTS (D2D Collection) and semi bulk collection (25 to 100 kg) is transported to the central wet waste processing plant, where it is processed into compost.

7.2 Muzaffarpur - Source Segregation

7.2.1 Background

Known as 'the land of litchi', Muzaffarpur is a sub-metropolitan city in Bihar north of and across the Ganga from Patna. In 2016, like several other North Indian cities, it had major solid waste pollution issues. The city had litter spots every 500 meters. Waste burning was a common practice. Even the

drains were clogged with plastics due to which it was becoming increasingly difficult for the city to deal with flood situations.

The Muzaffarpur Municipal Corporation (MMC) is responsible for SWM in the town. However, in the past, it had only invested in collection and transportation of waste to a dumping yard, situated 12 km away from the city in a village called Rautaniya. No treatment or processing of waste was being undertaken. In August 2016, CSE did a detailed investigation on the status of SWM in the city, and suggested the need for a decentralized waste management system.

7.2.2 Swachhta Swasthya Samridhi Programme

On 15 December 2016, the Swachhta Swasthya Samridhi programme was launched in Muzaffarpur under which an MoU was signed between CSE, MMC and ITC Ltd for facilitating better SWM in the city. The programme is helping transform Muzaffarpur into a zero-landfill city by adopting segregation and processing at source.

7.2.3 Muzaffarpur Waste Statistics

The 49 wards of Muzaffarpur city are divided into ten circles. Each ward consists of 1,500–3,000 houses. As per information provided by MMC, Muzaffarpur generates about 170 metric tonne of waste daily, with the daily per capita waste generation being close to 300 g.

7.2.4 Awareness and Propagation for Waste Segregation

Under ITC's 'well-being out of waste' initiative, 70 volunteers chosen from the city are responsible for door-to-door propagation to educate residents on why and how they must segregate their household waste. The volunteers accompany waste collector and check the levels of segregation. Their role is to ensure that over a period of time, segregation becomes a habit of the citizenry.

Figure 27: Awareness Raising Activities at Muzaffarpur City

households in 28 wards and commercial establishments in all 49 wards have adopted a decentralized mechanism for waste management.

Figure 28: Distribution of bins for dry and wet waste at Muzzafarpur city

MMC has provided all households in these wards with two superior quality plastic bins (green for wet and blue for dry waste) costing INR 195 each. Commercial establishments such as shops only generate dry waste and store it in cartons. Any biomedical, sanitary or hazardous waste is handed separately from the wet and dry waste.

Figure 29: Monitoring of the Progress at Muzzafarpur city

The details of the residents of the houses that have received the bins are noted and houses are marked with stickers to keep a track of the progress of segregation. The citizens also receive pamphlets explaining the process of segregation.

7.2.5 Waste Collection and Transportation

Figure 30: Waste Collection and Transportation at Muzzafarpur city

Tippers, tractors and tricycles provided by MMC are used for collection of waste. Currently, one tipper, one tractor and three tricycles are available for each ward. Four waste collectors gather waste from each ward. The tipper has two partitions for collection of segregated dry and wet waste streams. In addition, the tricycles have been partitioned to ensure transportation of segregated waste to all relevant facilities (dry waste franchise and to the Town Hall composting sites).

7.2.6 Waste Processing

About three–four tonnes of wet waste is collected every day from the 14 wards and sent to a model aerobic composting facility near the Town Hall. The facility near the Town Hall has 40 pits, each with a capacity of 1,000 kg. MMC is planning to set up seven such decentralized composting centres in the near future.

Figure 31: Waste Processing at Muzzafarpur

Collectors are incentivized as they earn about Rs. 2,000 per month by selling dry recyclable waste. They sell dry waste to the local scrap dealers (dry waste franchise) at their collection centre where it is further segregated into different kinds of waste for recycling purposes.

7.2.7 Results

The project has witnessed tremendous participation from the residents with over 80 per cent segregation achieved on a daily basis. This is a remarkable result, as in a majority of other cities where segregation at source is happening the segregation percentage is about 50.

Muzaffarpur has seen incredible improvement in cleanliness with streets and public areas looking very clean. Litter spots have declined, and so has waste burning. The citizens are very happy with the progress as the incidence of vector diseases has also lessened.

7.3 Hamburg's Waste Disposal Concept

The City of Hamburg is Germany's second largest city. Currently, around 19,00,000 people live here in about 10,41,724 private households. Moreover, there are about 1,00,000 commercial enterprises. In addition, Hamburg has Europe's second-largest port and is an attractive location for industries and companies.

In Hamburg, a distinction is made between waste from private households, from commercial enterprises including public facilities, from wastewater treatment and street cleaning (infrastructure waste), construction and demolition waste, hazardous waste, and ash (slag) from municipal waste incineration. Private households generate the largest volume of waste, closely followed by commercial enterprises. Street cleaning waste represents the lowest volume of waste in Hamburg.

To ensure a successful waste management in Hamburg, a holistic approach to waste treatment is required. This includes the prevention of waste by the population. At the same time, environmentally friendly and efficient waste disposal systems are needed. As a third factor, innovative projects highlight new techniques and unimagined cooperation on micro and macro level.

7.3.1 Lowering Waste Production - City Projects and Citizens Engagement

The easiest and best way to protect the environment and own wallet is and remains the avoidance of waste. True to the motto: The best waste is the waste that is not produced in the first place. This is why Hamburg has participated in the joint Federal Waste Programme, which was adopted by the Federal Cabinet in 2013. The following measures taken by Hamburg to avoid waste should be highlighted:

First of all, there are two Horizon 2020 projects taken by Hamburg in the lead management of the European Union:

The FORCE Project – Cities Cooperating for Circular Economy: This HORIZON 2020 project on recycling management (2016-2020), in which the Senate Chancellery, Stadtreinigung Hamburg, Aurubis, Hafen City University and the University of Applied Sciences are involved, is coordinated by the City of Copenhagen. The project aims to develop new concepts for waste prevention and treatment for four different recyclable materials (plastics, biomass, waste electrical equipment and wood - municipal waste). Within the framework of this project, Hamburg has dealt with old electrical appliances and established new processes that enable the continued use of these appliances.

Furthermore, there is the **CIRCuIT Project** – Demonstrating systemic urban development for circular and regenerative cities: Together with the City of Copenhagen and the Helsinki Region Environmental Services Authority, this recently launched project (2019-2023) aims to develop methods to reduce the

consumption of raw materials in urban development and to increase the degree of reuse of building materials in a sustainable way. In Hamburg, the project is expected to realise a pilot building made of recycled building materials (Wilhelmsburg Town Hall district). In consultation with the senior building director and the IBA International Building Exhibition, building contractor Otto Wulff is currently drawing up a concept for the building project. In Hamburg, the City in the form of the Senate Chancellery, the Technical University Hamburg and the companies Otto Wulff, EGGERS Tiefbau and Dörner Kies und Deponien are involved in this project.

To complement these city-lead projects, several measures have been created for the citizens of Hamburg:

With 68 recipes in the **"Hamburg climate cookbook - enjoy it to the full and save CO2"**, Stadtreinigung Hamburg wants to whet the appetite for sustainability and explain the connections between food and environmental protection. To ensure that as little as possible has to be thrown away, most main courses are accompanied by a leftover dish, where leftovers and excess purchase can be processed into another tasty meal. Readers will find tips on how to avoid food waste and cleverly recycle leftovers. Stadtreinigung Hamburg provides the cookbook free of charge. (https://www.stadtreinigung.hamburg/export/sites/default/download/PDF/Kochbuch.pdf)

Recycling and Upcycling: Likewise, the City of Hamburg implemented warehouses for used goods ("Stilbruch" https://www.stilbruch.de/) where citizens bring their clothes, furniture, toys and tableware. The goods are upcycled in repair shops and re-sold. This concept is broadly accepted by the citizens and contributes remarkably to decrease the amount of solid waste.

Beyond this, the free Zero-Waste-App, which is unique in this form for Hamburg, helps Hamburgers to find so-called Zero-Waste-Hotspots in their area. It offers them the opportunity to actively add their own tips and suggestions. Zero-Waste-Hotspots include shops and cafés that place value on climate-friendly consumption and avoid avoidable packaging. (https://www.hamburg.de/pressearchiv-fhh/12772940/2019-07-23-bue-zero-waste/)

Finally, there is a clean-up campaign called "Hamburg tidies up!" which takes place annually. On a set day, volunteers clear public areas such as playgrounds, schoolyards or parks of loose rubbish. This clean-up campaign improves the quality of life of every citizen and raises awareness of our environment and nature. Having fun and getting things moving together also promotes a sense of community among everyone involved. (https://www.hamburg-raeumt-auf.de/)

7.3.2 Waste Separation

After waste prevention, waste separation is an important component of Hamburg's holistic approach. Waste in Hamburg is divided into different types of waste: Paper and cardboard, bio and green waste, metal, waste wood, glass, plastics, packaging and similar recyclables, electronic scrap, textiles, bulky waste and mixed commercial waste. Most of this waste is picked up by refuse collection vehicles of which the City of Hamburg has got about 200. Apart from that, there are 12 recycling yards in Hamburg where citizens can hand in bulky waste, green waste, recyclable and problem materials.

7.3.3 Processing of Waste

At the next level, the waste is brought to one of Hamburg's waste incineration and processing plants. The Hanseatic City comprises two major waste processing plants, the waste processing plant Borsigstraße (MVB) and the waste processing plant Rugenberger Damm (MVR). MVB operates a plant with two lines for the thermal recycling of household waste and waste similar to household waste and

a biomass cogeneration plant for the recycling of waste wood. In this way, environmentally friendly electricity can be generated and a large part of the basic supply of district heating can be ensured in the Hamburg districts. In 2019, MVB generated around 7,88,000 megawatt hours of district heating and over 1,18,000 megawatt hours of electricity for Hamburg's population from the recycling of over 3,40,000 tonnes (t) of municipal waste and more than 1,46,000 tonnes (t) of waste wood. MVR also operates a waste-to-energy plant for the thermal treatment of household and similar waste. The plant has two incineration lines with a total annual waste capacity of about 3,20,000 tonnes. The energy generated is fed into the local supply networks in the form of process steam, electricity and district heating. It supplies industrial customers in Neuhof with process steam and the Neuwiedenthal district with heat. Operation of the former biogas plant was discontinued in the first quarter of 2019. In addition, Hamburg has a paper marketing company, a distribution company for compost products and one for slag, which is responsible for the distribution of slag produced in waste incineration plants as a building material, in particular for road and path construction. The Centre for Resources and Energy (ZRE) will be built by 2025 on the former site of a decommissioned waste incineration plant, a combination of different plants for sorting and recycling waste that is unique in Germany until now. A core element is a sorting plant that will process up to 1,40,000 tonnes (t) of household waste per year. Recyclable materials are sorted out and passed on for processing. Residual waste and bio-waste are to be used to produce biogas. ZRE generates climate-friendly district heating and electricity with biogas, dried biomass and plants for the thermal utilisation of waste wood and substitute fuel. All plant components together produce up to 60 megawatts of heat, up to 15 megawatts of electricity and around ten megawatts of biogas. ZRE will generate up to nine percent of the district heating produced in Hamburg and thus play a central role in the future supply of Hamburg households with climate-friendly district heating. (https://www.stadtreinigung.hamburg/nachhaltigkeit/umweltdienstleistungen/verwertung/)

7.3.4 Recycling and Energy Production

In 1999, Hamburg became the first federal state to completely discontinue the landfilling of untreated municipal waste. This measure was not only a decisive step for the environmental service branch, but also an important contribution to climate protection. The fermentation of waste used to produce large quantities of greenhouse gases at landfills, including methane, which is extremely harmful to the climate. Today, we can avoid these emissions of around 5,00,000 tonnes (t) of CO2 per year. By using waste sensibly, we save another 5,00,000 tonnes (t) of CO2: Energy recovery from waste replaces fossil fuels, and by recycling valuable materials we reduce the consumption of primary raw materials. We assume responsibility for the aftercare of eleven old waste deposits. The overall share of recycled waste lies at around 58.2 percent (2019). The aim of the Hamburg Government is to reach 65 percent by 2030. (For further information please contact thomas.jacob@sk.hamburg.de).

7.4 Support Development of a Market Economy for Waste Recycling: Case Study: Mexico City – Barter Market for Recyclables

7.4.1 Background

Establishing local systems where waste materials can be recycled or reused to fully harness existing outlets -- in addition to identifying and developing new, reliable and stable markets for recycled/ recovered materials in cities -- is key to creating a sustainable waste management system with high valuation for materials. Achieving greater local recycling and reprocessing capacity in cities will also lead to several other benefits, such as job creation; reduced waste transportation (with its associated costs and environmental impacts); greater self-sufficiency and resilience of the waste management system; and greater public confidence and participation. A successful domestic recycling market will

provide visible evidence of a successful recycling system, thereby strengthening public confidence in the environmental benefits of recycling and drive forward participation.

In March 2012, Mexico City's administration initiated a barter market project to trade clean and separated household solid waste recyclables for locally produced agricultural products. The overall objective of the barter market is to build an educational program promoting a culture of recycling and local consumption among the population of Mexico City. With about 12,500 tons of municipal solid waste generated per day ending up in landfills, the city created the barter market to explore sustainable alternatives to landfilling, as well as develop and maintain a culture of waste minimization and recycling. An additional aim of the project is to provide support to local producers and traditional forms of agriculture in the rural areas of Mexico City.

7.4.2 Results

The barter market takes place once a month on a Sunday morning in public places such as parks or plazas. The market is itinerant in order to gradually cover the different boroughs of Mexico City. Each citizen can trade up to 10 kilograms of waste per market day in one or more categories of valuable recyclables, which currently include paper, cardboard, PET, glass, tetra pack, aluminium, tin cans, and electronic waste. The agricultural products that are traded for waste are grown by local producers in rural areas of Mexico City and range from fruits and vegetables to plants and homemade jams. The barter market has developed strategic partnerships with 80 local producers and several recycling companies that are responsible for collecting the waste gathered during the event and transporting it to recycling facilities at their own cost. In exchange for the recyclables the private companies provide in-kind donations to the city government in form of environmental education materials.

The project contributes to the citywide recycling target of 5,000 tonnes/day (twice as much as the current recycling rate) and it has yielded significant results on a small scale. In 2013, 12 editions of the barter market were conducted, with nearly 20,000 citizens trading their recyclable solid waste, adding up to approximately 1,51,000 tonnes of material in total. The main environmental goal of this project is to divert valuable recyclable waste from final disposal in landfills, but it is also expected to bring significant co-benefits, such as contributing to the fight against malnutrition, a recurrent health issue in Mexico, by providing healthy, good quality food traded at barter markets. The market not only benefits local agricultural producers (80 were involved in 2014 through a strategic partnership) who receive subsidies from the city in the trading process, but also benefits the private waste industry by generating jobs in collecting and reusing valuable recyclables. The barter market is very popular among citizens, with more than 2,000 citizens participating in the trade every month. Reasons for success: The barter market is a remarkable social laboratory in which citizens actively get involved to promote a sustainable recycling economy. It is an opportunity for citizens not only to learn to separate, collect and value recyclable household solid waste in order to reduce final disposal in landfills, but also to consume local agricultural products (healthy produce with fewer GHG emissions from transport as they are grown close to the consumer). The barter market is growing in popularity because it provides families with fresh seasonal agricultural products in exchange for household waste. When/why a city might adopt an approach like this: Cities can adopt this approach to foster awareness of the value of recyclables among urban citizens, while supporting local agricultural production or other local products and services that can be offered in exchange for recyclable waste. The project particularly benefits the low-income population, generating important social and economic co-benefits

7.5 Integrate Waste Management and Social Inclusion: Case Study: Bogota - Zero Waste Program:

When designing solutions for waste management issues, it is important to ensure that their effects are sustainable over the long-term. In developing cities, with age-old informal waste handling systems, it is often counter-productive to completely replace these with new highly automatized technologically mature versions. There are multiple benefits of incorporating informal SWM infrastructures into new solutions, such as the regularization of informal waste pickers, thus improving their living standard and promoting participatory waste management. Such adaptations not only promote social well-being and financial efficiency, but also contribute to the creation of public ownership for the waste management system and urban area in the broader sense by directly involving citizens

Bogota's Zero Waste Program was created to achieve a change of cultural behaviour and waste perception among citizens. The aim was to privilege conscious consumption and a strong recycling policy for the city, while making sure the informal "recyclers" are integrated into the social and economic structure of the city, dignified for their labour and remunerated appropriately. The Zero Waste program, which was integrated in the city's Development Program "Bogota Humana" in 2012, has 6 priority areas: 1) Separation at source; 2) Manufacturers' extended responsibility; 3) Recycling model; 4) Reduction of disposal in city landfill; 5) Zero debris; and 6) Hazardous and special waste management. Results: The Zero Waste Program created a legal framework for a social inclusion plan and evolution of the established solid waste collection and disposal system into one that privileges the 'reduce-reuse-recycle' model, conscious consumerism, and social inclusion. The goal for 2016 is to divert at least 20% of solid waste from landfill. The social inclusion of recyclers in particular was designed to address the challenges they were facing, such as a lack of transparent organization and often violent competition between recyclers; a lack of technical training; a lack of information about their basic rights; a significant percentage facing homelessness; and cases of child labour or lack of schooling.

The Zero Waste Program not only contributes to the integration of informal workforce, better waste management and waste reduction (about 1 ton/day of usable materials have been recycled), but also has multiple co-benefits, including a reduction in the cost of waste collection service by 15.23%; better health protection for recyclers through the distribution of about 12,000 protection kits in 2015 by the UAESP (City Public Service Special Administrative Unit responsible for waste management); and power generation at the Doña Juana Landfill biogas plant (39.69 MW monthly average production in 2014), which also leads to CO2 emissions reduction of about 700,000 tons/year. Reasons for success: The project successfully used the existing informal infrastructure to build an integrated waste collection model, while providing livelihoods to local communities. It also recognized the potential and necessity of behaviour change to achieve a mature and cost-effective waste management system. When/why a city might adopt an approach like this: Cities with an existing informal waste collection economy can adopt this approach to integrate existing infrastructure and workers at lower costs than establishing new systems. All cities should include an education and awareness-raising element to motivate behaviour change among urban citizens and help build a sustainable modern waste management/ resource valuation system

7.6 Best Practices from Vilnius City[31]

7.6.1 Vilnius – City Profile

Vilnius, the capital of Lithuania, is situated in south east of the country. It is the 2nd largest city in the Baltic states having an area of 401 km^2. The city has multilingual residents wherein 50% speak two foreign languages, dominant foreign languages being English, Russian, German and Polish. Vilnius is the second youngest capital in North Europe after Copenhagen[32], and Vilnius has the largest population of young people in the Baltic Sea region capitals. The population of Vilnius is 5,80,020 as of January 1, 2020. The city of Vilnius holds shareholding in 25 stock and closed stock companies, 71 public companies and 313 budgetary institutions. The Vilnius municipality is one of the 60 municipalities in the country, has 51 members, provides administrative services, organizes the provision of public services and adopts political decisions. The council committees perform activities related to environment and energy, economy and finance, culture, education and sports, urban planning and development, services and city maintenance, social affairs, health and local government development. Additionally, the municipality has 1.6 administrative employees per 1,000 inhabitants under the municipality. The political structure of Vilnius municipality is illustrated in the figure given below.

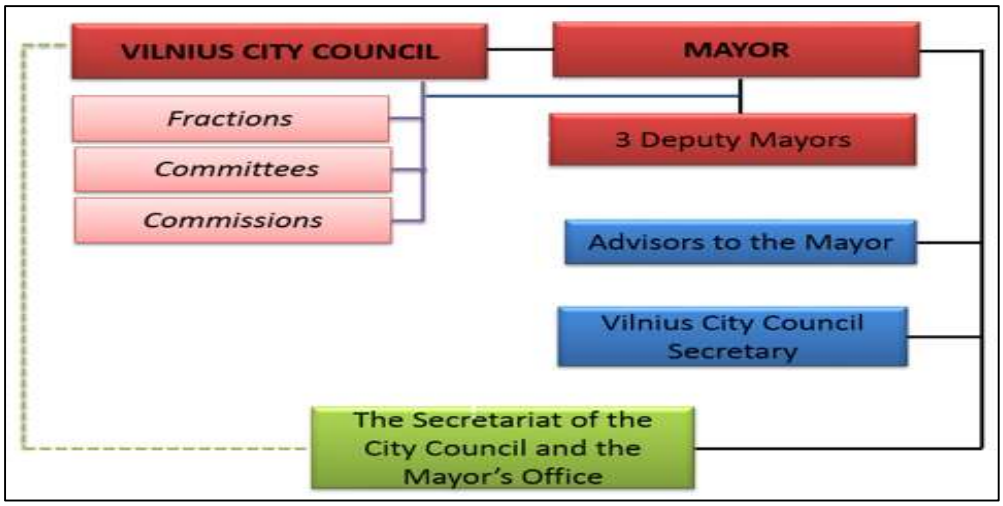


Figure 32: Political Structure of Vilnius Municipality

Source: Presentation on Vilnius city and Vilnius municipality

7.6.2 Solid Waste Collection in Vilnius

The Vilnius municipality is responsible for organizing collection and disposal of waste, and collection of recyclables such as paper, glass, plastic etc. Service providers for collection of waste and recyclables are selected by the municipality through tendering procedure. For private (individual) households, municipality appointed waste collectors, provide door-to-door collection services for the collection of paper, glass, cardboard, mixed cans, plastics etc. Owners of such individual houses have signed contracts for the use of containers for segregated waste collection. An underground waste container system has also been developed in Vilnius, which is described below. Apart from individual houses,

[31] *https://iuc.eu/indiahi/resources/?s_title_o=BASELINE+STUDY+FOR+SOLID+WASTE+MANAGEMENT+IN+KOCHI&s_topic=&s_sdg=&s_type=&s_country=35&s_language=&c=filter*

[32] *Nordea Analysis from EU National Statistics, 2015*

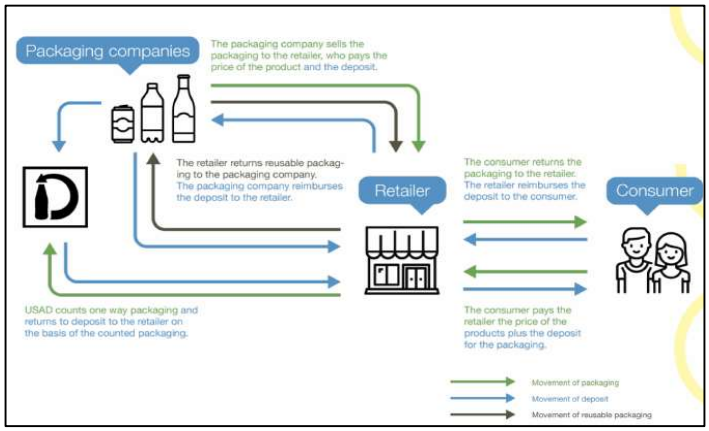
residents of apartments must deliver the recyclable waste to 'collection points' located within a distance of 50-500 meters from homes) and bio-waste to 'Civic Amenity sites' (one civic amenity site per 50,000 inhabitants), operated by municipality appointed contractors. Additionally, a deposit and return system is in place for all kinds of packaging products primarily drink containers. While waste collection, transportation to civic amenity sites and waste disposal are financed through municipal tax levied on homeowners, door-to-door collection of recyclables is financed by manufacturers and importers. The underground waste container system and deposit recycling facility used in solid waste collection are described below.

7.6.3 Underground Waste Container System

An underground waste container system has been developed in Vilnius as per which all the residents in the capital city have installed dozens of underground and semi-underground containers, which will be separate for household wastes, paper, plastics and glass. These containers are economical, reliable, and suited for both urban and rural communities, especially for areas undergoing redevelopment. Areas having large amounts of waste such as shopping centers, residential areas etc., have high utility for such containers. These containers have 75% of their depth underground and hence are aesthetically more pleasing than scattered collection bins.

7.6.4 Deposit Recycling Initiative

Under this initiative, the recyclable and reusable material is returned for recycling, back to shops or to reverse vending machines. While returning the material and packaging (such as PET, metal, glass, plastic, beverage packaging etc.) with printed deposit marks, a small refund (incentive) is provided. To combat litter and increase waste collection and recycling rates, consumers pay a deposit amount, while purchasing say drink containers, and the amount is refunded, when the empty container is returned for recycling. To get the refund, the returned packaging must be empty, with its original shape maintained, its labels undamaged and barcode clearly visible. This is a supplementary waste collection system organized by manufacturers and importers association and financed by manufacturers and importers. Collection points are in comfortable locations. The facility has brought about considerable reduction of packaged waste with 91.9% of all beverage containers being returned for recycling by the end of 2017. The prices of the deposit system are provided in Table 10 below:



Source: USAD presentation 2018 – Lithuania deposit system

Table 10: Prices of the Deposit System

Deposit system	Price (EUR/tonne)
PET	2,000
Aluminium	1,000
Iron	1,500
Glass	83

Source: Vilnius data

7.6.5 Solid Waste Disposal and Treatment in Vilnius

In addition to waste collection and transportation, Vilnius municipality is also responsible for organizing disposal of waste generated in the city. Vilnius County Waste Management Center (VAATC), founded in 2003, by the municipality is responsible for creating a waste management system for Vilnius city and for effectively implementing waste management tasks. It is a large SWM plant with state-of-the art facilities. The plant manages the mechanical biological treatment (MBT) plant, operates the Vilnius county regional landfill, operates 17 bulky waste disposal sites and six green waste composting sites. The waste management center sets an example by paying attention to reducing environmental impact, evaluating practical examples, and applying best available techniques.

7.6.6 Vilnius County Regional Landfill

In 2017, a year after the mechanical biological treatment plant started operations, ~1,75,000 tonnes of waste was disposed at the landfill site, whereas ~2,25,000 tonnes of waste was treated at the MBT plant. The waste is received at the waste reception area of the landfill site, registered, and then disposed of at the landfill site. The landfill gas, wastewater and leachate are collected and treated wherein the landfill gas is collected and treated by a contractor. Continuous monitoring of operations and maintenance and environmental monitoring is conducted at the landfill site.

7.6.7 Mechanical Biological Treatment (MBT), Vilnius

Vilnius city has a mechanical biological treatment plant, which is a type of waste processing facility that uses source separated waste, combines re-sorting of mixed utility waste from the Vilnius region with a form of biological treatment of waste such as anaerobic digestion or composting. Biological

processing produces solid recovered fuel (SRF). The MBT was built on a design, build, operate (20 years) model and started operations in 2016 and was partially financed by EU funds. The MBT is managed by Vilnius County Waste Management Center (VAATC) and is operated by UAB Energesman. The plant serves eight municipalities including Vilnius city and Vilnius district. Some advantages of the MBT plant in Vilnius are: a) Reduces landfilled waste especially biodegradable waste and hence reduces greenhouse gas emissions, b) Sorts secondary material for recycling, c) Prepares RDF for waste to energy plant, d) Prepares high calorific value SRF for cement industry, e) It is cost efficient through economies of scale, f) 11,000 tonnes per year from the Vilnius region treated, and g) Accurately weighs municipal waste and commercial and industrial waste is no more accounted as municipal. The main parameters of the MBT plant are provided in table 11 below:

Source: ***http://www.versina.lt/portfolio/vilnius-mechanical-biological-waste-treatment-plant/***

Table 11: Main Parameters of the MBT Plan

Design capacity	250,000 tonnes/year
Number of workers	120-150
Working days/week	Five
Shifts	Two
Land plot	40,000 m^2
Area of buildings	21,000 m^2

Source: Vilnius data

7.6.8 Vilnius Waste System Administrator – Sivasa (VASA):

Apart from VAATC, as described above, the Vilnius waste system administrator is a company established in 2015 by the Vilnius municipality pursuant to the provisions of the law on waste management of Lithuania. The aim of the company is to carry out efficient administration of waste management, control and supervise the provision of municipal waste management services, and to create a provision to transfer information to municipal waste holders and authorities of the Vilnius municipality. The company is responsible for monitoring the efficacy and efficiency of the waste management system in Vilnius. The company does so by maintaining and constantly updating the database of municipal waste holders, developing and determining the accounting system and quantum of user charge for waste management related activities, undertaking detailed studies regarding the quantum of waste collected, the amount of waste collection containers required and waste transport route monitoring and formulation. The entity is also responsible for waste related information collection, management and dissemination.

7.6.9 Waste to Energy (WtE) Cogeneration Plant:

A WtE cogeneration power plant is being constructed in Vilinius, which will convert waste into useful heat and electricity. It is expected that the plant will treat 1,60,000 tonnes/year of non-recyclable, non-usable waste (after sorting) at the MBT facility, following which the waste will be incinerated for production of electricity and recovery of heat simultaneously, known as cogeneration. The plant funded by the European Union (EU) and led by Vilinius kogeneracinė jėgainė, is expected to have a

capacity of 70 MW, of which electricity would account for 16-20 MW and the rest would be heat (51-55 MW). It is expected that the plant will supply electricity to 90,000 households (~20%) in Vilinius and will result in EUR 10 million savings each year on spends in waste diposal services by Vilinius inhabitants. The project would result in 95% reduction in landfill space and would result in reduction of 10% of greenhouse gas emissions from the waste sector or reduction in ~130,000 tonnes of CO_2 annually. The WtE project, expected to be completed by 2020 is important for Vilinius as it will help to build a sustainable and integrated municipal SWM system.[33]

7.6.10 Other Best Practices Followed by Vilnius:

The city of Vilnius follows some best practices in other areas apart from SWM, such as different companies for handling the city's different functionalities, a separate maintenance company providing all utility services as well as the usage of drones for city surveillance. Such best practices are described below.

Different companies for handling city's functionalities: The Vilnius city municipality has formed companies, each handling a separate functionality for the city. These companies have their own independent CEOs, supported by a team of experts and dedicated individuals focused on the roles assigned to them. For Indian cities this is a new concept and a novel idea.

Utility services in the city*:* Vilnius city municipality has a maintenance company called Grinda UAB which provides all utility services to the city such as repair and maintenance of streets and courtyards, removing graffiti from monuments, bridges and viaducts, organizing work on the beaches of Vilnius, providing special care and quarantine for homeless animals, providing specialized sanitary services, providing internal network emergency services etc. Grinda's formation has revolutionized the utility sector in Vilnius. It has brought many innovative and smart applications for better service delivery such as electronic task management system that helps to manage tasks, Open Vilnius that shows the routes of special vehicles online, WAZE that helps users to register obstacles and potholes on mobile application etc.

Usage of drones: Grinda, the maintenance company uses drones for city surveillance, assessing emergency situations, identifying illegal buildings and/or landfill sites, for maintenance of urban infrastructure networks and supervision for road cleaning.

7.6.11 Conclusion

The city of Vilnius has exhibited a well-rounded approach to SWM across the entire lifecycle from collection to disposal. The city has introduced several novel concepts such as underground waste collection bins, deposit recycling facilities, and setup of cogeneration plants to meet the cities power and heat requirements. Vijayawada could adapt a similar integrated waste management adopting the best practices employed by Vilnius. Vijayawada can also look at setting up of a dedicated company which will be wholly owned by the VMC and shall be responsible for the entire municipal waste management lifecycle. The setup of an independent organization will reduce the burden of waste management from KMC and also enable the organization to employ waste management experts who are well equipped at tackling the specific waste management challenges faced by Vijayawada.

[33] https://ec.europa.eu/regional_policy/en/projects/lithuania/cogeneration-in-vilnius-converting-waste-into-electricity-and-useful-heat

7.7 Stockholm – Case Study[34]

Stockholm is the capital and most populous urban area Sweden. Stockholm had a population of 975,904 as of December, 2019**.** The city is the cultural, political and economic centre of the country, accounting for over one thirds of Sweden's GDP. It has an extensive network of roads, rails and airways connecting the City of Stockholm with the surrounding urban and metropolitan municipalities (together forming the Stockholm County).

7.7.1 Solid Waste Generation in Stockholm

The total waste generated in Stockholm has been decreasing over the recent years. The volume of waste processed in 2018 was 6,14,110 tonnes compared to 6,88,330 tonnes processed in 2017. Household waste accounted for 4,41,530 tonnes (~72%) of the total waste generated in 2018. The recent trend of decreasing waste generation is primarily because of the emphasis of congestion taxes, waste management plans and policies related to waste generation. Further, data suggests that the volume of household waste per resident is projected to decrease to 452 kg in 2020 and 424 kg in 2026 (as compared to 477 kg waste per resident in 2015). [35]

7.7.2 The Swedish Recycling Revolution:

One of the special focus of the country has been to achieve a zero-waste society – transitioning from dumping waste in landfills to recycling and reusing. Sweden has had a can and bottle deposit system for a long time. This system gives people money back on recycling and has been in place since 1984 for aluminum cans, and since 1994 for plastic bottles. Each year Sweden recycle 1.8 billion bottles and cans. In 2017, the government also reformed its tax regime so that people prefer used items/reusing. In 2018 the Swedish government even established a special advisory group to help it make circular economy a key part of its policy, the so-called cradle-to-cradle approach. Due to its position in the Swedish economy and populace, Stockholm has had a lot of influence from these policies. It has been one of the main centres of driving the recycling revolution for the Swedish government. [36]

[34] *https://iuc.eu/indiahi/resources/?s_title_o=BASELINE+STUDY+FOR+SOLID+WASTE+MANAGEMENT+IN+KOCHI&s_topic=&s_sdg=&s_type=&s_country=35&s_language=&c=filter*

[35] *https://www.stockholmvattenochavfall.se/globalassets/pdf1/riktlinjer/avfall/avfallsplan/sva072-avfallsplan_en.pdf*

https://www.avfallsverige.se/fileadmin/user_upload/Publikationer/SAH_2019_EN.pdf

https://www.avfallsverige.se/fileadmin/user_upload/Publikationer/Avfallshantering_2018_EN.pdf

[36] *https://sweden.se/nature/the-swedish-recycling-revolution/*

Source: https://www.nytimes.com/2018/09/21/climate/sweden-garbage-used-for-fuel.html

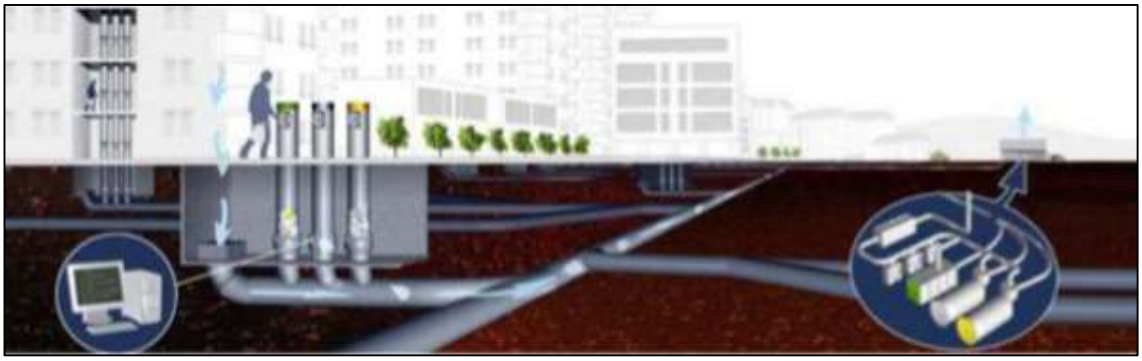
7.7.3 Stockholm Waste Management Plan 2017-2020:

The purpose of the Stockholm waste management plan is to have a strategy to manage, recycle and reuse through planning new areas, reviewing building permits and supervising environmentally hazardous activities, besides specifying how residents, businesses and other organisations manage their waste. The plan has four major objectives: (a) waste from household/businesses to decrease and waste produce to be utilised in resource-efficient manner, (b) harmful waste to be prevented and managed early, (c) waste management to be adapted to people and (d) waste management to be a natural part of cities physical planning.

7.7.4 Benefits of the Stockholm Waste Management Plan:

Due to the waste management plan in effect, the City of Stockholm was able to process 6,14,110 tonnes of waste in 2018, generating an energy of 16,41,360 MW. The plan has helped keep the residual waste generation relatively constant at 2,30,000 tonnes per year despite the population growth. It targets to collect 70% of the available food waste by 2020, corresponding to just over 66,000 tonnes. It has developed 30 different classifications to separate and collect bulky wastes and plans to add 5 more categories of waste fractions by end of 2020. Everyday waste is processed in waste to energy plants to generate energy for home and the city. Stockholm has also launched a biochar pilot plant in 2017 to manufacture biochar through pyrolysis of resident's garden waste. There are also plans to build a new sorting, pre-treatment and anaerobic digestion facility. The city is also creating a network for stationary underground vacuum waste collection system across buildings with three

refuse chutes. At a later stage, this will be incorporated with a built-in recording and weighing system so that waste can be utilised optimally. All this has been possible through the utilization of Green IT – IT infrastructure to support waste management and environment.[37]



Source: http://sajms.com/wp-content/uploads/2015/01/Sustainable-Solid-Waste-Management-Best-Global-Practices1.pdf

7.7.5 Conclusion

Stockholm has an exceptional approach to cover the entire value chain to manage solid and other types of waste. This spans from the point to waste generation to the point of waste use. It has put in place tax regimes and incentive structures to curb waste generation and promote reuse of materials. The city has prepared plans for an underground waste collection and sorting system. The collected waste is then segregated into 30 categories before it is used for energy generation through one of the two means- anaerobic digestion or waste to energy through incineration– to achieve flexibility and resource efficiency. Through an integrated waste management plan the city recycles almost 99% of the household waste generated.

[37] https://www.stockholmvattenochavfall.se/globalassets/pdf1/riktlinjer/avfall/avfallsplan/sva072-avfallsplan_en.pdf

https://www.avfallsverige.se/fileadmin/user_upload/Publikationer/SAH_2019_EN.pdf

https://www.avfallsverige.se/fileadmin/user_upload/Publikationer/Avfallshantering_2018_EN.pdf

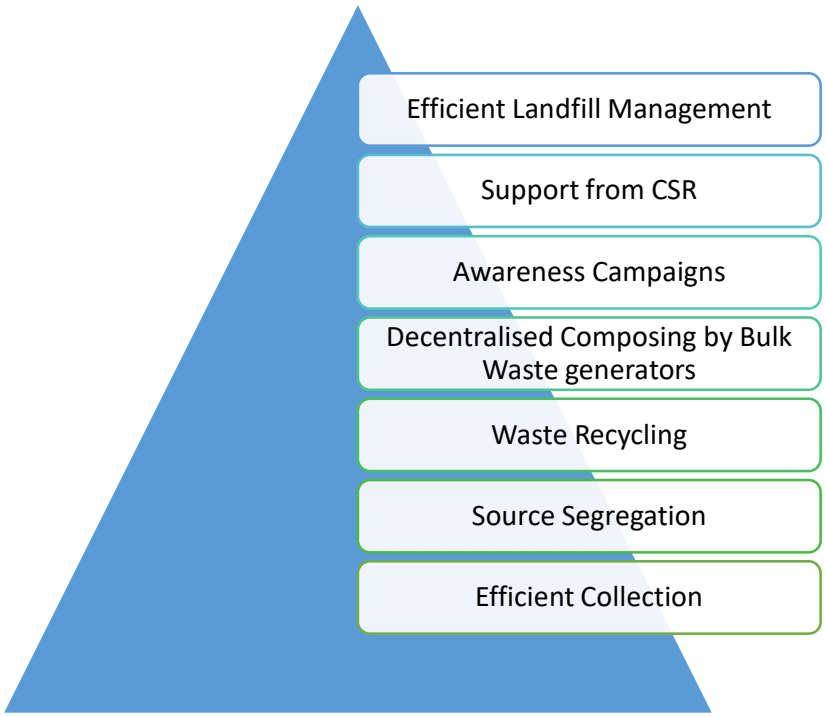
http://sajms.com/wp-content/uploads/2015/01/Sustainable-Solid-Waste-Management-Best-Global-Practices1.pdf

8 KEY LEARNINGS AND WAY FORWARD

This chapters summarizes the need for an efficient SWM in Vijayawada and lists out important points as a way forward for relevant stakeholders

8.1 Key Learnings

Vijayawada needs a holistic and robust SWM system in the city. Lack of source segregation is the basic issue which leads to various major problems like inefficient transportation, difficulty in various processes like composting, bio methanation, material recovery, recycling, reuse etc. The next big issue is coverage with respect to collection of waste from various parts in the city. As per different information received from various relevant stakeholders, secondary research and analysis, it is learnt that the city is not collecting waste from all the parts of the city which result in dumping of waste an unauthorized place which then leads to other problems like sewer blocks, public inconvenience etc. The third major issue is insufficient waste disposal site. Initially, the waste was dumped at two dumping stations – (a) Auto Nagar and (b) Ajith Singh Nagar. Over a period of time, these areas have evolved as major residential colonies and commercial areas where significant number of households are residing and commercial establishments have been set up. VMC has then identified a new place in rural Vijayawada which is called Pathapadu for the disposal of waste generating in the city. It is observed that the villagers near this area are also very agitated due to the unscientific dumping of waste at this site. They have complaint of foul smell, mosquitoes and other diseases that the villagers are facing due this disposal site. Therefore, there is an immediate need for VMC to address these issues on a priority basis so that city dwellers can lead a good life. Following are the key learnings from the Vijayawada SWM plan:



8.1.1 Waste Collection Efficiency

The municipal corporation needs to increase the collection efficiency so that all the areas of Vijayawada city could be covered. This will also help in reducing the instances of dumping of waste at unauthorized places and drains. The municipal corporation can do so by increasing the sanitary staff to all parts of the city.

8.1.2 Source Segregation:

The municipal corporation should conduct awareness programs for general public for encouraging waste segregation at source. This single initiative can prove to be very beneficial for the city. This will not only result in solid waste efficiency but also help in efficient processing of waste for composting, bio methanation, waste to energy etc. projects. The municipal corporation could do so by conceptualizing and implementing city wide awareness programs, public rallies and other medium of communication like newspaper, television, radio etc.

8.1.3 Increase the Number of Waste Recycling Units

Vijayawada city has already been doing waste recycling through support from various recycling units. Plastic waste, iron waste, paper waste and other similar type of waste are potentially recyclable. VMC should increase the number of these waste recycling units to ensure their availability in all parts of the city so that recyclable waste do not get dumped with regular waste. This will curtail the burden of waste collection and handling and also improve the overall waste management practices in the city.

8.1.4 Decentralized Composting by Bulk Waste generators

Big housing societies, commercial complexes and industrial areas are the entities that generate waste in bulk quantities. As per the SWM Rule 2016, these bulk waste generators should explore and adapt potential solutions to treat their waste at the source of generation. Amongst various potential solutions, composting is found to be the easiest to implement solution. Therefore, all the bulk waste generators in Vijayawada should necessarily practice composting at source. This will further reduce the burden on waste collection and increase VMC's waste handling efficiency.

8.1.5 Regular Awareness Campaigns by VMC

VMC should conceptualize and implement regular public awareness campaigns targeted towards educating general public about the efficient disposal of waste in the city. These should specifically address the issues of littering, source segregation, reduce, reuse and recycling principles of waste management. VMC can use various modes of awareness like public rallies, newspaper, radio, television etc.

8.1.6 Support from Corporates to Handle the Plastic and C& D Waste

There is a huge potential to tap funds under corporate social responsibility. Vijayawada is home to many industrial units. These industries should be contacted and convinced for their contribution towards the social responsibilities. VMC already has good experience of engaging potential corporates in efficient waste handling services. This should be widely explored and practiced.

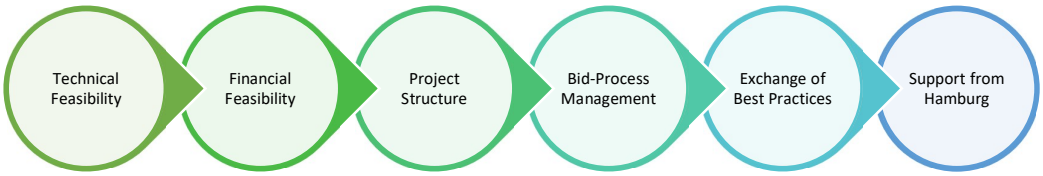
8.1.7 Identification of a Scientific Landfill Site:

At present the landfill as well as the dump site of Vijayawada city is scattered amongst various locations – (a) Auto Nagar, (b) Ajith Singh Nagar and (c) Pathapadu. It is observed that (a) these

disposal sites are not sufficient for accommodating the waste generated in the city and (b) the public in general are not satisfied of these dump sites because these are not operating in a scientific manner.

8.2 Way Forward

It is largely understood that Vijayawada needs to evaluate its SWM practices in a comprehensive manner and need to act upon the gaps as per the requirements. It is understood that the city needs to heavily work on awareness raising, collection efficiency and establishment of a scientific landfill site. The city can take part in various national and international programs to address these issues. There is also a need to prepare a detailed feasibility report where the technical recommendations after evaluating various available technologies could be provided to the city government. Based on the recommendations of the feasibility report, the city can form alliances, chose technical partner, explore various funding options and implement the recommendations in a phased wise manner:



8.2.1 Technical Feasibility:

This part of the feasibility report should cover all the technical aspects, including upgrading and streamlining the SWM value chain in Vijayawada. Additionally, the technical feasibility should comprise of identification and assessment of best practices and processes used for solid waste collection (for example, deposit recycling facility), transportation, disposal, and processing/treatment, along with an estimation of feasibility and costs related with each new process or best practice thus added to the value chain. For the SWM value chain, the input and output specifications, performance standards, social and environmental assessment, and risk assessment would also need to be conducted.

8.2.2 Financial Feasibility

The feasibility study should cover in detail the user charges that could be formalized and levied on different waste generators such as households, institutions, industries, commercial units and hospitals, thus earning revenue for VMC. It should also undertake a detailed financial assessment of streamlining the SWM value chain, covering a detailed estimation of capital expenditure, operational expenditure and revenue, sensitivity analysis, and value for money analysis.

8.2.3 Project Structure:

The study should cover the feasibility of appointing a private player for integrated waste management, for upgrading and streamlining the entire SWM value chain in Vijayawada. This would include roles and responsibilities of various stakeholders, particularly that of the private developer and the implementing agencies, mode of contracting such as PPP or EPC, mode of payment, and contract duration.

8.2.4 Bid-Process Management

The feasibility study should also provide details regarding the next steps in project preparation and execution, i.e., bid process management. This part should explain in detail the number of stages that will be employed for the procurement process, bidding parameters including technical and financial parameters, appointment of transaction advisors, formation of data rooms, and customization of bidding documents.

8.2.5 Exchange of Technology

The detailed feasibility report should also include information on suitable technologies that may be required for better processing of waste at various transfer stations as well as the landfill site. Vijayawada city could also explore the opportunity to exchange certain best practices from the paired city Hamburg which has an advanced SWM system in place.

8.2.6 Support from Hamburg

Vijayawada city is paired with Hamburg in Germany for the purpose of exchange of best practices in the areas of sustainable urban development. Both the cities have mutually agreed to work on the topic of SWM where the certain best practices from Hamburg could be transferred to Vijayawada in terms of exchange of technology, providing expertise and policy level recommendations.

9 REFERENCES AND BIBLIOGRAPHY

The chapter lists the documents and links to various news articles, publications, policy documents, research papers, company reports, and case studies that were referred to during the preparation of this study.

- Model Framework for Segregation published by Centre for Science and Environment
- Solid Waste Collection and Segregation: A Case Study of MNIT Campus, Jaipur
- Best Environmental Management Practice for the Waste Management Sector by JRC Science Hub
- The challenge of future landfill: A case study of Malaysia
- The efficient functioning of waste markets in the European Union - legislative and policy options
- International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-6C2, April 2019
- Socio-Economic Survey of Andhra Pradesh (2018-19)
- Public Health and Sanitation Profile of Vijayawada city
- Vijayawada City Sanitation Plan
- Urban Infrastructure - Analysis of Urban Infrastructure Interventions, Vijayawada City, Andhra AUTHORS: Parijat Dey Senior Manager IL&FS
- Good Practice Guide - Sustainable Solid Waste Systems- C40
- http://www.vmcdm.org/city_profile.html
- https://www.macrotrends.net/cities/21435/vijayawada/population
- https://www.financialexpress.com/economy/worlds-top-10-fastest-growing-cities-are-all-from-india-check-which-cities-made-it-to-oxford-list/1585498/
- https://timesofindia.indiatimes.com/travel/destinations/andhra-pradesh-adventure-tourism-records-massive-growth/as68081336.cms
- http://www.ourvmc.org/#/aboutvmc
- http://www.ourvmc.org/#/adminactivities
- https://www.newindianexpress.com/cities/vijayawada/2019/dec/11/experts-review-vijayawada-municipal-corporations-waste-management-2074412.html
- https://timesofindia.indiatimes.com/city/vijayawada/vmc-spends-year-harnessing-tech-for-effective-solid-waste-management-eliminating-plastic/articleshow/73051399.cms
- https://www.newindianexpress.com/cities/vijayawada/2020/feb/14/vijayawada-municipal-corporation-steps-up-efforts-for-participation-in-ease-of-living-survey-2103264.html
- https://timesofindia.indiatimes.com/city/vijayawada/vmc-spends-year-harnessing-tech-for-effective-solid-waste-management-eliminating-plastic/articleshow/73051399.cms
- https://www.newindianexpress.com/cities/vijayawada/2020/feb/14/vijayawada-municipal-corporation-steps-up-efforts-for-participation-in-ease-of-living-survey-2103264.html
- http://www.ourvmc.org/general/struct1.pdf
- https://www.newindianexpress.com/cities/vijayawada/2019/nov/17/vijayawada-civic-body-preparing-plans-for-power-generation-from-waste-material-2062885.html

- https://www.newindianexpress.com/cities/vijayawada/2020/feb/17/agency-to-segregate-garbage-from-vijayawada-bwgs-2104524.html
- http://shodhganga.inflibnet.ac.in/jspui/bitstream/10603/188151/9/09_chapter%202.pdf
- https://www.newindianexpress.com/cities/vijayawada/2019/nov/17/vijayawada-civic-body-preparing-plans-for-power-generation-from-waste-material-2062885.html
- https://www.newindianexpress.com/cities/vijayawada/2019/dec/03/vijayawadas-automobile-hub-autonagar-turning-into-solid-waste-dumping-yard-2070536.html
- https://www.ohiovalleywaste.com/ohio-valley-waste-news/reduce-reuse-recycle-what-does-it-mean-3049
- http://www.gcpcenvis.nic.in/PDF/Waste%20to%20Energy.pdf
- https://link.springer.com/referenceworkentry/10.1007%2F978-3-319-58538-3_167-1