

Various Strategies for cities to help manage Solid Waste and achieve Zero Garbage.

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ABSTRACT

Waste is generated by human activities, and natural result of various process on earth which can be never avoided. As man's activity has disturbed the eco balance which is creating problem to earth in recycling the waste generated on it. The waste generated on earth is way faster than the rate it can be recycled on its own. Urban and rural areas have different type of waste generated, depending on the occupancy of the major population. If the population is majorly dependent on farming then the major percentage of waste generated will be organic and biodegradable waste where as in cities plastic usage and processed packaging waste develops which comes under different criteria. For such different waste generation are the action plans and governance activities should vary. Active functioning management system is one of the success factor for creating sustainable and clean cities and villages. Various strategies has been implemented by various cities in India to achieve desired results in management but some sustained and some got faded out through time .

Keywords: Solid Waste Management, Recycle, Governance, Action Plan, Sustainability, Strategies, Achievements.

I. INTRODUCTION

Solid Waste Management (SWM) is process of storage, collection, transportation, processing and disposal in a safest way. It is an integrated process containing various collection methods, storage process and recycling methods. Solid waste which is refused can be biodegradable, non-degradable, recyclable and non-recyclable. Many experiments have been done on many places by government but many of them failed as they were not designed in simplified and sustainable manner. Any process should be financially feasible and should generate money for the government to operate it, moreover we can call it as cyclic process where all the process falls into a loop if once it gets revenue. Let us observe some case studies of different cities in India which adopted some governance policies to manage the waste generated in their cities.

GOVERNANCE ASPECTS IN SOLID WASTE MANAGEMENT SERVICES.

As public health is more dependent on solid waste collection and sanitation services, Government puts this in first place to deal with in a best way it could. Many old cities in developing countries are struggling with the same. (Rodić, Resolving Governance Issues to Achieve Priority, 2017) When pandemic conditions like covid-19 strikes up on the society we can more rely on sanitation and waste management to control the outbreak of the deadly virus. Piles of uncollected waste attracts more germs and the spread of the virus increases by attacking the human immune system. (<https://www.downtoearth.org.in/news/waste/rubbish-for-remain-or-bins-for-brexite-how-the-eu-affects-your-garbage-54362>, 2020) As the growth of the city increases the space value increases and land occupancy for living increases and the landfills are converted into construction lands which is very dangerous. (Sandhu, 2014)

The role of governance on Solid waste management is a multifaceted task which handles stakeholders and operations to achieve sustainable approach towards the action plan. Several nations have adopted decentralized

system form centralized to decrease the burden on the government to deal with it.(Massoud, Towards improved governance for, 2019).

HIGHLITES OF SWM RULES2000

- This rule was declared on 25th sept 2000 by government of India with ministry of environment and Forest.
- To indicate waste processing options including; standards for composting, treated leachates and incinerations.
- Specifications for landfilling indicating; site selection, facilities at the site, specifications for landfilling, Pollution prevention, water quality monitoring, ambient air quality monitoring, Plantation at landfill site, closure of landfill site and post care.

HIGHLITES OF SWM RULES 2016

- Municipal bodies who are accountable for allotting land use must consult with state board committee for the permission of any dumping activity on the territory.

Segregation of waste at source

The waste which is generated at home is divided into 3 categories for easy segregation process one is biodegradable waste which is also called wet waste ,dry waste and third one is hazardous household waste which consists of sanitary napkins,diapers,mosquitorepellents,etc.,.

Collect back scheme

The packaging material whichever the product havesale should collect it back and recycle to reduce the packing waste.

User fee for waste collection

For processing door to door collection of waste minimal amount should be collected from the user to encourage collectors and the scheme to sustain.in this rule fine for littering and non-segregation is also included to keep the sanitation under a channel. (Earth, 2017)

There is a need to evaluate past policies and experiments on the cities and villages in approach to the waste management to design a new one which could make the policy more efficient and productive.

Action plans as per the waste generation

Depending on the amount of waste generated the treatment methods changes and such the action plan differs here is some attached data as per govtnoms.

To calculate the waste generated on an average as per govt standards

Garbage Generated From	Average Waste
Population Range up to 1 lakh	0.27 kg per person per day
Population Range 1 to 5 lakh	o.31kg per person per day
Population Range 5 to 10 lakh	0.45kg per person per day
Population Range 10 to 20 lakh	0.67 kg per person per day

(development, 2006)

Table 2 Plan selection on basis of amount of waste generation

Range	Plan
>500TPD	Modernization/mechanization of waste storage and transportation facilities Privatization/contract with 'operators' for collection of waste from various sources and its transportation. Seeking support of private entrepreneurship in setting up of waste processing and disposal facility.
Between 100-500 TPD	Modernization/mechanization of waste storage and transportation facilities Privatization/contract with operators for collection of waste from various sources and its transportation Seeking support of private entrepreneurship in setting up of waste processing and disposal facility.
Less than 100 TPD	Proper system for waste collection ,storage and transportation considering the local situation. Aerobic composting Such towns can be the member of cluster/regional facility
Less than 50 TPD	Technological solution which could be managed without high skill operations Proper collection of waste and motivating citizen for segregation of waste Composting Such town located near the Regional facility,should be the part of it.

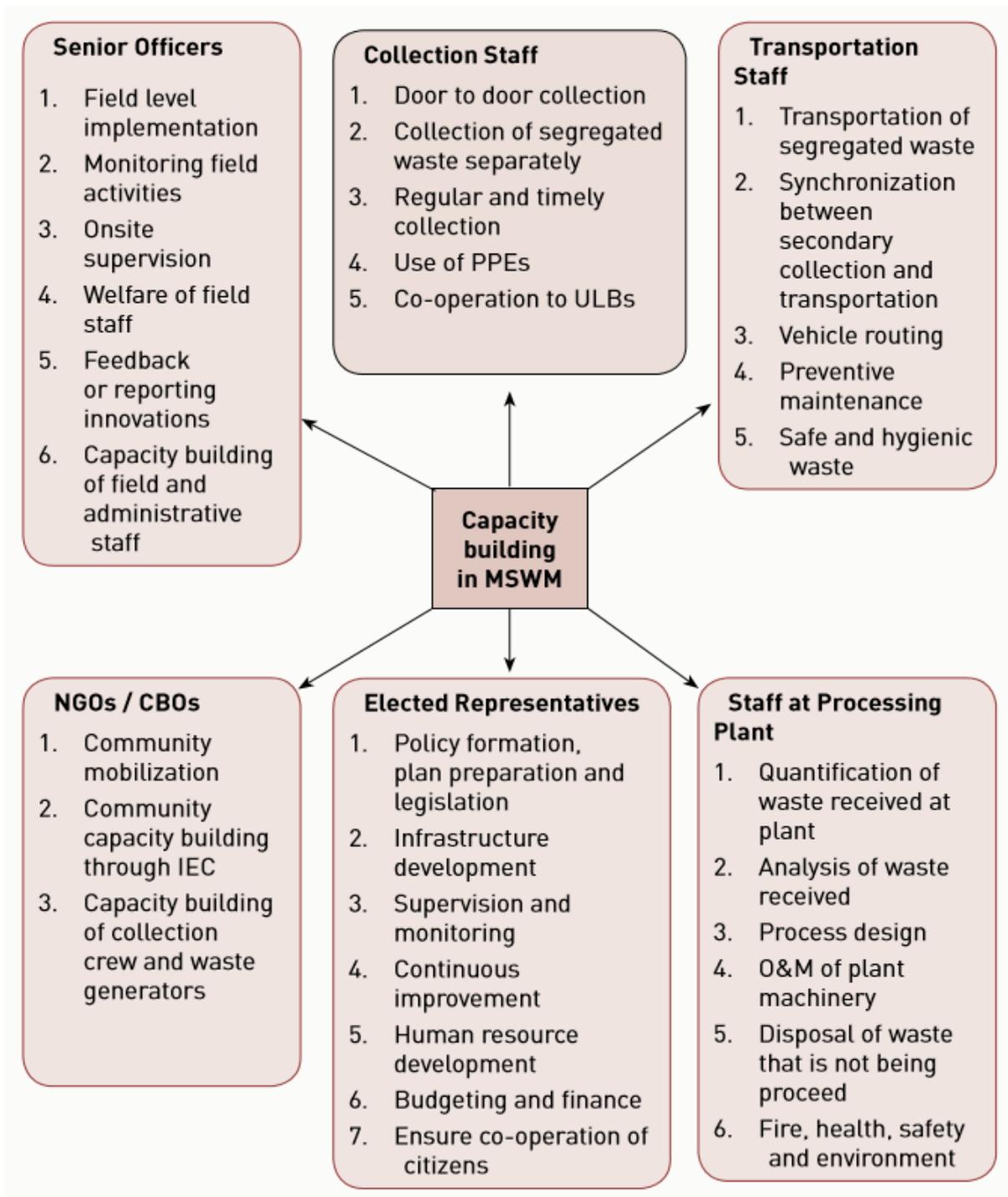
Frequency of Sweeping as per character of street.

(2017, 2017)

Table 3 Frequency of sweeping as per character of street

Class	Character of Street	Frequency of Sweeping
A	City Centre-Shopping areas	Daily/ Twice, Depending on need
B	Market areas	Daily
C	Minor Streets	Daily
D	Sub-Urban Shopping streets	Daily
E	Residential Streets	Daily
F	Roads and Streets having no households/establishments on either sides	Once a Week
G	Highways	Rarely necessary to sweep highways due to turbulence through motor traffic
H	Sub-urban Shopping Streets	Twice a Week
I	Open Spaces	Occasionally when required.(minimum once in a fort night)

(2017, 2017)



flow chart 1Capacity Building in M.S.W.M (2017, 2017)

PREPARATION OF A MUNICIPAL SOLID WASTE MANAGEMENT PLAN - A SEVEN STEP APPROACH

STEP 1: policies, programs & legal framework

STEP 2: ASSESSMENT OF CURRENT SITUATION AND GAP ANALYSIS

STEP 3: STAKEHOLDER CONSULTATION FOR MSWM PLANNING

STEP 4: PREPARATION OF DRAFT MSWM PLAN

- Future projection
- Rules, regulations and municipal byelaws

- Community participation
- Storage ,collection and transportation
- Identification of land & inclusion in city master plan/city development plan
- Selection of process & best available technology for processing and disposal.

STEP 5: Schedule for implementation

- Timeline
- manpower requirement
- Financial viability

STEP 6: Stakeholder consultation for MSWM plan validation

STEP 7: City council Approval for MSWM plan. (valaven, 2016)



Figure 1 Kerala Location Plan

Case studies:

ALAPPUZHA

PROBLEM:

The city's main dump yard was closed due to protests by people living in surrounding areas.

ACHIEVEMENT:

Decentralized waste management. 100 per cent segregation in 12 of the city's 23 wards. 80 per cent households now have biogas plants and pipe composting system.

- Population - 0.174 million , households – 40,000 ,wards-52
- Solid waste production per day- 58 tons,
- Project -Nirmala Bhavanam Nirmala Nagaram (Clean Homes Clean City) since November 2012.
- Focus of the initiative i-segregation and treatment of wet waste at the source.
- “About 75 %of the waste is biodegradable, and 1/3rd of this comes from households,”
- The Clean Home Clean City program was started in 12 of the most urbanized wards, covering 12,000 households, as a pilot project.
- The fixed biogas plant costs INR 17,500 and can treat 8-10 kg of waste per day and provides biogas for two–three hours daily.
- The portable biogas plant has a capacity of 1,000 liters and costs INR 13,500.
- In this plant, 5–7.5 kg waste can be converted into compost and the biogas is available for 80-90 minutes.

Suchitwa Mission, the state's nodal agency in-charge of the total sanitation program, gives 75 per cent subsidy to biogas plants and the cost to the user is around INR 5,000.



Figure 2Goa Location Plan

PANAJI

There are 115 residents in Panaji which are divided into 12 waste management zones which are under supervision of collection and transportation of waste. They make a track record of each day collection and disposal of waste.

They charge rupees 365 per year as their sanitation fee which is further linked to house tax.

Depending on the waste generated commercial spaces such as hotels and function halls are been charged from 300-10,000.



Figure 3Karnataka Location Plan

MYSURU

PROBLEM:New segregation system has been adopted by the city.Floating population of 0.2 million a day is adding the worse to the problem.

ACHIEVEMENT:

- 95% door-to-door waste collection
- 30% segregation at source
- The 65 wards are divided into nine zero-waste management units in which eight are functional and 1 is to be started.
- There are targets allotted to each zwm to achieve for which environmental engineer is appointed whose target is to achieve the maximum result at the zwm.



Figure 4 Andhara Pradesh Location Plan

BOBBILI

PROBLEM: Inefficient waste management system.

ACHIEVEMENT: 100 per cent door-to-door collection of waste.

- The 3.4 ha park.
- 14 MT of waste generated and collected in the town per day.
- 3.6 MT is processed.
- The park rears a few pigs which are fed the food-waste received from hotels. Similarly, chickens take care of little insects in the waste heaps and ducks eat the fish-food waste.
- The rest is dumped without any processing.



Figure 5 Mizoram Location Plan

AIZAWL

PROBLEM: There was no concrete plan for solid waste management till 2010

ACHIEVEMENT: Efficient garbage collection system. Municipal councilors prepare the waste management plan and decide the number of trucks needed for collection

- Solid waste generated-165 MT
- Biodegradable waste-62.7MT
- Recyclable waste-64.35 MT
- Non-biodegradable waste.-37.95
- Around 15 medium-capacity trucks -15
- 4 low-capacity vehicles.-4
- Trips made per month for waste collection from households-2,200
- They collect the waste and dump it at trivial, a dumping site 18 km from the city, where rag pickers segregate the waste and sell it.
- But clearly this is not a long-term solution.



PUNE

Figure 6Maharastra Location Plan

PROBLEM: Rapidly filling up landfill of the city. A growing city with increasing problem of garbage management

ACHIEVEMENT: Use of innovative garbage treatment technologies such as biogas, composting and refuse-derived fuel

- Generated waste- 1,400 to 1,600 tons of municipal solid waste (MSW)
- Wet waste-70%.
- The city's current capacity to process waste - 2,100 tons per day.
- Tackling wet waste
- Municipal biogas plant -4,000-odd residences.
- Residue PMC's gardens.
- 12 % of the 80,000-odd commercial and residential buildings have started composting their wet waste because PMC provides property tax rebates to such buildings under its Eco-Housing Scheme.



Figure 7Gujarat Location Plan

SURAT

PROBLEM: The city's garbage disposal system was so poor that there was a plague outbreak in 1994 .

ACHIEVEMENT: Ninety-seven per cent collection efficiency. 92 per cent door-to-door collection

1. of waste generated - 1,570 metric tons (MT)
2. Scheme - Anudan Scheme.
3. Amount paid to each society under this scheme-15,00.
4. Surat also collects fines of up to Rs 1 crore every year from citizens,
5. Shop keepers and residential localities for violations such as littering and not keeping their premises clean.



Figure 8Telangana Location Plan

SURYAPET

PROBLEM: No segregation, treatment and processing system for waste

ACHIEVEMENT: 100 % door-to-door waste collection

1. Population - 0.1 million
2. Area - 24 sq. km
3. The slums that house 62 per cent of Suryapet's population are cleaner than many posh areas of Delhi.

Strategies implemented by various places

Table 4 strategies implemented by various places.

s.no	place	Strategy Implemented
1	Allapuzha	75 per cent subsidy to biogas plants
2	Panaji	Collecting sanitary fee from waste generators
3	Mysuru	Allotting each unit area with environmental engineer with weekly targets
4	Bobili	Allowing pigs,cattle,ducks to eat all the food waste to reduce waste
5	Aizawl	Taking help of rag pickers to segregate waste collected in dumpyard
6	Pune	Provides property tax rebates to such buildings under its eco-housing scheme.
7	Surat	Fine system for littering and for not keeping premises clean
8	Suryapet	100% door to door collection

(2017, 2017)

Strategies implemented depending on the status of area, severity of problem and people behavior to the problem.

INTERNATIONAL DEALING OF WASTE WITH INNOVATIVE IDEAS

1. INDONESIA-Trade trash with Health care

Almost 55,000 tons of garbage is generated in Malang City, Indonesia. People started to use trash as currency and created garbage clinical insurance which is trading trash with the insurance policy which covers medical services like checkups and medicines.Trash collected here is converted into health.

2. SWEDEN- GARABAGE INTO ENERGY

Sweden garbage generated energy provides heating to 950,000 swedish households and electricity to 260,000 homes.sweden recycles and sorts the trash from other European countries to fuel its power needs .Seeing garbage as a commodity, Sweden imports trash from other European countries to fuel its power needs, with 700 kg (1543 lbs.) of rubbish translating into up to 250 kg (551 lbs.) of energy and fuel.

3. UGANDA – WASTE AMUSEMENT PARK

Artist and environmentalist Ruganzu Bruno is bringing ecological art to the slums of Kampala. Eco Art Uganda is a collective of artists dedicated to promoting environmental awareness, and the group created an amusement park for children from discarded materials. Recycled swings and life-size board games made from plastic bottles are just some of the attractions at the Eco Art amusement park. The creative initiative works on many levels - beautifying the community, empowering and educating kids and effectively recycling trash and managing waste.

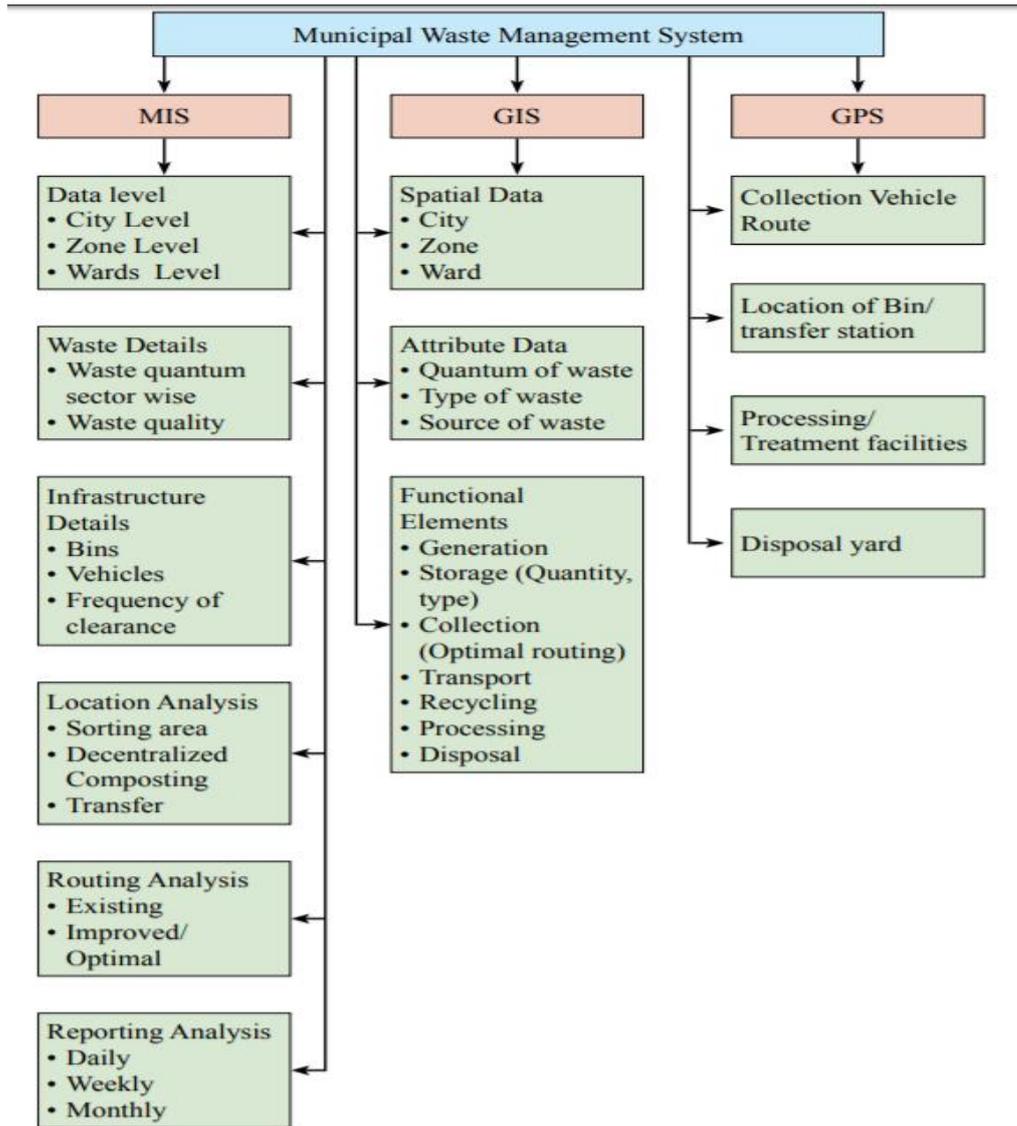
4. HONG KONG –LANDFILL TO ECO-PARK IN

The Sai Tso Wan landfill used to hold up to 1.6 million tons of waste, stacking up to be 65 meters or 213 feet high! After being closed and sealed off with soil in 1981, a multi-purpose playground was created in 2004 powered by wind turbines, solar cells and energy derived from methane generated from the decomposed trash.

TECHNOLOGY FOR WASTE MANAGEMENT SYSTEM

Real time monitoring of status of bin clearance, estimation of amount of waste in and around bins, surveillance of movement of vehicles, optimization of routes and reallocation of bins according to the estimated waste, are possible through integration of several technologies, hence providing transparency in civic administration.

As GIS can model the world landmarks and streets, it can play an important role in waste collection sector. GIS in combination of other software can give information regarding the most reliable routs, number of residents, number of contracts, their validation, and potential frauds.



WASTE BIN MONITORING TECHNOLOGY

1. Waste bin monitoring technology using Global System of Mobile (GSM), it is a latest trend in the field of waste collection.
2. In this technology sensors are placed in public garbage bins to detect a certain optimum level of waste.
3. As the garbage reaches the threshold level, indication will be transferred to the controller which will further give indication to driver of collection truck for emptying the bin urgently.
4. The indication will be send to the driver through SMS using GSM .

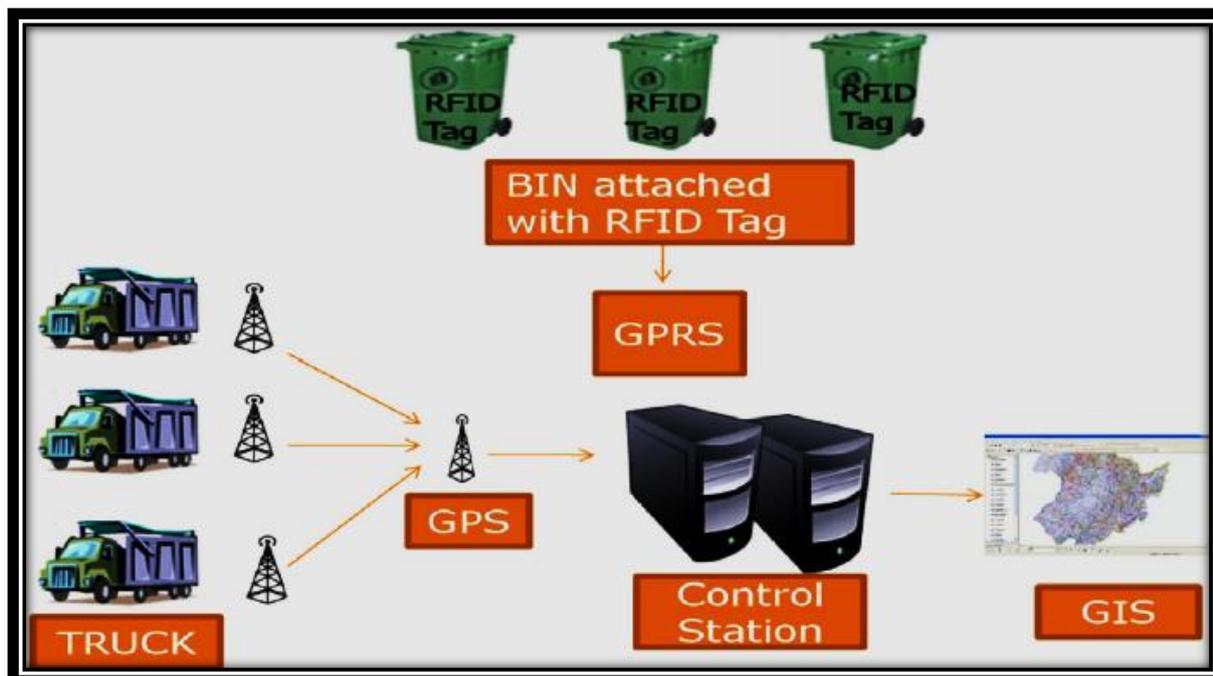


Figure 9 Bin Attached to GIS Technologies(2017, 2017)

BIOREACTOR TECHNOLOGY

- The latest technology to process disposed of waste rapidly is bioreactor technology.
- The basic aims of this technology are to enhance the rate of decomposition, circulation of leachate and increase in the growth of microbes, which decompose municipal waste.
- The waste is then dried by Conventional landfill technology.

FLUFFING

- Recently a processing method has been evolved in which the solid waste is separated, sterilize and the organic portion is processed to form pulp like material known as fluff.
- Many processing facilities have shredders which reduce the size of paper, metal, glass, and organic waste up to 2-5cm. Batteries, carpet and other type waste is separated manually.
- The reduced size product is then transferred to conveyer stream where metallic portion separates out.
- High temperature steam is then introduce for further breaking of molecular bonds which destroys pathogens.
- The product is further grind, dewatered, and separated from other types of waste.
- The remaining is fine cellulosic material emerges as sanitized, sand like, granular fluff [30]
- The fluff by product can be used as soil amendment because of its organic base and high nitrogen content. If not utilized so, the fluff can enter the landfill with 30-75% reduced volume as compare to original content.
- This technology is currently adopted by western countries where 95% recycling rate has been achieved

AUTOMATED SORTING MODERN SORTING

- Plants are converting to sensor based sorting systems to improve sorting efficiency.
- This technology had exempted the low technology or manual sorting options.

- This technology is beneficial because it has high recovery rate, low operation cost and high reorganization capability.
- This process can convert useless garbage to highly useful product output, which can reduce carbon footprint and emission.

Gap analysis

Gap analysis has to be done for the selected area to get a clear point on the gap formed from governance policies and action plans such that the gap can be filled with new policy and better sustainable results can be achieved. (2017, 2017)

Some strategies to attain sustainable zero waste city.

HOME COMPOSTING :-

- As the waste generated in kitchen waste goes in home composting.
- It reduces waste collection to 60 percent.
- Compost is made to preserve earth quality and capacity gardening which is environmentally friendly
- Reduces load on municipalities to process the waste. (Dr, 2014)

COMMUNITY SERVICE:-

If a person is unable to pay the fine, he/she will have to do community service like sweeping or clean the spoiled wall or area on their own.

FELICITATION:-

The continuous segregation of waste in their home and keeping clean of the premises has to be appreciated with award and felicitation by giving subsidy in tax payment, and free medication camp for social workers.

ADARSH WARD:-

Increasing competition for Adarsh Ward Award among the wards to keep their ward litter free and clean premises. (EPTRI, 2017)

SKILL DEVELOPMENT PROGRAMME:-

To increase skills in waste management, and easy tips to deal with it has to be a information sharing session to educate workers.

BIN MONITORING SYSTEM

- All the secondary collection points are marked and monitored for daily lifting of garbage through a well-established network of sanitary inspectors and supervisors.
- The bins are reported cleared, not-cleared or not reported daily by the designated sanitary inspector. The application is monitored by the municipal minister directly.

E-GOVERNANCE

- Solid waste management is a part of the same e-governance platform to be implemented by all ULBs.
- The tracking of dumping sites and digitizing route plans of municipal vehicles is envisaged to be instigated under the same plan.- (joseph, 2014).

BIN FREE CITY

- The concept of “Bin free city” comes from having 100% door to door collection of waste with reduced or no need of secondary collection points/dustbins.

- Many towns in Andhra Pradesh are looking forward to this concept and implementing ways to strengthen their door to door collection system. (Walther, 2011)

ADARSH WARDS

- Adarsh wards are the wards selected on pilot basis for the implementation of door to door collection and segregation of waste.
- Municipalities have developed phase wise plan to scale the coverage of services from pilot stage to city level.
- “Hundred days Sanitation Program” is a kind of Sanitation drive done to promote cleanliness and increase awareness about handling solid waste amongst the local people and sanitation department.
- The drive took place in the municipalities and people were provided knowledge about segregation of waste and its significance for processing and generating value out of the waste. (Agarwal, 2005)

II. Conclusion

Any action plan or public related management plans has to be done with people support for plan Agenda, to make the action plan more sustainable and successful the plan should also be included with people behavioral change ideas. Waste is not a problem unless it is reduced, segregated and treated well, on earth production and composting of waste is a natural process, but due to our added material and dumping a lot amount of waste in one small area which is the main reason for all these waste problems, composting waste into earth regenerates its energy and is good for crops, but in the waste composition plastic is included which cannot be decomposed soon and pollutes land and environment.

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