Solid Waste Management: A Case Study of Ahmedabad

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Abstract— Due to population upsurge and urbanization, solid waste management is now one of the chief issues to deal with as it affects quality of life. Ahmedabad is the 7th largest city of India and generates about 4000 Metric tons of waste daily. The foremost segments responsible for the emission of GHGs are energy supply with 26% followed by industrial activities with 19%, while the commercial areas including buildings and residential with 8% and waste sector with 3%. Out of the total emissions from waste sector, the solid waste contributes nearly 22 % of total greenhouse gas emission in Indian context which in turn is the 3% of the total sectorial emissions. The studies reveal that this MSW comprises of more than 50% of organic waste in Indian context as it contains vegetable, food waste, animal dung, paper, cloth and other biodegradable components as well.[1] This study aims at providing an overview of the stages of waste management i.e. Prevention, Minimization, Reuse, Recycle, Energy recovery, Disposal and its composition at the Ahmedabad city level. It also provides a further insight of feasibility and aids of adopting segregation at source and decentralisation of swm in order to provide better future. A sample survey of Ghatlodiya that was carried out by JTC Agency which revealed that vast majority of people are willing to segregate as per law (87%+). [2] Decentralization and segregation at source can be beneficial as compared to current cost of INR 1000 per ton for solid waste management, cost can reduce to 418 per ton and also can lead to better standard of living of society. Out of 4000 MT generated daily only 800 MT would be needed to dispose daily which would lead to 80% volume reduction then current scenario. As only 800MT tones would be disposed, it would further lead to reduction in GHGs emission and thus would help lower carbon footprint.

Key words: Solid Waste Management, AMC, Composition, Green House

I. INTRODUCTION

The waste management hierarchy consists of six stages i.e. Prevention, Minimization, Reuse, Recycle, Energy recovery, Disposal. Economic development, urbanization and civilizing living standards in cities, have headed to an increase in the quantity and difficulty of generated waste. Prompt growth of inhabitants and industrial development degrades the urban environment and places severe strain on natural resources, which destabilizes reasonable and justifiable development. Unsystematic management and dumping of solid waste which is an obvious cause of degradation of the environment in most of the cities of the developing countries. Municipal corporations of the developing countries are not able to handle increasing quantity of solid waste, which results in higher volume of landfill heaps.

Per capita waste generation increasing by 1.3% per annum. With urban population increasing between 3-3.5% per annum. Yearly increase in waste generation is around 5% annually. India produces more than 55 million tons of municipal solid waste annually. Urban local bodies (ULBs) spend between Rs500/- to Rs1500/- per ton on solid waste management out of which 60%- 70% is spent on collection, 20%-30% on transportation and less than 5% on treatment and disposal which is very essential to prevent environmental pollution. Ahmedabad is in the top ten cities generating solid waste in India. The associated cost for processing and disposing 80% of this waste at an average cost of 1000 INR per MT is approximately Rs10 crore per day. Hence there it is very much essential to segregate the solid waste at source. [3]

The present study has been carried out from a detailed waste assessment and possible alternatives to increase efficiency of processing and disposal of solid waste at city level.

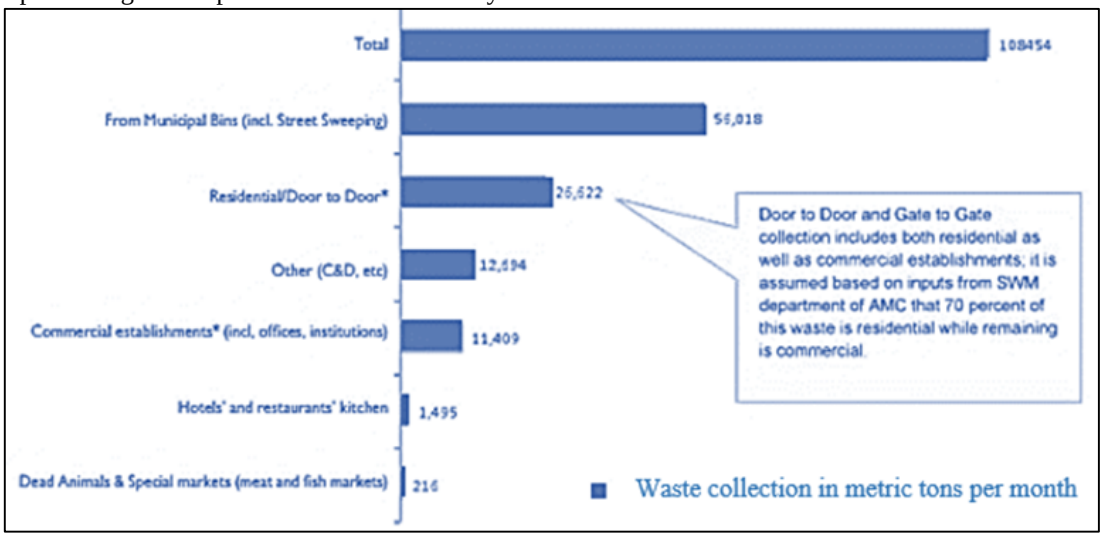

Fig. 1: Solid waste management profile of Ahmedabad (source AMC)

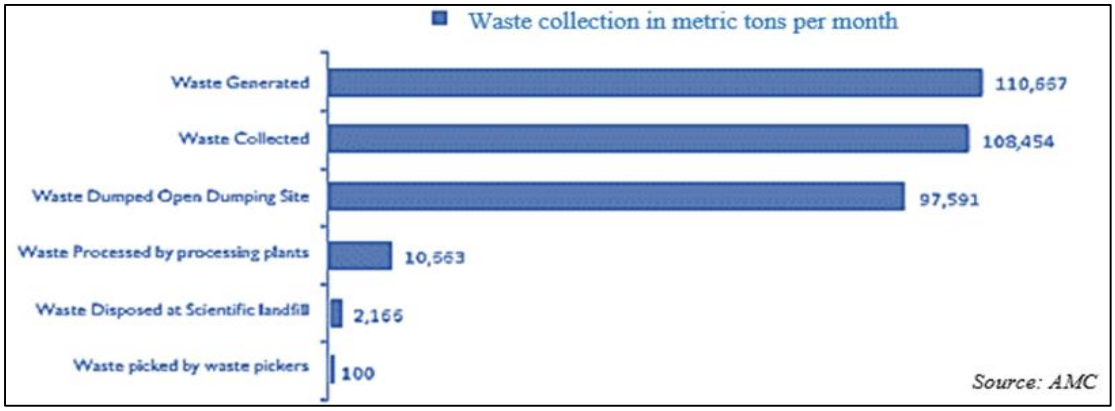

Fig. 2: Solid waste management profile of Ahmedabad.

Over the years, Municipal Solid Waste (MSW) has increased exponentially. AMC has been providing services to gather, transport, treat and dispose it. Daily MSW collection in AMC has enhanced from 750 MT in 1981 to nearly 4000 MT in 2011. The figure3. shows this growth of 533 % from 1981 to 2011:

Fig. 3: Daily MSW Collection in Ahmedabad from 1981 to 2011

II. MUNICIPAL SOLID WASTE (MSW) GENERATION, COLLECTION, PROCESSING, DISPOSAL AND BUDGET

A. Generation

Majority of waste is generated from households (57%), followed by 24% from street sweeping, while only (2 %) waste is generated by kitchens of hotels and restaurants.

Category	Unit	Waste Generated	Percentage*
Residential	Tons/ Month	63,080	57 %
Street Sweeping	Tons/ Month	26,561	24 %
Hotels' and restaurants' kitchen	Tons/ Month	2,213	2 %
Special markets (e.g. veg. & non veg. markets, mandis)	Tons/ Month	NA	NA
Commercial establishments (incl. offices, institutions)	Tons/ Month	NA	NA
Other (C&D waste, etc.)	Tons/ Month	18,814	17 %
Total	**Tons/ Month**	**110,667**	
*Note: * This percentage is based on percentage allocation to categories of waste prepared by AMC in 2009 for SLB data.*			

Table 1: A detailed break up of MSW generated by various categories of use (Estimated Waste Generation in Ahmedabad) Source (AMC)

B. Collection

Approximately 106,000 to 110,000 MT (around 98%) of waste is collected monthly by AMC from various stream or sources of generation including: Door/gate to dump system (includes residences, hostels, commercial establishments, offices, institutes, etc.), Street sweeping, Hotels and restaurants' kitchen waste, Construction & Demolition (C&D) waste. Waste from special markets (including slaughter house, meat / fish / vegetable markets), Lifting of dead animals.

C. Processing

Ahmedabad has currently 2 operational MSW processing plants contracted out to private agencies. One of them converts MSW to compost while the other produces Eco fuel in the form of refuse derived fuel (RDF). Details of waste processed in Ahmedabad have been provided in table2.

Details of MSW received at Processing/ Disposal Facilities	Unit	2011
Quantity of MSW received - Processing & Recycling Facilities	Tons/ Month	10,763
Direct disposal at dumping site	Tons/ Month	97,591
Quantity of MSW taken away by recyclers from intermediate points	Tons/ Month	100
Total MSW received at Processing/ Disposal Facility & Recycled	**Tons/ Month**	**1,08,454**

Table 2: Summary of quantity of MSW processed Source (AMC)

Ahmedabad city processes 10,763 MT of MSW monthly through private agencies contracted for processing in December 2011. Nearly 100 MT of MSW is picked up daily by rag pickers from secondary collection points and from open dumping site at Pirana. Table3 provides some details of existing and under construction processing facilities for MSW in Ahmedabad.

	Unit	2011	
Does the ULB have any MSW processing facility	Yes/No	Yes	
Are daily logs of MSW intake at processing facilities available	Yes/No	Yes	
Provide MSW processing facility details as under		**Installed Capacity**	**Current Operation**
Excel Industries	Tons/ Month	15,000	4,875
UPL Djai Power Ltd.	Tons/ Month	7,500	5,888
Creative Ecorecycle Port Pvt. Ltd. (I) *	Tons/ Month	24,000	-
Hanjer Biotech Energies Pvt. Ltd.*	Tons/ Month	15,000	-
Total	**Tons/ Month**	**61,500**	**10,763**
MSW collected by rag pickers for processing	Tons/ Month		100
Total MSW Processed in the ULB	**Tons/ Month**		**10,863**
Quantity of MSW rejected by processing facilities at intake point	Tons/ Month		2,166
Quantity of post-processing rejects sent to dumpsite/ landfills	Tons/ Month		
*Note: * Under construction, Creative Company's plant to be operational by January 2012 and Hanjer by March 2012.*			

Table 3: MSW Processing Installed Capacities and Actual MSW Received for Processing

D. Disposal

AMC dumps nearly 97,500 MT/month at Pirana by open dumping in 84 acre of open area. Dumpers dispose solid waste including restaurant and hotel solid waste over 800 times a day at Pirana. [2]


Fig. 4.1 & Fig. 4.2: Rag pickers splitting out plastic, paper, cloth, metal, rubber waste etc. from Pirana dumping site

1) Emissions from Disposal Site:

The major sectors responsible for the emission of GHGs are energy supply with 26% followed by industrial activities with 19%, commercial areas including buildings and residential with 8% and waste sector with 3%. Out of the total emissions from waste sector, the solid waste contributes nearly 22 % of total greenhouse gas emission in Indian context which in turn is the 3% of the total sectorial emissions. The studies reveal that this MSW comprises of more than 50% of organic portion in Indian context as it contains vegetable, food waste, paper, cloth and other biodegradable components as well. The total CO2 released on account of municipal solid waste is in order of 5218119.24 tons/year out of which 22838.88 tons/year in form of transport sector and remaining 5195280.37 tons/year from disposal of waste at dump site at Pirana presently [1].

The waste which is dumped at Pirana dumping site is of mixed variety and no segregation is done at the source except some valuable materials. There is quantifiable amount of heavy metals found in MSW dumped at Pirana through heavy metal analysis done by the SGS India Pvt. Ltd. For the waste samples before the composting is done by M/s EXCEL plant at Pirana. The quantity of heavy metals such as arsenic, cadmium, chromium, copper, nickel and lead are in order of 6.02, 8.02, 18.55, 1152.96, 150.39, 391, 1950 tons respectively of year 2011. As it is open dumping, these quantities may post threat to eco system of soil, subsurface of water and ground water over period of time. Methane emissions from these are in order of 71394717 m3 per year and 75.23 m3 per ton of waste. [1]

E. Budget:

Total budget of Rs340 crore was granted in 2014-2015 for solid waste management to AMC, within which collection of solid waste was granted Rs163.29 crore in which Rs48.99 crore was from central government and other from state government grant. [6]

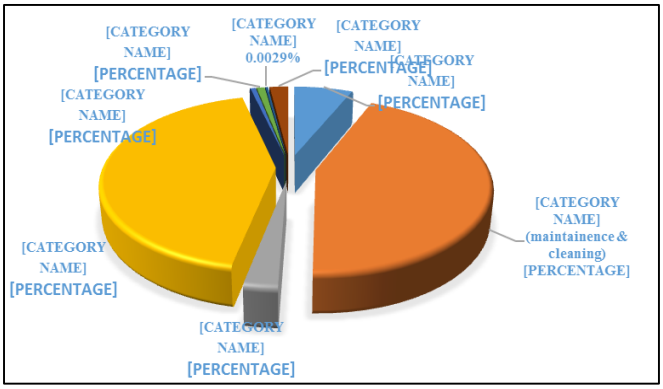

Fig. 5: SWM management according to budget 2014-2015

III. PRIVATE AGENCIES PARTICIPATING

Over the years, AMC has been disposing MSW in open dumping site at Pirana. Out of 84 acres, around 65 acres of land has 20 to 25 meter high heaps of garbage stocked. Thus there is potential to tap methane gas generated from these heaps and hence USEPA has undertaken a pilot project in the year 2007 for measuring the percentage level of methane concentrations found; estimated at about 950 cubic.metre. daily. [5]On an average, landfill gas contains 45 to 55 percent of methane. The gas collected can then be sold off to nearby industries as raw fuel.

IV. PREFERABLE SOLUTION

Adopting segregation of waste at source can be beneficial based on our analysis. The dry refuse generated can be recycled and save public money of transporting it to the dump yards. Wet waste can be used for making manure by disposal waste at source, i.e. at their premises or zone wise. Composting and installing of biogas system are the ways in which garbage disposal can be done.

Benefits of adopting segregation at source and decentralisation:

- Improvement in aesthetic condition of the locality
- No more need of a secondary collection of waste by the municipality which leads to decrease in volume of the dumping site
- Better income, opportunities and employment options to underprivileged sections of the society in the locality due to decentralised scheme

The legal framework headed by the Honourable Supreme Court of India has given support to community based waste management schemes through national legislation – the Municipal Solid Waste rules, year 2000 (Ministry of Environment and Forest 2000). One section of the rules needs the urban native bodies to promote and implement waste segregation at the source. The community can will thus avail of legal backing for its decentralized initiative for municipal waste management. [3]

A. Ghatlodiya Ward: Case Study

A survey was done in Ghatlodiya ward by JTC Agency for AMC. Ghatlodiya is a part of New West zone of Ahmedabad and has 24000 household units. The demographic details and outcome are given in table4 and figure5 respectively**.**

Total Population	1,04,538[†]
Ward Area	4.4 sq. km
Slum population	24,583[2]
Non slum population	79,955[2]
Household units	24,000[‡]
Non-residential units	4000[§]

Table 4: Overview of Ghatlodiya ward

Based on survey carried out 50 ton per day plant was proposed which is shown in figure5. The waste composition consisted of 24 ton per day organics, 10 ton per day recyclables, 1ton per day other (diapers etc.) and 15 ton per day inert (sand, dirt).[2]

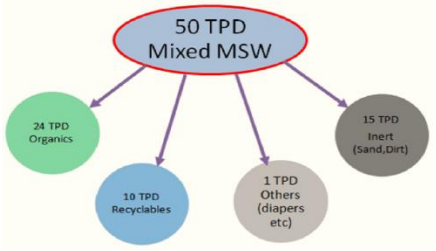

Fig. 5: Represents the estimation of categories of solid waste generated in AMC's mixed MSW

According to the survey the total area required for processing was 2730 Sq.Mtr for which the total land cost was Rs1.59 crore. For plant and machinery the total expense was Rs3.29 crore and the total operational cost was Rs2.57 crore per year. Ghatlodiya ward was provided with buckets and bins which costs around Rs1.68 crore.[2] Hence one time investment cost comes out to be Rs6.65 crore (bucket cost + land cost + machinery cost).

Statement of Income	Unit	Avg Rate/Kg	Avg. Rate Per Day(Rs.) lacs	Avg. Rate Per Month(Rs.) lacs	Avg. Per Year(Rs.) lacs
Recyclables	10000	8	0.8	24	288
Inert	15000	0.25	0.037	1.12	13.6
Rdf	5000	2	0.1	3	36.5
Total	30000		0.94	28.12	342
Profit Per Month	6.66 lacs				
Profit Per Year	79.9 lacs				

Table 5: Income statement and profitability

B. Problems in Current Method

Major hurdles in MSW management in current practice:

- Non Segregation of waste at source
- Low recycling percentage
- Higher open dumping leading to very high Land consumption
- Single stream technology like RDF & composting is unable to reduce the Landfill volume

C. Suggested Method for Decentralization:

Decentralization ward wise collection centers and segregation centers can be set up.

- All 64 wards will have at least one dry waste collection center
- The dry waste generated in the space will be brought to this centers and will be further re-segregated and recycled
- The centers will be handed over to Companies/NGOs/Resident Welfare Associations for operation and maintenance for the period of 3 years and MOU will be executed with them. Over a period of time these Decentralization ward wise collection centers may be organized in to Cooperative model
- Rag Pickers would be engaged in these centers
- Citizen can directly handover the dry waste to the Decentralization ward wise collection centers and get the money out of it
- This can save national resource and conjointly save the price and efforts to eliminate such waste

A decentralized initiative has several indirect benefits. The localised collection and processing of wastes, avoids the carrying of wastes too far off dumping sites. It reduces air pollution, labour cost, and carbon footprint, the expenditure of imported diesel, resulting traffic congestions and road maintenance costs. It also would decrease the pollution of ground water through the seepage of leachates. The government thus should see the benefits of treatment of wastes locally and provide some better initiatives to communities and make this practice more widespread.

Current cost per tonne of waste for solid waste management borne by AMC is near 1000 Rs. If the model is adopted profit of 582 Rupees would be there per tonne which means cost per tonne would become 418 for solid waste management which means reduction of cost by 58.2% for solid waste management.

Also based on our analysis out of 4000 MT generated daily, 2400MT would be directly sold by making RDF, inert material and recyclables and remaining 1600MT waste would comprise of 1000MT of organics which can further be treated to get manure from which 800MT of manure would be generated. Thus only 800 MT would be needed to dispose at landfill site which would further lead to volume reduction in landfilling by 80% which is quite huge amount.

Samples tested at Pirana dumping site revealed high content of food waste – around 40 %. As seen from domestic waste characterisation and samples from Pirana dump site, it presents a strong case for promoting segregation of wet waste at source and hence designing municipal solid waste management system for Ahmedabad to cater to segregated waste.

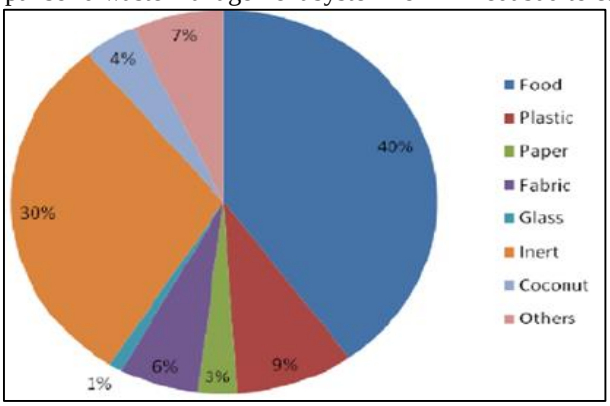

Fig. 6: Composition of waste reaching Pirana

Table4. Explains the details of the operational cost of all six zones calculated based on unit sq.km operational cost calculation of Ghatlodiya ward done by JTC Agencies.[2]

Operating cost details of Ghatlodiya ward				Zones of Ahmedabad					
	Ghatlodiya ward			**Central**	**North**	**South**	**East**	**West**	**New west**
Area in sq.km	4.4			16.6	41.54	92.05	78.52	56.53	175.76
Operational cost	**Unit**	**Amount(Rs)/per annum, lacs**	**Operational cost, lacs per sq.km**	**Operational cost for six zones in lacs**					
Electricity		36	8.18	130	340	750	640	460	1438
Fuel cost		27	6.13	100	250	560	480	350	1078
Manager	1	5.4	1.22	20	51	110	96	69	210
Loader driver	1	1.8	0.41	6.8	17	37.6	32	23	72
Security	1	1.3	0.30	5	12.5	27.6	23.5	17	52.7
Supervisors	1	1.62	0.37	6.1	15	33.9	29	20.8	64.7
Electrician	1	1.8	0.41	6.8	17	37.6	32	23	72
Mechanics	2	3.24	0.736	12.2	30.5	67.7	57.8	41.6	130
Skilled labors	5	8.1	1.8	30.5	76.5	1.7	140	100	320
Semi-skilled labors	10	12.6	2.8	47.5	120	260	220	160	50
Un skilled labors	30	27	6.13	100	250	560	480	350	1070
Packing material		6	1.4	23	56.6	120	100	77	240
Water charges		2.4	0.545	9	22.6	50	43	30.8	96
Interest (3 month working capital)at 15%	3,357,000	5.03	1.14	19	47.5	100	90	64.7	200
EMI on capex at 14%, 7 yr. Term	48,785,000	113	25.6	430	1060	2360	2000	1450	4500
MSW & maintenance cost		5.4	1.2	20	51	110	96	69	210
Total operational cost		258	58.37	966	2417	5186	4560	3306	9803.4

Table 4: Operational cost details of zones of Ahmedabad

By initiating the decentralized method for MSW profit obtained for all the six zones of Ahmedabad is represented in table5.

Zone	Total area of zone(in sq. Km)	Projected profit per day(in rupees) lacs
Central	16.6	0.84
North	41.54	2.1
South	92.05	4.6
East	78.52	3.96
West	56.53	2.85
New west	175.76	8.87
Total	461	23.3
Total profit per month	-	700
Total profit per year	-	8500

Table 5: Projected profit if decentralization is adopted

Table5: Projected Profit considering cost of electricity, fuel cost, manpower, packing material, water charges, interest(3 months working capital) at 15%, EMI on Cap Ex at 14%(7 year term), MSW and maintenance cost, for awareness campaign.

A sample survey of Ghatlodiya was carried out by JTC Agency which revealed that vast majority of people are willing to segregate as per law (87% +). [2]

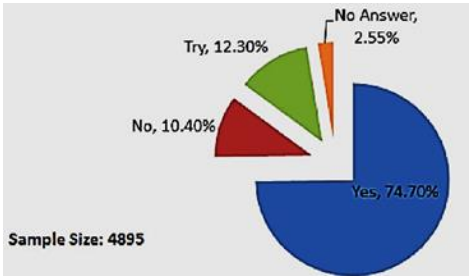

Fig. 7: Willingness to segregate

V. CONCLUSION

Based on our analysis it can be deduced that a radical paradigm shift is need of the hour to boost this waste management scenario in Ahmedabad, and to position its future as a contemporary, clean, enticing and live able city. Decentralization and segregation at source can be beneficial as compared to current cost of INR1000 per ton for solid waste management, cost can reduce to Rs. 418 per ton and also can lead to better standard of living of society. Out of 4000 MT generated daily only 800 MT would be needed to dispose daily which would lead to 80% volume reduction then current scenario. As only 800MT tones would be disposed, it would further lead to reduction in GHGs emission and thus would lower carbon footprint. Henceforth, adopting segregation at source can thus lead to cleaner and better environment. Thus a sustainable, preventative and comprehensive approach towards waste is needed.

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