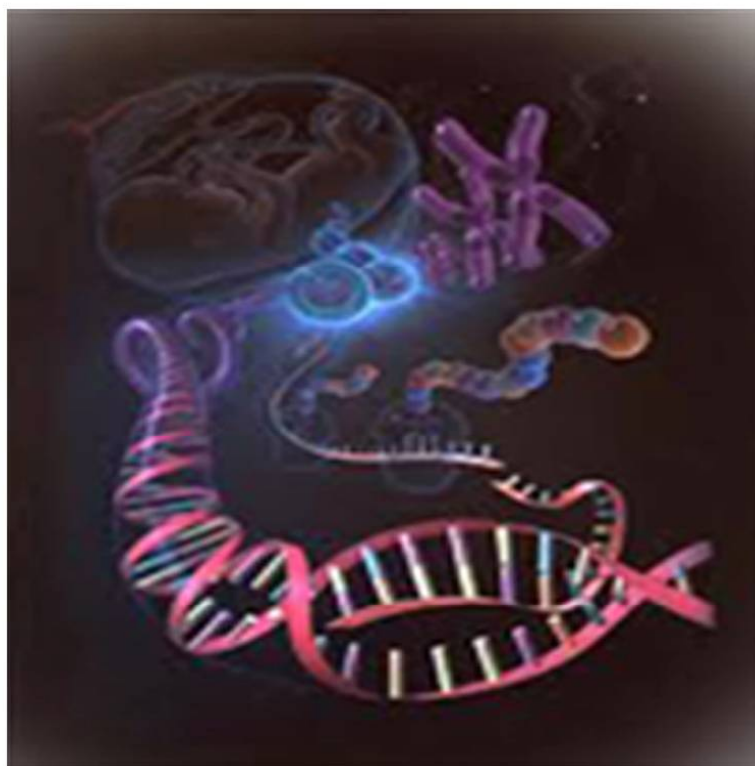




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Case Study

## MUNICIPAL SOLID WASTE PROBLEM AND MANAGEMENT IN GONDIA CITY IN INDIAN PERSPECTIVE (MS): A CASE STUDY

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Present scenario and Status of the Municipal Solid Waste (MSW) Gondia city was studied. The results indicated that the organic waste was highest among other components of the wastes. A considerable proportion of organic carbon was found which causes the health problem to the dwellers of the city. In order to avoid this situation small community bins are placed in the nook and corner of the city, in addition the litterbins are provided as per requirement. Disposal vehicles, small auto rickshaws, hand carts and tricycles are provided to maximize the collection of waste. Still the facilities are inadequate, and it is an ardent need to improve the solid waste. Moreover the authorities of municipal council are apathetic towards MSWM. Considering all these factors such as increasing population and industrialization the strategy should be well developed and formulated.

**Keywords:** Gondia, NHK, Collection, MSWM, Apathy.

### INTRODUCTION

Municipal Solid Waste Management is (MSWM) is one of the environmental problems in India. Improper management of Municipal Solid Waste (MSW) causes hazards to the inhabitants. In India studies reveal that about 85%-90% of MSW is disposed of unscientifically in an open land and landfills, creating problem to public health and overall environment.

Urbanization and Industrialization has increased the quantity and diverse nature of

wastes, which need proper handling and treatment. India is a mixed demograaaaaphic profile with about 300 million of total population living in urban area. In most of the urban areas the urban areas are highly unsatisfactory due to inadequate services, limited finances and municipal authorities as well as people's apathetic behavior towards MSWM (Pandey and Jain, 2010). The solid waste management is one of the essential duties of municipal bodies to arrange for daily street sweeping, cleaning, collection,

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transportation processing and disposal of waste in scientific way at appropriate site. Improper handling and disposal practices of solid wastes continue to be a serious problem (Karthi, 2007).

Dynamics of the urbanization in developing countries have accelerated due to technological development, globalization and population growth. Indian MSW composition is depicted in the tables given below.

Description	Percentage by Weight
Vegetable leaves	40.15
Grass	3.80
Paper	0.81
Plastic	0.62
Glass/ceramics	0.44
Metal	0.61
Stones/ashes	41.81
Miscellaneous	11.73

S. No.	Metro City	Municipal Population	Municipal solid waste, (Tones/day)	Per capita generated (kg/day)
1.	Ahmedabad	28,76,710	1,683	0.585
2.	Bangalore	41,30,288	2,000	0.484
3.	Bhopal	10,62,771	546	0.514
4.	Bombay	1,22,88,519	5,355	0.436
5.	Calcutta	1,06,43,211	3,692	0.347
6.	Coimbatore	8,16,321	350	0.429
7.	Delhi	8,41,908	4,000	0.475
8.	Hyderabad	40,98,734	1,566	0.382
9.	Indore	10,91,674	350	0.320
10.	Jaipur	14,58,483	580	0.398
11.	Kanpur	18,74,409	1,200	0.640
12.	Kochi	6,70,009	347	0.518
13.	Lucknow	16,19,115	1010	0.624
14.	Ludhiana	10,42,740	400	0.384
15.	Madras	47,52,976	3124	0.675
16.	Madurai	9,40,989	370	0.393
17.	Nagpur	16,24,752	443	0.273
18.	Patna	9,17,243	330	0.360
19.	Pune	22,44,196	700	0.312
20.	Surat	14,98,817	900	0.600
21.	Vadodara	10,31,346	400	0.388
22.	Varanasi	10,30,863	412	0.400
23.	Visakhapatnam	7,52,037	33	0.399
Total/Average		6,68,85,287	30,058	0.449

**Table 3: Characteristics of Municipal Solid Waste Generated by Metro Cities (CPCB, 1999)**

S. No.	Name of City	Characteristics (% by Weight)							
		Paper	Textile	Leather	Plastic	Metal	Glass	Ash, Fine Earth and other	Compo-stable matter
1.	Ahmedabad	6.0	1.0	–	3.0	–	–	50.0	40.00
2.	Bangalore	8.0	5.0	–	6.0	3.0	6.0	27.0	45.00
3.	Bhopal	10.0	5.0	2.0	2.0	–	1.0	35.0	45.00
4.	Bombay	10.0	3.6	0.2	2.0	–	0.2	44.0	40.00
5.	Calcutta	10.0	3.0	1.0	8.0	–	3.0	35.0	40.00
6.	Coimbatore	5.0	9.0	–	1.0	–	–	50.0	35.00
7.	Delhi	6.6	4.0	0.6	1.5	2.5	1.2	51.5	31.78
8.	Hyderabad	7.0	1.7	–	1.3	–	–	50.0	40.00
9.	Indore	5.0	2.0	–	1.0	–	–	49.0	43.00
10.	Jaipur	6.0	2.0	–	1.0	–	2.0	47.0	42.00
11.	Kanpur	5.0	1.0	5.0	1.5	–	–	52.5	40.00
12.	Kochi	4.9	–	–	1.1	–	–	36.0	58.00
13.	Lucknow	4.0	2.0	–	4.0	1.0	–	49.0	40.00
14.	Ludhiana	3.0	5.0	–	3.0	–	–	30.0	40.00
15.	Madras	10.0	5.0	5.0	3.0	–	–	33.0	44.00
16.	Madurai	5.0	1.0	–	3.0	–	–	46.0	45.00
17.	Nagpur	4.5	7.0	1.9	1.25	0.35	1.2	53.4	30.40
18.	Patna	4.0	5.0	2.0	6.0	1.0	2.0	35.0	45.00
19.	Pune	5.0	–	–	5.0	–	10.0	15.0	55.00
20.	Surat	4.0	5.0	–	3.0	–	3.0	45.0	40.00
21.	Vadodara	4.0	–	–	7.0	–	–	49.0	40.00
22.	Varanasi	3.0	4.0	–	10.0	–	–	35.0	48.00
23.	Visakhapatnam	3.0	2.0	–	5.0	–	5.0	50.0	35.00
	Total/Average	5.7	3.5	0.8	3.9	2.1	2.1	4	

## STUDY AREA

Gondia is one of the district headquarters in Maharashtra State, India and situated between Mumbai-Howrah rail routes, 120 Km. from Nagpur towards Howrah.

Gondia district was formed after the bifurcation of Bhandara district into two. It is situated on North-Eastern side of Maharashtra state having state

border of Madhya Pradesh & Chhattisgarh. The total population of the city is 120902 (as per 2001 census). The male and female population is 61418 and 59484 respectively. The literacy rate of city is 65.00%.

This is underdeveloped city and most of land is covered with agricultural land. Paddy is main agriculture product. The main profession of people is farming.

There was no large scale industry in this region due to this it is economically backward but due to the commencement of work of Adani Power Plant it is now developing & many existing rice mills in city in future air pollution occur as paddy is the main agriculture produce here. Wainganga and Bawanthadi rivers are most important.

**Location:** Gondia city lies at latitude 21°23' longitudes 80°13'. The adjoining districts to Gondia city are, on the Northern side Balaghat district of Madhya Pradesh and on the eastern side Dongarghad city of Chhattisgarh State. To the south and west are Sakoli Tahasil and Bhandara district of Maharashtra respectively. This city is on Mumbai-Calcutta railway route. The location

of Gondia city is indicated in the Map 1, Map 2 and Map 3.

**Climate:** Gondia city experiences extreme variations in temperature with Tropical hot summers and very cold winters and an average relative humidity of 62 percent being in the Agro-Climatic zone in Eastern plateau & hill region. Black, Red, Sandy clay soil present in Gondia city.

**Rainfall:** Gondia City receives rainfall from South-Western winds mainly in the months of June, July, August and September. July and August are the months during which the maximum rainfall as well as maximum continuous rainfall occurs.

The following table shows average rainfall:

<b>Table 4: Rainfall in Gondia City</b>				
	Average Rainfall During (in mm)			
	2005	2006	2007	2008
Gondia	1508.00	1438.00	1232.00	1179.00
Normal Rainfall During (in mm)				
Gondia	1413.00			

<b>Table 5: Gondia Municipal Council at a Glance</b>		
Municipal Council Gondia		
1.	Area (Sq.Km) Collection Area	18.08
3.	No. of Wards/Zones	40
4.	No. of Sweeping Units	40
5.	No. of Employees	
	Driver	
	Laborers	
	Sweepers	1038284 (sanction manpower)
6.	Waste Generation (gm/capita/Day)	150-200 gm
7.	Waste generated per day (Tons)	38-40 Tones
8.	Waste collected per day (Tons)	35
9.	Population covered with piped water supply(%)	80

**Table 6: Gondia Municipal Council at a Glance**

10.	Public Toilets	88
11.	Pay & Use Toilets	03
12.	Paved Roads (Kms.)	139.01 Km
13.	Equipments	Short and Long handle brooms, community bins, etc.
14.	The waste collected by the sweepers during sweeping is brought by them to dustbin sites by wheeled barrows. Collection and Transportation vehicles and Machinery	
	Truck	
	Tractor with Trolley	
	Handcart	
	Tanker	
	Ghantagadi	
	Hydraulic Hopper	0307140024003
15.	Land fill site	Not available
16.	Dumping site	02
17.	Proposed composting unit at Temni about 10 km away from Gondia city	But now a days this unit closed due to

**Table 7: Demography and Profile of Gondia City**

1.	City	Gondia
2.	Dist.	Gondia
3.	State	Maharashtra
4.	Country	India
5.	Population as per 1991 census	98152
6.	Population as per 2001 census	120904
7.	Population as expected in the year 2011	135000
8.	Agriculture pattern	Rice, Wheat, Gram
9.	Area (Sq.Km)	18.08
10.	Roads in Kms.	139.10
11.	Present MSW in Tons per Day	38 to 40
12.	No. of Wards / Zones	40
13.	No. of Schools and Colleges	30
14.	No. Hospitals	168 / 2 gov.
15.	No. of Veterinary Hospitals	01
16.	Banks	14
17.	Credit Co-operative Societies	13
18.	Petrol Pump	05
19.	Temples	10
20.	Bars & Restaurants	18
21.	General Stores	162
22.	Kirana Shops	184
23.	Xerox Centers	93
24.	Medical Stores	72

## SANITATION SET-UP IN MUNICIPAL COUNCIL OF GONDIA

The health officer heads the sanitation operation and supervision of the city. The sanitary inspector, sanitary workers and sweepers work under the supervisor (Table 8).

S.No.	Portfolio	No. of Officers /Workers
1.	Health Officer	00
2.	Sanitary Inspector	02
3.	Sweepers	262
4.	Macadam	06
5.	Driver	10
6.	Laborers	38
	<b>Total</b>	<b>318</b>

## PRESENT PRACTICE OF SOLID WASTE MANAGEMENT

The Municipal Council is divided into 40 no of wards. As per present practice collection carriage and disposal of solid waste is done by engaging 262 sweepers (Table 9), under supervision of Macadam and 02 Sanitary inspector. The tractor, trolleys, Handcarts and tricycles are engaged alternate day for carriage of solid waste from community bins to disposal site. The household waste is collected in the community bins daily through handcart vehicles and is disposed off to the site twice a week. The tricycles and trolleys are engaged in collecting the household waste from the road side to the community bins. The dumped garbage are allowed to decompose and shrink at the spot, spreading and leveling are often done by dozer/excavators as and when required.

S. No.	Compliance Criteria	Present Status	Action required
1.	Prohibition of Littering	200 litterbins have been installed yet.	Estimated requirement is 1016 No which needs verification and provision in the budget and plans to provide for litterbins or identify sponsors for the same.
2.	Community storage bins	Storage bin are provided	Estimated requirement as per block estimate is 125 Nos. of capacity 1100 lit.
3.	Storage & Segregation	75 % to be done	Estimated requirement as per block estimate is 120 Nos. of capacity 1100 lit.
4.	Collection & Transportation	Not done *Existing bin arrangement is not rule compliant. *Existing vehicle arrangement is not rule compliant. *Existing system causes multiple handling of waste	* 100% house to house collection to be achieved for which rule compliant Tractor Container model is proposed. *Rules compliant system as suggested above should be implemented. *Rules compliant system as suggested above should be implemented. *Rules compliant system as suggested above should be implemented.
5.	Processing	*Composting is under consideration	*Survey individual wards and fix suitable sites in the wards for processing the waste. *Finalize the technology and start the work.
6.	Disposal at existing site	Disposal is done periodically	*development and use of sanitary land fill site is planned.
7.	Development of the new sanitary landfill	*Present site is adequate and hence not required to identify new land.	*Land is already in possession. *Plan for development of site. *Follow up the authorization of land from MPCB.
8.	Awareness and involvement of Citizens & NGOs	Not done	Awareness creation on storage, segregation and anti-littering should be done with the help of NGOs. Organize the workshop for the awareness and involvement of citizens.

**Sources of Solid Waste are as below**

S.No.	Source of Waste Generation	Percentage to the Total
1.	Domestic Waste	68.50
2.	Shops and Establishments	14.23
3.	Vegetable and Fruit Market	6.00
4.	Meat, Fish and Mutton Market	4.25
5.	Clinical Waste	3.52
6.	Construction/ Demolition	3.05
	<b>Total</b>	<b>100.00</b>

**ANALYSIS OF DATA FOR PHYSICAL AND CHEMICAL COMPOSITION****Physical Composition****Estimation of Moisture Content**

$$\text{Moisture Content} = \frac{100 - 69.87}{100} \times 100$$

$$= 30.13\%$$

Convert moisture content into hydrogen and oxygen.

**Categories of Solid Waste are as below**

S.No.	Type of MSW	Quantity (MT/Day)	Quantity (%)
1.	Biodegradable Waste	4.60	57.50
2.	Recyclable Waste	1.40	17.50
3.	Debris, Slit, Construction Waste	0.80	10.00
4.	Green Waste	1.20	15.00
	<b>Total</b>	<b>8.00</b>	<b>100.00</b>

**Table 12: Zone wise Percentage of MSW**

Zone No.	Ward No.	Paper (%)	Rubber, leather, plastic (%)	Glass (%)	Metals (%)	Compostible matter (%)	Inert Material (%)
Zone 1	1 to5	1.86	0.89	0.55	0.52	53.34	42.82
Zone 2	6 to10	2.20	0.91	0.88	0.74	54.28	40.60
Zone 3	11to15	1.59	0.36	0.44	0.44	40.52	56.05
Zone 4	16to20	1.69	0.53	0.50	0.48	42.41	55.02
Zone 5	21to25	2.18	1.03	0.74	0.70	48.38	43.83
Zone 6	26to30	1.69	0.50	0.56	0.54	43.12	53.81
Zone 7	31to35	1.80	0.67	0.62	0.58	49.65	50.17
Zone 8	36to40	1.92	1.01	0.56	0.55	54.48	41.25

**Table 13: Average Constituents of Msw**

S.No.	Constituents	Quantity (%)	S.No.	Constituents	Quantity (%)
1	Paper	1.86	4	Metals	0.57
2	Rubber, Leather and Plastic	0.74	5	Compostible matter	48.28
3	Glass	0.61	6.	Inert Material	47.94



$$a) \text{ Hydrogen} = 2 / 18 \times 30.13 = 3.35 \text{ Kg.}$$

$$b) \text{ Oxygen} = 26.78 \text{ kg. } 16/18 \times 30.13$$

$$= 26.78 \text{ Kg.}$$

$$\text{C/N Ratio} \frac{23.66}{0.8138}$$

$$= 29.07$$

### Estimation of Density

$$\text{Density} = \frac{1000}{3.54} = 282.10 \text{ kg/m}^3$$

### Estimation of Chemical Composition

[Peavey, Howard S., *et al.* (10-8) ]

Typical Values of C, H, O, N, S and Ash.

**Table 14: Estimation of Moisture Content**

Based on 100 kg sample of waste

S.No.	Components	% by Wet mass	Wet mass (kg)	Dry mass (kg)	Moisture content (%)
1.	Paper	1.86	1.86	1.75	5.91
2	Rubber, Leather & Plastic	0.74	0.74	0.69	6.75
3	Glass	0.61	0.61	0.59	3.27
4	Metal	0.57	0.57	0.55	3.51
5	Compostible material	48.28	48.28	22.40	53.60
6	Inert material	47.94	47.94	44.00	8.21
	<b>Total</b>	<b>100</b>	<b>100</b>	<b>69.87</b>	<b>81.25</b>

**Table 15: Estimation of Density**

Based on 100 kg sample of waste

S.No.	Components	% by Mass	Mass (kg)	Typical Density (kg/m <sup>3</sup> )	Volume (m <sup>3</sup> )
1.	Paper	1.86	18.60	86	0.21
2	Rubber, Leather & Plastic	0.74	7.40	66	0.11
3	Glass	0.61	6.10	480	0.013
4	Metal	0.57	5.70	775	0.072
5	Compostible material	48.28	482.80	300	1.60
6	Inert material	47.94	479.40	310	1.54

**Table 16: Analysis of Data for Chemical Composition**

S. No.	Components	Composition in Kg.					
		Carbon	Hydrogen	Oxygen	Nitrogen	Sulphur	Ash
1	Paper	43.5	6.0	44.0	0.3	0.2	6.0
2	Rubber, Leather & Plastic	78.0	10.0	—	2.0	—	10.0
3	Compostible material	48.0	6.4	37.6	2.6	0.4	5.0
4	Inert material	26.3	3.0	2.0	0.5	0.2	68.0

**Table 17: Computation of Chemical Composition of Waste Samples (Ultimate Analysis)**

Based on 100 kg sample of waste

S.No.	Components	Wet mass (kg)	Dry Mass (kg)	Composition in Kg.					
				Carbon	Hydrogen	Oxygen	Nitrogen	Sulphur	Ash
1	Paper	1.86	1.75	0.8	0.105	0.77	0.00525	0.0035	0.105
2	Rubber, Leather and Plastic	0.74	0.69	0.54	0.069	—	0.0138	—	0.069
3	Compostible material	48.28	22.40	10.75	1.43	8.42	0.58	0.0896	1.12
4	Inert material	47.94	44.00	11.57	1.32	0.88	0.22	0.088	29.92
	<b>Total:</b>	98.92	68.84	23.66	2.924	10.07	0.8138	0.1811	31.214

**Table 18: Summary Table**

S.No.	Components	Mass (Kg)
1	Moisture	30.13
2	Carbon	23.66
3	Hydrogen	2.924
4	Oxygen	10.07
5	Nitrogen	0.8138
6	Sulfur	0.1811
7	Ash	31.214

**Table 19: Final Summary Table of Chemical Composition**

S.No.	Components	Mass (Kg)	% by Mass
1	Carbon	23.66	34.35
2	Hydrogen	2.924	4.25
3	Oxygen	10.07	14.62
4	Nitrogen	0.8138	1.18
5	Sulfur	0.1811	0.262
6	Ash	31.214	45.33
	Total	68.86	100.00

## CONCLUSION, DISCUSSION AND SUGGESTIONS

In this work a detailed study of collection, storage, transport and disposal practices was conducted for Gondia city. An improvement to existing system has been proposed to meet the MSW (H & M) rules 2000. The site has been planned as an integrated facility for compost plant and sanitary landfill. In order to build up institutional capability it is necessary to harness and integrate the role of other emerging actors in the field of SWM. Private sectors, NGOs and rag pickers are to be brought in to the institutional framework for effective management of MSW.

1) The total quantity of MSW generated in Gondia City 38 to 40 T/Day.

2) The rate of generation of MSW is 150 to 200 gm/Capita/Day.

3) **Minimization of Waste:** To prohibit the littering the notification should be issued which is not done yet. Also it is required to increase number of litterbins. Litterbins provided in strategic locations for the citizens to deposit the waste in their hands while moving about, reduce the waste coming on the street. This will decrease the requirement for sweeping and thus reduces the cost of MSW management. A notification to this effect to the citizens will enable the council to enforce antilittering.

4) **Segregation of Waste:** At present there is no segregation of waste at source. Segregation of waste at the point of generation

i.e. homes, offices, shops must be done into two categories:

- a) Wet waste comprising of biodegradable waste such as food waste etc.
- b) Dry waste comprising of plastics, tins etc.

The council must enforce this by notifying the citizens to do so.

5) **Generation of waste:** The waste generation in the city is 50 to 200 gm Capita/Day.

Since the weight of the waste is only an estimate, it is suggested that the council collect information on the exact quantity of the waste generation. It is also suggested that the physical examination of the waste be carried out into the four categories:

- a) Biodegradable Waste
- b) Recyclable Waste
- c) Green Waste
- d) Debris and Demolition Waste

This will enable the council to plan recycling and processing of the waste.

6) **Street Cleansing:** In Gondia Municipal Council there are 40 wards covering an area of 18.08Sq.km. The council has employed only 47 sweepers for street cleansing which are insufficient for the work. Hence it is suggested that the council should employ sufficient number of sweepers so that the daily cleaning should be done.

7) **Collection:** Yet the council has not implemented the appropriate method of collection and it is suggested that the council should provide house to house collection.

8) **Transportation:** The council has only two vehicles with trolleys which are inadequate.

Though the generation of waste is 38 to 40 T/Day, only 35 T/Day is collected. Hence it is suggested that the council should increase the number of vehicles and laborers to fulfill the requirement.

9) **Processing:** Currently the council has no arrangement for processing hence it is suggested that the council should make the adequate number of incinerators so as to reduce the MSW at disposal site.

10) **Disposal:** Presently, waste dumping site is adequate for future. Also it is adequate for Sanitary landfill. According to population of Gondia city (2001) the 2822.7m<sup>2</sup> area is required for sanitary land-filling. But the council has not obtained authorization from Maharashtra State Pollution Board. Hence it is suggested that the council should follow up the authorization from MPCB and implement sanitary land filling.

11) There is no awareness and involvement of citizens and NGOs. Hence it is suggested that the council should create awareness on storage, segregation and antilittering with the help of NGOs. Also it is suggested to organize the workshop for the awareness and involvement of citizens and NGOs.

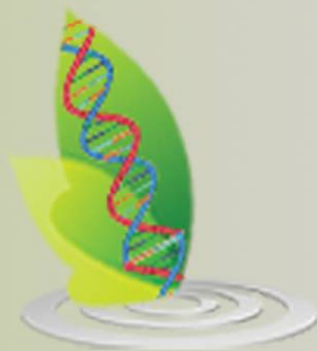
12) The porosity and permeability of the soil at the disposal site is very less. Hence, the possibility of ground water pollution does not exist. Therefore the present site is suitable for disposal of solid waste.

13) The C/N ratio of the waste generated at Gondia city is found to be 29.07, which is ideal for composting. Hence it is advisable to make composting plant.

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