

SOLID WASTE MANAGEMENT FOR MEDIUM SCALE TOWN OF SAURASTRA REGION OF GUJARAT: JETPUR TOWN

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Abstract- The majority of India population are still living in the rural area. According to census 2011 around 68.84 percent people are living in rural area of India. So the development of India is with development of rural area. One of the key point in rural development is effective management of solid waste. Due to change in lifestyle and economic revolution there is a quantum change in quality and quantity of solid waste. It is found that municipal solid waste management of medium scale towns and villages around are neglected due to lack of awareness and low budget allotment for these areas. Government is effectively working for cleanness of areas and solid waste management. The introduction of Swachh Bharat Mission has enforce gram panchayat to put in place a functional waste management system. At moment there are few SWM units and GPs (Gram Panchayat) in Tamil Nadu, Kerala, West Bengal, Gujarat and Rajasthan which are managing their solid waste successfully. The rural India is generating 0.3 to 0.4 million metric ton per day of solid waste in year 2016. In Gujarat around 25% of 14459 Gram Panchayat has started door to door collection of solid waste and after collection open dumping is done. This paper study the present scenario of solid waste management of Jetpur town which is located in western region of Gujarat state. Jetpur is a medium scale town with population of 1, 18,302 person. The existing data of solid waste management of the town has been collected. The analysis of this data has been done and identified the lacuna in the solid waste management system of the town. The waste generation rate of the town has been calculated which is 0.338 kg/capita/day. Also quantity of solid waste has been calculated ward wise and also future forecasting of population of the town have been calculated. Furthermore SWOT (Strength, Weakness, Opportunities and Threats) analysis of the town has been done. This paper also gives scientific methodology of solid waste management.

Index terms- Rural solid waste management, Vermicomposting, Gram Panchayat, Door to door collection, Environmental Hazards.

I. INTRODUCTION

India is a country of villages and its development is synonymous with the development of the people living in rural areas. At the time of independence around 83 % of Indian people were living in the rural area. According to census 2001 around 72.77 % of people are still living in rural area of India. So still the majority of the India population are living in the rural area of Indian soil. The development of the India will be with development of rural area as the majority of the people are living in this area. So more focus has to be given on the rural development but Indian government are lacking in addressing this problem. There are many key point which government has to address for rural development. One of the key point in rural development is proper management of solid waste which is generating with rapid space.

The term solid waste is defined as useless and discarded things from community. In recent time solid waste management is becoming major environment concern all around the globe. MSWM includes collection, transportation and disposal of solid waste. Due rapid population growth and industrialization there is a quantum change in waste generation rate has generated challenges for MWSM. The rural India is generating 0.3 to 0.4 million metric tons per day of the solid waste in year 2016 (Ministry of Drinking Water and Sanitation (MDWS), Government of India). The waste generating in the rural area are community waste, agricultural waste and agro based industries, animal wastes and oil bearing seeds etc. The waste generation rate in small scale town in India is 0.41 kg/capita/day while the surrounding village generate around 0.08 kg/capita/day of solid waste. The composition of waste for small-scale towns was found to be 48% decomposable, 30% recyclable and 22% inert material while in the villages composition of waste was found to be 73% decomposable, 20% recyclable and 7% inert materials (Dass Ravi, 2007).

The major problem related to rural solid waste management was that there was not any systematic way for collection of solid waste. Over the past few decades' people generally disposed of their generated solid waste by simply throwing on roads. Furthermore government has not taken any steps for management of solid waste in this rural area. Also in the majority of area there was not any organization which would take responsibility of solid waste management.

Over the past few year the solid waste management of rural area has changed drastically. By introduction of the Swachh Bharat Mission (SBM-Gramin), it has forces every Gram Panchayat to put in place a functional waste management system (Centre for Rural

Infrastructure, 2016). The door to door collection has been started in many areas of rural across the nation which has lead toward the proper collection of generated waste. In many villages gram panchayat has started providing the community bin dustbin for collect of the waste. Also in many part of the nation recycling or reusing of the organic waste has been started. Village has more compostable waste which is suited for composting so government has also planning to start some composting plan in rural areas.

At the present there are a few SWM units in Tamil Nadu, Kerala, West Bengal which has taken responsibility for management of solid waste in villages. Also one or two GPs (Gram Panchayat) in Gujarat and Rajasthan are managing their solid waste successfully. These GPs have a lot of practical suggestions to share with others GPs and SBM facilitators who are earnest about creating a system to manage solid waste at the Gram Panchayat level (Centre for Rural Infrastructure, 2016).

II. SOLID WASTE MANAGEMENT OF RURAL AREA OF INDIA

As per census 2011 around 68.84 % of people are living in the rural area of India. The rural India is generating 0.3 to 0.4 million metric ton per day of solid waste in year 2016. The waste generation rate of the rural area was about 0.08 kg/capita/day in 2007. The community waste generating from rural area was about 15 million tonnes in year 1990 which was about 0.81 % of total waste generated. The other types of waste are Agricultural Residues was about 17.4 %, animal dung was highest about 73.74 %, Agro-Industrial by-products was about 2.65% and Oil Seeds was about 5.4% (A.P. Jain, 1994)

In the Gujarat state around 25% of gram panchayat across the state are having door to door collection method and dumping in the pit and almost 52 % of those panchayat depends on self-disposal of waste in field for solid waste management (State of Environment Report Gujarat 2012). In the south India villages around 77% of the waste generated in the village was used as domestic fuel, animal feeder and organic fertilizer for crop production. The rest (23%) was left out in open fields for natural decomposition (M.Chowde Gowda, 1995). The villages in Tekapur area of Uttar Pradesh, generates about 287gms of residential/agriculture solid waste per capita per day. The common practice in these village for waste disposal is uncontrolled dumping (Rashmi Shah, 2012). In the Himachal area, the study on Shimla and Rangri villages revealed that in the villages around 49.7 % of solid waste is Biodegradable waste, 49.6% is non-biodegradable and 0.7 % is readily biodegradable waste. The common practice for waste disposal in the villages of Himachal is of open dumping. Some of the villagers directly dump their solid wastes by the road sides and nala. Around 44 % of the villagers burn their non-biodegradable waste in Shimla and Rangri village (Kesar Chand, 2014). In Maharashtra state, the Gondia town is generating 35 tons per day of solid waste in year 2012. The sources of solid waste in the town is from domestic waste (68.50%), Shops and Establishments (14.23%), Vegetable and Fruit Market (6%), Meat, Fish and Mutton Market (4.25%), Clinical Waste (3.52%), Construction/ Demolition (3.05%). From the study it was found that around 57.50% is biodegradable waste, Recyclable waste is around 17.5 %, Debris, Slit, Construction Waste is 10% and green waste is 15%. For the waste disposal of the town the common practice is of open dumping (Nambhau H Katre, 2012). In the Nagaland state, study on Kohima town revealed that the town is generating 54 MT of solid waste daily in 2007. The source of solid waste generation in the town are residential (57%), commercial (19%), institutional (15.5%), industrial (3%), hospital (0.5%), construction practice is open dumping in the Kohima town (R. Chatterjee, 2010).

III. ENVIRONMENTAL HAZARD OF DUE TO UNPLANNED MSWM

In India, due to unplanned solid waste management, the waste is left uncollected on the street, which has created a great threat to public health and environment. Around 88% of the total disease is due to improper solid and liquid waste management (Priyank Shah, 2015). The uncollected waste in rural area generally ends up in drain which will cause blocking of the drains and due to this, drain will get flooded and also create unhealthy conditions. Due to uncontrolled dumping of the solid waste, flies breed in solid waste and are very effective vectors that spread disease. Proportion of food waste in open dumping is an attractive shelter for rats. Rat consumes and spoil food and also spread disease. It was found that rats also damage the electric cables and other materials. Other than that in the rural areas solid waste is handling directly. Direct handling of solid waste can result in various types of infectious and chronic diseases with the waste workers and the rag pickers being the most vulnerable. For the disposal of the solid waste in rural area open burning of the collected waste is there which has created issues of air pollution (N. Ejaz, 2010). The waste plastics bags which are available in solid waste are a particular aesthetic nuisance and also cause death of the grazing animals that eat them. In the village the major method for disposal is open dumping which will create the leachate generation and pollute the ground water (Dass Ravi, 2007).

IV. DETAIL OF STUDY AREA

Jetpur Municipal Corporation has been selected for study purpose in Rajkot district of Gujarat state because Jetpur Municipal Corporation is yet not scientifically and technically study for MSWM.

Jetpur is a medium scale town in Rajkot district. The coordination of Jetpur city are 21°45'15"N and 70°37'20"E. The city has average elevation of 184 m (604 ft). Jetpur city total geographical area is 36 sq.km. The mean average city temperature of city is 28°C. Highest temperature is 41°C and lowest temperature is 13°C. The hottest month of year is May (34°C avg) and coldest month is January (21°C avg). The annual rainfall is about 446.8 mm and humidity is around 57%.



Figure (a) Location map of Jetpur town



Figure (b) Map of the Jetpur town

As of 2011 India census, Jetpur Navagadh had a population of 1, 18,302 people. Males constitute 53% of the population and females 47%. The average literacy rate of Jetpur Navagadh is 98% which is greater than the national average of 59.5%. The male literacy in this town is 98%, and female literacy is 97% (Census India 2011)

Table I Population increasing in the Jetpur

Year	1991	2001	2011
Population	73560	104312	118302

Source: - Census India

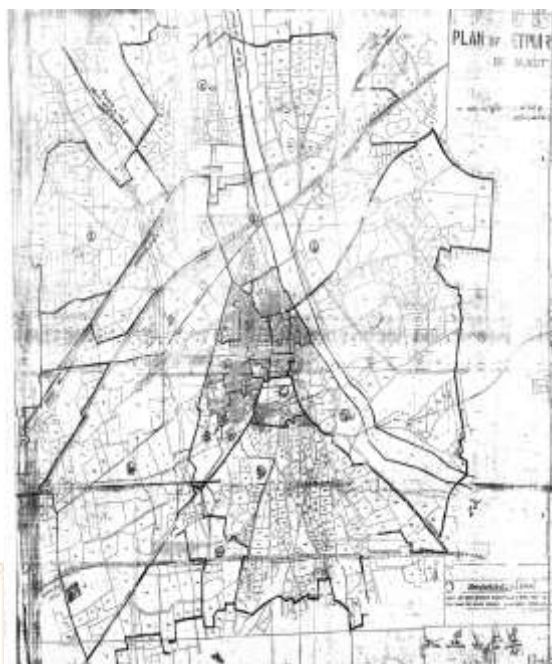


Figure (c) Ward wise map of Jetpur town

V. PRESENT SCENARIO OF MSWM IN STUDY AREA

The detailed study of existing municipal solid waste management system of Jetpur Corporation has been study. The people live in the city produced 40 MTPD (Metric tons per day) from various sources like household, domestic, industrial, construction waste, agricultural, school and office. Jetpur Municipal Corporation is working for collection, transportation and disposal of solid waste generated in city area. The general time for door to door collection is between 8 am to 6 pm. Street cleaning is done between 8 pm to 10 pm. All the 14 ward in city is collected by door to door collection on daily basis.

Table II Ward wise manpower of Jetpur town

SR NO.	WARD NO.	MALE	FEMALE
1	Ward-1	4	2
2	Ward-2	5	1
3	Ward-3	5	16
4	Ward-4	5	15
5	Ward-5	6	14
6	Ward-6	10	20
7	Ward-7	4	13
8	Ward-8	7	5
9	Ward-9	4	5
10	Ward-10	6	12
11	Ward-11	7	11
12	Ward-12	8	12
13	Ward-13	8	11
14	Ward-14	9	5

For solid waste management in the city they have 1 sanitary inspector, 4 SSI (Sanitary sub inspector) and 14 supervisors for 14 wards. They are responsible for all the management activity in the city for solid waste. For the street cleaning total manpower available to corporation are 230 worker. In that 14 wards male workers are 88 Nos and female are 142 Nos. (Table II).



Figure (d) Waste collection vehicle

The Jetpur city municipal corporation has 14 tipper rickshaws for door to door collection of waste collection. In that vehicle, there are two separate compartment for dry and wet waste. They manually separate dry (recycled, reuse) and wet (cooked food) waste at collection point. Also the corporation has 6 tractor and 1 lifter. The tipper and tractor directly transport the waste to disposal site after collection of waste.

Table III Ward wise container of Jetpur town

SR NO.	WARD NO.	CONTAINER
1	Ward- 1	8
2	Ward- 2	6
3	Ward- 3	6
4	Ward- 4	11
5	Ward- 5	15
6	Ward- 6	22
7	Ward- 7	9
8	Ward- 8	10
9	Ward- 9	10
10	Ward- 10	18
11	Ward- 11	8
12	Ward- 12	10
13	Ward- 13	10
14	Ward- 14	12

The city has total 155 no. of different waste collection points at different points of the city (Table III). From that point, community bin is transported to disposal site according to their fill ups.



Figure (e) Waste collection bin of Jetpur town

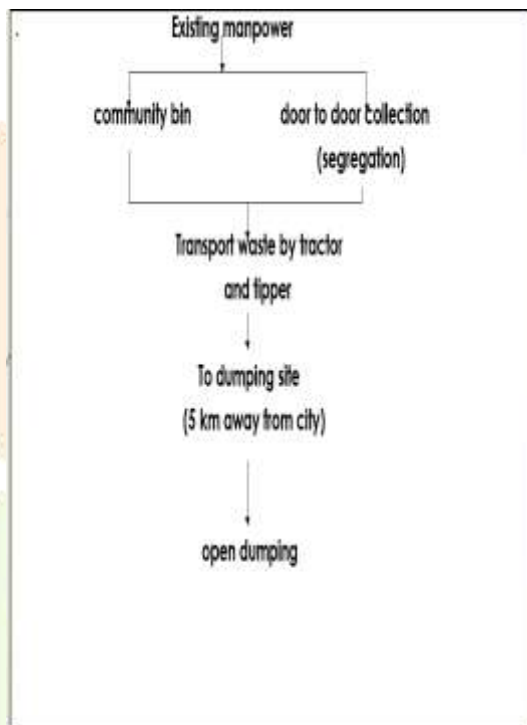


Figure (f) Present SWM system in Jetpur town

The waste is collected and transported to the disposal site. The disposal site is around 7 km from the city boundary. The land available for waste disposal is around 10 hectares. The recycle waste is segregated from others hand on site. The waste is spread on the ground the recyclable waste is collected manually. The remaining other waste is then collected and open dumping is done. The recycle waste like paper, plastics, metals and various others things are sold local market and to scrap dealers.



Figure (g) Waste disposal site of the Jetpur town

VI. SWOT ANALYSIS OF SWM OF STUDY AREA

The SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is a tool to identify the positive and negative points of the performance of any process, organization, project, and company. Strengths and weaknesses are internal factors while opportunities and threats are external factors.

STRENGTHS

Jetpur town has separate (sanitation) department for handling of solid waste management activity. So the environment sound technology for collection, transport, treatment, composting and final disposal can be achieved. For proper management of solid waste the Jetpur Corporation has appointed 1 SI, 4 SSI and 14 supervisor. So that active planning can be done for SWM. The other strength of are they can attracts a large number of inflow people from other area. This can be done because Jetpur town has large number of industry. So manual labour are available for required solid waste management.

WEAKNESS

The Jetpur town certainly has various weaknesses which need to be addressed. Due to the lack of stakeholders' participation in setting up of the regulation or standard, their ability to meet with standards will be low. Also lack of public education for the waste segregation is the main weakness of the town. In terms of the financial issue, limited support from the government is an issue when implementing any activities. Beside that Jetpur town does not have any waste processing plant for solid waste. The main weakness is, they does not have any scientific landfilling site for disposal of the waste. Jetpur city handles their waste by open dumping which is creating the problem of leachate and ground water pollution.

OPPORTUNITIES

The location of the Jetpur town is good which will attracted large number of people for investment. Also engagement of private sector in solid waste management can change the economic structure of the town. It was found that small scale town have high percentage of organic fraction (50%). So it will create opportunities to implement of waste to energy plant like RDF and can also construct composting plant.

THREATS

Due to rapid growth and change in life style the waste generation has been increased which will lead towards increase in the consumption of resources. This will create threats to lost in natural resources. Due to the open dumping of solid waste many harmful disease can attack to people. Also the problem of leachate generation is there which will leads towards the pollution of the ground water.

VII. RATE OF GENERATION OF MSW OF STUDY AREA.

Waste generation of the city is 40 MTPD as in year 2017. The population is about 118302 of the city according to census 2011
 The population of the city = 118302
 Waste generation rate = $40 / 118302$
 $= 0.338 \text{ kg/capita/day}$

VIII. POPULATION FORECAST FOR STUDY AREA

The present population of the city is about 118302. The future forecasting of population is done by two method.

- 1) Arithmetic method
- 2) Geometric method

ARITHMETIC METHOD

In this method the average increase in population per decade is calculated from the past census reports. This increase is added to the present population to find out the population of the next decade. Thus, it is assumed that the population is increasing at constant rate. The formula is

$$P_n = P + n \cdot C$$

Where, P_n is the population after 'n' decades and 'P' is present population. C is rate of change of population with respect to time is constant.

Table IV Population forecasting of study area by Arithmetic method

YEAR	POPULATION	INCREMENT
1991	73560	-
2001	104312	30752
2011	118302	13990

$$P_{2021}=140673; P_{2031}=163044; P_{2041}=185415$$

GEOMETRIC INCREASED METHOD

In this method the percentage increase in population from decade to decade is assumed to remain constant. Geometric mean increase is used to find out the future increment in population.

$$P_n = P (1 + IG/100)^n$$

Where, IG = geometric mean (%) P = Present population n = no. of decades.

Table V Population forecasting of study area by Geometric increased method

YEAR	POPULATION	INCREMENT	GEOMETRIC RATE
1991	73560	-	
2001	104312	30752	$30752/73560 = 0.418$
2011	118302	13990	$13990/104312 = 0.134$

$$P_{2021}=146221; P_{2031}=180729; P_{2041} = 223381$$

IX. FORECASTING OF SOLID WASTE GENERATION FOR STUDY AREA

The current waste generation of town is about 40 MTPD. Due to rapid growth and increase in the population, the waste generation will also be increased. The current waste generation rate of the city is 0.338 kg/capita/day. In 2021 the waste generation will about 47.54 MTPD and that generation will increased to 55.108 in 2031.

$$\begin{aligned} \text{Waste generation in 2021} &= 0.338 * 140673 \\ &= 47.54 \text{ MTPD} \end{aligned}$$

$$\begin{aligned} \text{Waste generation in 2031} &= 0.338 * 163044 \\ &= 55.108 \text{ MTPD} \end{aligned}$$

X. DETAIL SOLID WASTE GENERATION OF STUDY AREA

The Jetpur city has total 14 sanitation ward. The ward wise waste generation has been calculate

EX: - ward 1 (waste generation rate= 0.338 kg/capita/day)

$$\begin{aligned} \text{Waste generation} &= \text{population} * \text{waste generation rate} \\ &= 7956 * 0.338 \\ &= 2.69 \text{ MTPD} \end{aligned}$$

Table VI Ward wise quantity of solid waste generation in the study area

WARD NO.	POPULATION (as per census 2011)	WASTE GENERATION (MTPD) (population * waste generation rate)
1	7956	2.69

2	7612	2.57
3	8076	2.729
4	9020	3.048
5	10933	3.695
6	7125	2.408
7	6508	2.199
8	8022	2.711
9	6509	2.200
10	10535	3.560
11	8413	2.843
12	8397	2.838
13	11098	3.751
14	8098	2.737
TOTAL = 40 MTPD		

XI. SUGGESTION FOR SCIENTIFIC MANAGEMENT OF MSW OF STUDY AREA

The solid waste collection of the Jetpur town is done effectively but in many rural part solid waste has not been collected effectively. For effective and scientific management of the solid waste in rural, the focus should be on management at house hold level. If the management is not possible at house hold level the management should done at community level. For the scientific management of solid waste following approach should have to be followed:

- Segregation of solid waste at the household level (biodegradable and non-biodegradable).
- Reuse of non-biodegradable waste at the household level to the possible extent.
- Public support has to be increase by educating them which will increase the source separation at generation point as biodegradable, inert and recyclable material.
- Identifying the infamous spots which are prone to waste disposal. Local government has to identify that and educate the people not to throw waste in this empty space.
- Government have to start focusing on door to door collection.
- Various tax has to be implement on solid waste management so that funds for inadequate resource of municipal bodies can be manage.
- For primary collection of waste private agencies and NGOs has to be involved.
- Viable composting plant has to be install so that dependency on landfill is reduced.
- Vehicles which are used for waste collection, transportation and disposal are of specific design and suiting waste characteristics.
- Manufacturing of non-recyclable materials like plastics bags should be banned or any alternative method should be research for manufacturing of biodegradable plastic bags.
- Sanitary landfilling sites needs to be developed instead of open dumping.
- Proper protection of ground water has to provide from leachate because leachate generally percolate from soil and mixed with groundwater.

XII. ADVANTAGES

- Educating people will increase awareness among the society about solid waste disposal and management to understand the importance of better solid waste management.
- Source segregation will help in better handling of solid waste.
- Proper Collection of waste will decrease the amount of waste on streets and also decrease the rate of disease related to it.
- By introducing the tax on solid waste collection, funds can be generated for vehicles so that effective collection and transportation can be done.
- Vermicomposting plant will decrease the load on landfilling and also it will generate useful fertilizer.
- Scientific landfilling site will decrease the amount of leachate generated and protect the ground water from getting polluted and also decreased the level of disease.

CONCLUSION

In many of the rural area of India, proper method for collection and facility for transportation of solid waste is still not there. As the majority of the people are still living in the rural area, Indian government have to take some serious steps to address this problem of solid waste management. The Jetpur town is generating 40 MTPD of solid waste. The waste is disposed of in open at dumping site which has created great problem for public health and environment. The SWOT analysis of the Jetpur town reviled that private sector play pivotal role in managing the solid waste effectively. The lack of government support in managing the solid waste is weakness of

the Jetpur Corporation. The problem of solid waste can be solved by adopting the scientific way of solid waste management. This can be achieved by educating people about the importance of solid waste management, by achieving the source separation of solid waste, by introducing the effective method for collection and transportation of solid waste. In rural area as the major portion is of organic waste, composting facility is a good option for solid waste processing.

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LIST OF ABBREVIATIONS

Abbreviations	Full form
GPs	Gram Panchayats
MTPD	Metric ton per day
RDF	Refuse Derive Fuel
SBM	Swachh Bharat Mission
SI	Sanitary Inspector
SSI	Sanitary Sub Inspector
SWM	Solid waste management
SWOT	Strength Weakness Opportunities Threat