

## Solid Waste Management in Jaipur City of Rajasthan State

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### Abstract

Solid waste management of Jaipur city is a significant issue. The waste shall be collected and transported in segregated form for its better processing and disposal. Under SBM mission, vehicles of vendor BVG India Limited with two separate compartments of dry and wet waste go to households for segregated waste collection. Sources of solid waste are residential, industrial, commercial, institutional, construction and demolition, municipal services, process manufacturing, agriculture and cattle's shed and stable refuse. The recyclable content of waste ranges from 13% to 20%. As per the guidelines given by Ministry of Environment and Forest under Municipal Solid waste (management and handling) rules 2016, there is a provision of generation to disposal of solid waste in most effective and efficient way but the current study shows that those provisions are completely neglected by solid waste generators, community, corporations and transporting agencies in JMC. After analyzing all the functional elements of MSWM i.e. collection, storage, transportation, disposal it is observed that segregation is the missing link. Segregation of waste into biodegradable and non-biodegradable or wet and dry waste is not followed from the generation stage itself, which further makes it really hard for waste collectors to segregate the bulk waste. After the launch of Swachh Bharat Mission, there is a regular door to door collection of waste which has resulted into clean roads, drains but unsegregated waste has made the treatment of waste ineffective. We conclude that solid waste management of Jaipur city has witnessed considerable changes during the studied period.

**Key words:** Solid waste, Jaipur city, SBM mission, BVG India Limited, MSWM, Transportation, Collection, Disposal.

### Introduction

Jaipur, The capital of Rajasthan is one of the best planned cities of modern time in India. It's all around accelerated growth such as population growth, urbanization and industrialization has made a positive impact on society by creating employment opportunities, increasing income level to the individual, technology and infrastructural advancement, improved transportation and communication facilities, quality education, medical facilities etc. on one hand. However it has adverse impact to the environment on other hand by causing gigantic concentrations of people competing for limited resources, overcrowding, decreasing in amount of limited natural resources available to each individual, poor distribution of resources, dwindling of access to fresh drinking water, water scarcity viz., increasing demand for water, reduction of water resources, increasing of pollution of water and decreasing of water quality. This has overall results in over exploitation of natural resources and deterioration of individuals quality of life and standard of living which in turns adversely affect the rich hinterland of Jaipur.

A waste is viewed as a discarded material, which has no consumer value to the person abandoning it. According to World Health Organization, (WHO) the term 'solid waste' is applied to unwanted and discarded materials from houses, street sweepings, commercial and agricultural operations arising out of mass activities.

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## Solid Waste Management in Jaipur City of Rajasthan State

*Kalpana Choudhary & Prof. R. N. Sharma*

Solid waste has become an urban environmental problem due its improper disposal on land. Generation of garbage is related to day to day man's activities. In urban areas, especially in the metropolitan cities, the generation and disposal of solid wastes have also posed threat to human health causing occurrence various diseases (Gupta and Dutta, 1996).

**Table 1: Sources of Waste, Waste Generators and Solid Waste Contents**

Source of waste	Typical waste generators	Solid waste contents
Residential	Organic/Inorganic waste from the single or multifamily houses, colonies, apartments, etc	Food waste, paper, cardboard, plastics, textiles, glass, metals, ashes, special wastes (bulky items, consumer electronics, batteries, tires and household hazardous wastes).
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants.	Paper, cardboard, plastic, wood, food waste, glass, metals, special wastes, hazardous wastes, Oil soaked rags, thermoplastic wastes, chemical refuse including toxic matter
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, hospitals, prisons, government centres	Wastes from hospital wards, cabins pantries, operation theatre wastes, needles ampoules, cotton, gauzes, plaster and Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Construction and Demolition	New construction sites, road repair, renovation sites, demolition of buildings	Earth, asphalt, concrete, dust, wood, glass stones, brick, plaster etc.
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and waste water treatment plants.	Street sweepings, landscape and tree Trimmings, general wastes from parks, beaches, and other recreational areas, sludge
Process (Manufacturing)	Heavy and light manufacturing, refineries, Chemical plants, power plants, mineral extraction and processing.	Industrial process wastes, scrap materials, off-specification products, slay tailings
Agriculture and Cattles Shed and Stable Refuse	Crops, orchards, vineyards, dairies, feedlots, farms and animal wastes	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g., pesticides).

**Source:** National Solid Waste Association of India

## Solid Waste Management in Jaipur City of Rajasthan State

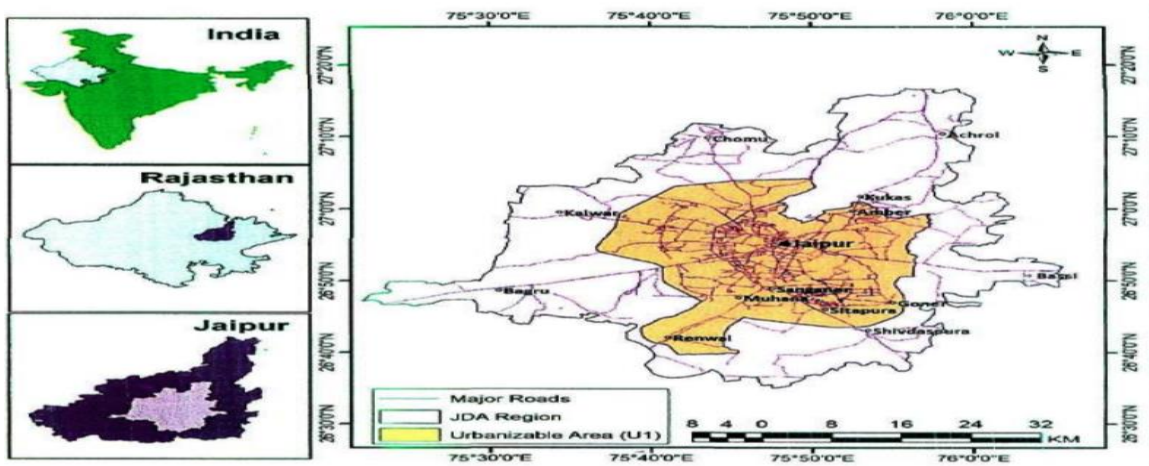
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The study area extends from 26°46' north latitude to 27°1' north latitude and 75°37' east longitude to 76°57' east longitude (jaipurmc.org). The area of Jaipur Municipal Corporation is estimated to be 370.95 sq. km. with its extension from the Amber and Vidhyadhar Nagar in the north to Sanganer in the south and Aadarsh Nagar in the west to Jothwara in the east. Figure 5.1 explains the extension of Jaipur city and the study area. The Jaipur municipal area is divided into 8 zones and 91 wards. Following table gives a brief detail of wards in each zone.

**Wards in Various Zones of Jaipur Municipal Corporation**

Zone	Area (Sq Km)	Wards	Total ward
Vidhyadhar Nagar	69.09	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,23,24,25,79,80,81,82	21
Civil Lines	64.91	15,16,17,18,19,20,21,22, 26,27,28,3,56,57,58,76	16
Sanganer	93.82	35,36,37,38,39,45, 46,47,48,49,50,52	12
Mansarovar	40.40	29,31,32,33,34,40, 41,42,43,44,55	11
MotiDungri	41.79	51,53,54,59, 60,61,62,64,65	9
Hawamahal (East)	22.37	63,66,67,68,69, 70,71,72,73,85,86	11
Hawamahal (West)	6.12	74,75,77,78,83,84	6
Amber	32.45	87,88,89,90,91	5

Source: Jaipur Nagar Nigam



Source: Jaipur Development Authority

**Fig 1: Location map of Jaipur city**

**Solid Waste Management in Jaipur City of Rajasthan State**

*Kalpana Choudhary & Prof. R. N. Sharma*

### Objectives

1. To Access the production of waste in Jaipur city.
2. Reduce pollution effects occur due to waste in Jaipur city.

### Composition of MSW in JMC

The composition of SWM in urban areas generally bears the seasonal effect on it. Figure 2 explains the general composition of MSW in Jaipur. MSW in Jaipur mostly contains 46% of biodegradable waste and about 27% of waste can be considered as combustibles.

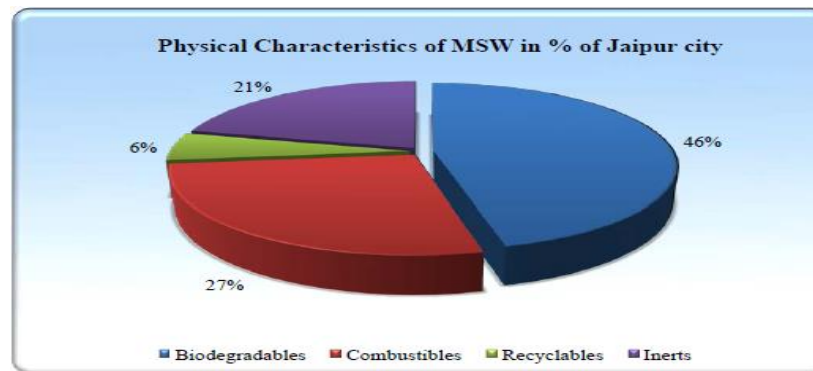


Fig. 2: Composition of MSW

Source: Jaipur Nagar Nigam

### Generation of MSW and Future Projections of Population and MSW Generation

The per capita waste generation of solid waste is strongly correlated to the Gross Domestic Product of a country (Annepu, 2012). The rate of solid waste generation generally increases with the increasing GDP. The average per capita waste generation in India is 370 grams/day as compared to 2,200 grams in Denmark, 2,000 grams in US and 700 grams in China. In India, per capita waste generation rate in western cities was observed to be lower (440 gm/capita/day) than the other parts of the country and even less than the eastern cities with 500 gm/capita/day.

Municipal Corporation of Jaipur estimated the municipal solid waste of city to be about 1600 MT per day with a generation rate of 450 gm/capita/day. Various estimations of per capita waste generation for Jaipur city are compared in Table.

An assessment states that per capita waste generation is increasing by 1.3% per year (CPHEEO, 2016). This rate is observed to be about 1.2% during 2004-2018 for Jaipur. The population of Jaipur city area was about 2.31 Million in 2001 which increased to 3.04 Million in 2011 (Census of India, 2011).

#### Per Capita Waste Generation Rate in Jaipur City

Year	Jaipur City S. No Year	Sources
2004	0.39	CPCB, 2004
2018	0.45	JMC, 2018

Annual average increase in population of Jaipur city was 2.38 percent from 2001-2011 whereas the

## Solid Waste Management in Jaipur City of Rajasthan State

*Kalpana Choudhary & Prof. R. N. Sharma*

rate of increase for previous decade (1991-2001) was about 3.46%. For sustainable future development of the urban centres a comparatively correct estimation of population projections and waste generation is necessary.

**MSW Storage, Collection and Transportation**

As per municipal solid waste management rules 2016, wet waste (mainly biodegradable in nature) is to be placed in covered green bins and dry waste (non biodegradable waste) in a covered blue bin and domestic hazardous waste in separate bin. These practices are generally not being followed in JMC area. However, municipal corporation instructed the commercial establishments to keep at least two type of waste bins for dry (blue) and wet waste (green).

In residential areas, people are storing the waste without sorting, in a single bin. Municipal waste in JMC area was being collected, transported and disposed by Municipal Corporation before it was outsourced to BVG India Limited in 2017.



Waste storage bins at main road of Jawahar Nagar Slum area.



Waste storage bins at Sanganer road Sodala



Waste heaps at Jawahar Nagar slum area



Waste management in Rajasthan University Campus



Waste collection and transportation at Sodala



Waste collection and transportation outside SMS medical hostel

View of Management of MSW in Jaipur City (collection, storage, transportation, disposal)

**Solid Waste Management in Jaipur City of Rajasthan State**

*Kalpna Choudhary & Prof. R. N. Sharma*

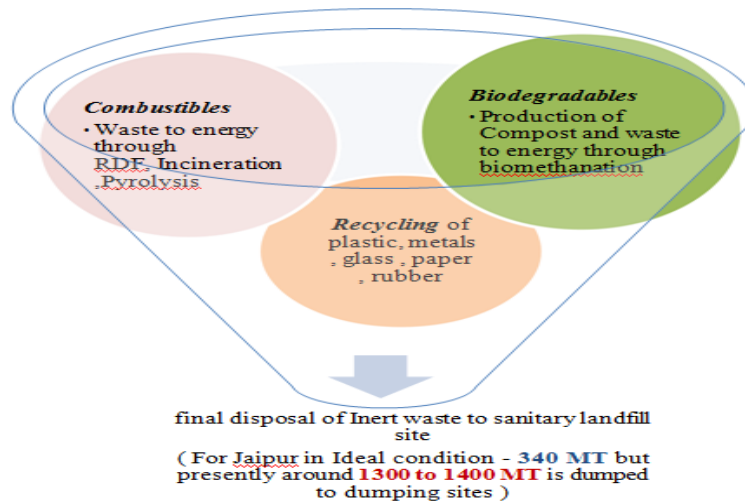
**Processing and Disposal of MSW in JMC**

The waste which has been transported through secondary transport vehicles majorly goes to 4 locations. These are at Mathuradaspura dumpsite, Langariawas RDF Plant, Sevapura dump site and Sevapura composting plant. Other than these, there is one upcoming waste to energy plant with a capacity of 700 MT and one sanitary landfill site is also under process at Langariawas. Processing of municipal solid waste can be done by 2 methods, they are: wet waste processing and dry waste processing. The bio-medical waste shall be disposed of in accordance with the bio-medical waste management rules 2016, the hazardous waste shall be managed in accordance with the hazardous and other waste (management and trans boundary movement) rules 2016, and e-waste in accordance with the e-waste (Management) rules 2016, as amended from time to time. For bio-medical waste separate bio-medical waste treatment plant is in operation. Table shows the composition of total waste generated in Jaipur Municipal Corporation. Biodegradable waste for Jaipur city is approximately 738 MT which can be processed through wet waste composting and bio-methanation. Similarly, 87 MT is recyclable waste and combustible waste is around 433 MT which can be used to create energy through process shown in Figure 3.

**Composition of Total Waste Generated in JMC Area**

S. No	Constituents	Percentage	Municipal solid waste
1	Biodegradables	46.13	738.08
2	Combustibles	27.1	433.6
3	Recyclables	5.46	87.36
4	Inerts	21.31	340.96
5	Total	100	1600

Source: Researcher



**Fig. 3: Solid Waste Management in Ideal Condition.**

Source: Researcher

**Solid Waste Management in Jaipur City of Rajasthan State**

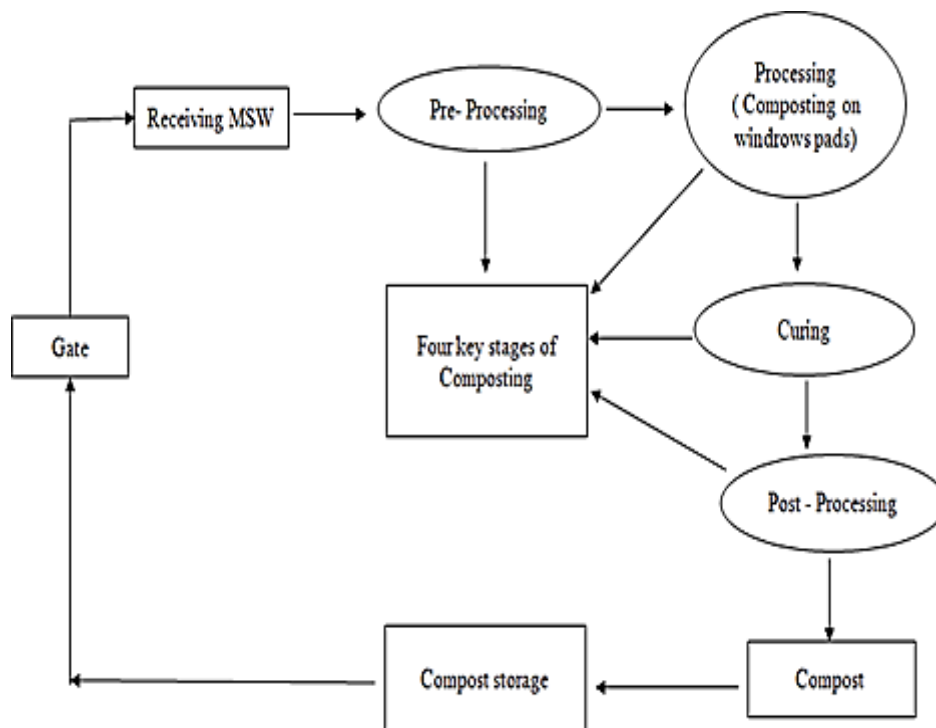
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### Wet Waste Processing

The wet waste processing plant was established by IL & FS on December 29, 2008, with an expected life span of 30 years. This plant is constructed on 'DBOOT' method with a capacity of 250 TPD. The following paragraph explains the processing of the composting plant.

The first step is **pre-processing**; where the waste gets sorted into a size of 100 mm after the manual pre-sorting. The waste of size less than 100 mm is stacked in heaps and sprayed with inoculum and turned periodically to provide proper aeration and temperature control. This process is known as the 'processing' of the waste. Then it passes through the curing process which is necessary to obtain a mature and stable product, and finally to the post-processing which is required to meet quality criteria for sale and distribution of the product. Figure shows the important stages of composting followed at the Sewapura composting plant.

The refined compost is stored in the compost storage area and the same can be bagged manually. The inert materials are sent to landfill. Figure shows in detail the steps of composting followed at Sewapura composting plant Figure 4 the analysis of compost quality for November month of the year 2018. It was observed that the quality of compost suits to the FCO 2017 standards. There are few BGGs installed with the onsite composting machine in Jaipur, along with 51 household composting.



**Figure 4 : Four Key Processes of Composting at Sewapura Site**

Source: IL & FS Composting Plant, Sewapura, Jaipur

This composting plant with a maximum operating capacity of 250 MT/day is the only centralized facility for the total generated 738 MT biodegradable wastes (Table) for Jaipur. Figure5 shows the composting operation carried out at the IL & FS Sewapura composting plant.

## Solid Waste Management in Jaipur City of Rajasthan State

*Kalpna Choudhary & Prof. R. N. Sharma*



**Figure 5: IL & FS Composting Plant at Sewapura (Jaipur)**

The waste collection in an unsegregated way creates many hurdles in working of this plant on full capacity. The other issues faced by this plant include stockpiling of final compost due to fewer sales. This need to be solved by creating awareness about segregation among citizens and at the same time government should initiate some efforts to create awareness among farmers for using this compost in the agricultural field. Government shall extend their efforts to motivate the farmers to use this compost instead of using fertilizers for increasing production. Table compares the requirements of the composting plant in general and present status of the composting plant in Jaipur.

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## Solid Waste Management in Jaipur City of Rajasthan State

*Kalpana Choudhary & Prof. R. N. Sharma*



## Compost quality analysis at Sewapura composting plant

S. No	Parameters	Composition (13-11-2018)	Composition (19-11-2018)	Composition (21-11-2018)	FCO Standards
1	Moisture Content	12.08	17.24	9.17	15.0 - 25.0 %
2	Colour	Dark black to brown	Dark black to brown	Dark black to brown	Dark black to brown
3	Odour	Absence of foul odour	Absence of foul odour	Absence of foul odour	Absence of foul odour
4	Particle Size	98.57	99.68	97.904	Minimum 90% Material should pass through 4.0 mm IS sieve
5	Bulk Density (g/cm <sup>3</sup> )	0.99	0.8	0.97	< 1.0
6	Total organic carbon (% by weight)	12.87	25.41	23.6	12.0 minimum
7	Total Nitrogen (% by weight)	0.93	1.34	1.24	0.8 minimum
8	Total Potash (K <sub>2</sub> O % by weight)	0.88	1.16	0.906	0.4 minimum
9	pH	7.14	6.89	6.65	6.5-7.5
10	Conductivity as dSm <sup>-1</sup>	3.52	2.98	3.69	Not more than 4.0
11	C:Nratio	13.87	18.96	18.99	< 20
12	Total Phosphate P <sub>2</sub> O <sub>5</sub> (% by weight)	0.91	0.89	0.98	0.4 minimum

Source: IL & FS Composting Plant, Sevapura, Jaipur

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## Solid Waste Management in Jaipur City of Rajasthan State

*Kalpana Choudhary & Prof. R. N. Sharma*

**Compliance Status of Composting in JMC in  
Contrast of SWM 2016 Rules**

S. No	Compliance Criteria for Composting	Status in Jaipur
1	Waste storage area with impermeable base and facility for leachate collection. Precautions to minimize nuisance of odour, flies, rodents, bird menace and fire hazards.	IL&FS composting plant at Jaipur fulfill all these requirements.
2	Windrow area with impermeable base. Such a base shall be made of concrete or compacted clay of 50 cm thick having permeability co-efficient less than $10^{-7}$ cm/sec. The base shall be provided with 1 or 2 percent slope and circled by lined drains for collection of leachates.	IL & FS composting plant at Jaipur has the impermeable base with separate leachate collection tank.
3	The end product compost shall meet the standard prescribed under the Fertilizer control order notified from time to time.	The compost generated at IL & FS composting plant at Jaipur lies well within the standard limits of FCO 2017 standards.
4	Phase out of use of chemical fertilizers in 2years from notification of rules and use compost in all parks, gardens maintained by the local body	Though JMC is using some amount of this compost for their parks, this process is required to further strengthen.

Source: Researcher

### **Dry Waste Processing**

One MSW processing has been established at village Langariawas by M/s Grasim Industries in 2005, which is designed to process municipal solid waste at 350 MTPD. This plant produced refuse derived fuel which can be used onsite in boilers and offsite by forming pellets. RDF consist of residual dry combustible fraction of municipal solid waste including paper, textile, rags, leather, rubber, non-recyclables plastic and multilayered packaging shows the RDF plant at Langariawas.

The RDF production line consist of various units in the operation, as shown in Figure 6, to separate unwanted material like big objects, dead animals, stones, glass, metallic scrap and so forth through manual inspection, shredding for size reduction, magnetic separators to separate iron scrap, trammel screening for sieving, ballistic separators to separate glass, stones and further shredding and conditioning to obtain required RDF. From this plant RDF goes to cement factories in Rajasthan and Madhya Pradesh where 10% RDF is used as a substitute of coal in kilns in the cement factories. Figure explains various steps followed in RDF production.

Though plant capacity is 350 MTD but it is not operating in its full capacity because the input material does not come in segregated form due to which there is frequent machinery breakdown which hinder the capacity utilization of RDF plant. Table explains the compliance status of RDF in JMC area in contrast to SWM 2016 rules.

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## **Solid Waste Management in Jaipur City of Rajasthan State**

*Kalpna Choudhary & Prof. R. N. Sharma*

Compliance status of RDF in JMC in contrast of SWM 2016 Rules

S. No	Compliance Criteria for RDF	Status
1	Non-recyclable waste with the calorific value of 1500K/cal/kgs shall not be disposed in land fill. This can be used for energy generation through RDF.	Un-segregated waste collection allows most of such waste to go to dump sites.

Source: Researcher

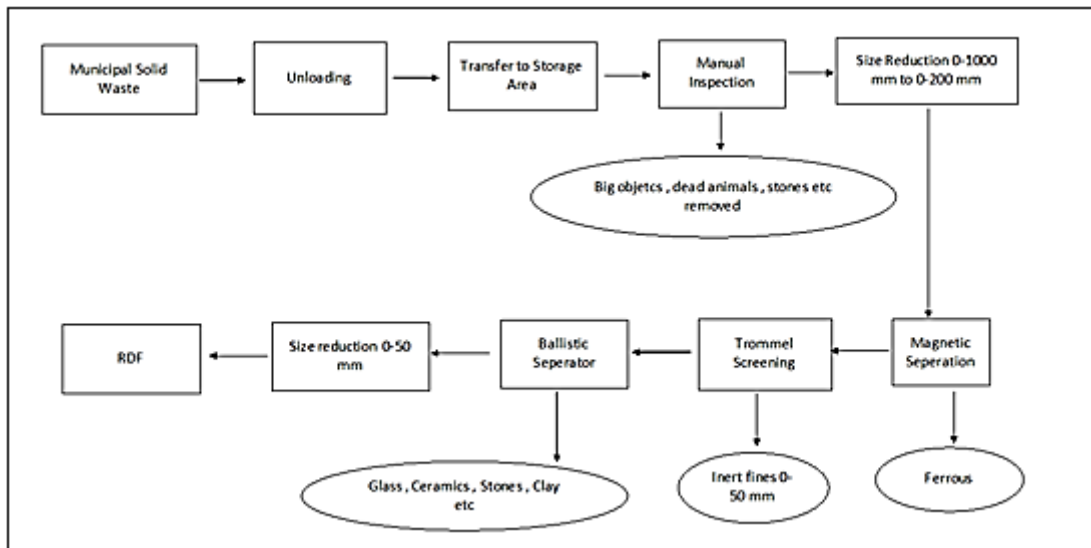


Fig. 6: Process Flow of RDF Production at Langariawas RDF Plant

Source: Langariawas RDF Plant



RDF plant in operation at village Langriawas, Jaipur

Fig. 7

Solid Waste Management in Jaipur City of Rajasthan State

Kalpna Choudhary & Prof. R. N. Sharma

**Duties and Responsibilities of Local Officials**

Table shows the compliance status of duties and responsibilities of local authorities in contrast to SWM 2016 rules.

**Compliance Status of Duties and Responsibilities with Respect to Waste Collection to Disposal of Local Officials in Contrast to SWM 2016 Rules**

S. No	Parameters	Compliance Criteria	Status
1	<b>Collection of Municipal Solid Waste</b>	Door to door collection of segregated Municipal Solid waste from municipal area	Work of door to door waste collection is outsourced to BVG India Ltd.
2		Ensure participation informal sector in solid waste management including door to door collection.	Health section of JMC along with NULM section is engaging the informal sector in the process of waste collection
3		Collection of biodegradable waste on daily basis and promote setting up of decentralized compost and bio-methanation plant.	Waste is being collected on daily basis but number of decentralized composts is very less. No bio-methanation plant has been installed in JMC.
4		Bio-medical and industrial waste should not be mixed with municipal solid waste and this type of waste should be separately disposed of as per the rules specified for the purpose.	There is separate facility for bio-medical waste treatment in JMC though the mixed waste is going at dump sites and bio-medical waste plant.
5		Waste (garbage, dry leaves) shall not be burnt	Frequent events of waste burning can be seen at dumpsites at Sewapura and Mathuradaspora.
6	<b>Segregation of Municipal Solid Waste</b>	Direct the waste generatorsto segregate the waste atsource.	Notifications have been issued in this regard byJMC. Though lack of IEC caused low awareness in Public regarding
7		Establish hazardous waste collection centres for every twenty square kilometres area and notify the timing of receiving domestic hazardous waste at such centres.	Hazardous waste collection points are established in each zone offices. Though the numbers of such points are not in line with rules.

**Solid Waste Management in Jaipur City of Rajasthan State**

*Kalpana Choudhary & Prof. R. N. Sharma*

8		In order to encourage the citizens, municipal authority shall organize awareness programs for segregation of waste and shall promote recycling or reuse of segregated materials.	JMC lack in this section of municipal solid waste management.
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10	<b>Storage of Municipal Solid Waste</b>	Municipal authorities shall establish and maintain Material recovery facility or secondary storage for sorting of recyclable material.	No such facility in JMC area
11	<b>Transportation of Municipal Solid Waste</b>	Vehicles used for transportation of waste shall be covered or not exposed to open environment.	Waste is mostly being transported in dumper truck which litter waste on roads.
12	<b>Transportation of construction and demolition waste</b>	Transport as per the provision of the Construction and Demolition Waste management rules 2016	Facility for collection and transportation of C & D waste is under tendering process. No such facility exists as on now.
13	<b>Disposal of Municipal Solid Waste</b>	Land Filling shall be restricted to non - biodegradable, inert waste	Landfill site is not in use and waste goes to dumping yards.
14		Bio-mining at old open dumpsite and existing operational dumpsite	Work of Bio-mining and Capping of existing and old dump sites are under tendering process.

Source: Researcher

MSWM in JMC: Views of Public and Officials

## Result and Conclusion

### Forecast of Solid Waste Generation

Table depicts projected population and solid waste generation. An annual increment of 1.3% in rate of solid waste generation was used for forecasting solid waste in JMC area. It is estimated that by 2051 the solid waste of Jaipur city will increase by more than three times of existing waste generation.

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## Solid Waste Management in Jaipur City of Rajasthan State

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**Projections of population and solid waste generation in JMC**

S. No	Year	Population (in Millions)	Rate of SW Generation (Kg/capita/day)	Solid Waste in MT
1	2018	3.50	0.45	1574
2	2028	4.40	0.49	2154
3	2038	5.52	0.60	3310
4	2051	7.31	0.69	5041

Source: Researcher

### Conclusions and Suggestions

As per the guidelines given by Ministry of Environment and Forest under Municipal Solid waste (management and handling) rules 2016, there is a provision of generation to disposal of solid waste in most effective and efficient way but the current study shows that those provisions are completely neglected by solid waste generators, community, corporations and transporting agencies in JMC. After analyzing all the functional elements of MSWM i.e. collection, storage, transportation, disposal it is observed that segregation is the missing link.

Segregation of waste into biodegradable and non-biodegradable or wet and dry waste is not followed from the generation stage itself, which further makes it really hard for waste collectors to segregate the bulk waste. After the launch of Swachh Bharat Mission, there is a regular door to door collection of waste which has resulted into clean roads, drains but unsegregated waste has made the treatment of waste ineffective.

The amount of waste generated in Jaipur city is approximately 1600 MT per day. Most of the waste is directly dumped to the open dumpsite at Mathuradaspora and Sevapura which degrades the quality of soil and groundwater and also poses risk to human health and environment. Due to rapid population growth and economic development in the city there is a substantial increase in the waste generation in the last few years. The collection efficiency of waste is around 90% of the total waste generated. However, in general the JMC doesn't has any strong SWM policy, lack of which the goal of 'waste to wealth' seems unachievable. The present status of SWM in JMC is not in good shape and lot of efforts and willingness of incorporating new technologies is required both from the waste producers and the managers. In JMC, 3R approach is missing, as involvement of waste producer (to reduce and reuse the waste) and informal sectors (reuse and recycle) is not as per requirement.

As per SWM rules 2016, there should be the state policy and strategy for solid waste management plan developed by the urban department of state, in absence of which in Rajasthan most ULBs including Jaipur do not strictly follow the SWM rules. The user charges are not being collected in JMC due to unwillingness of political leadership. This makes the JMC dependent on government for funds which eventually causes lack of ownership and interest of residents/waste generators. Payment of the contractor/vendor working in JMC for waste collection and transportation is linked with the waste quantity (weight) and not with the quality of work which eventually reflects in transport of unsegregated waste. This hampers the processing of waste and causes financial loss to the JMC. The

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## Solid Waste Management in Jaipur City of Rajasthan State

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timeline frame mentioned in MSW rules 2016 is not followed by JMC and other agencies in state which is putting negative effect on waste management and eventually harming the environment and health of residents of ULBs.

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