

Physical Characterisation and Management of Solid Waste of Rajsamand City

Parth Samdani¹, Dr. M.P. Choudhary²

¹M. Tech. Environmental Engineering, UCE, RTU, Kota, Rajasthan, India

²Associate Professor, Department of Civil Engineering, UCE, RTU, Kota, Rajasthan, India

Abstract: Disposal of solid waste is one of the major environmental problems of most of the Indian cities, therefore municipal solid waste management is an emerging concern in major cities of India, including Rajsamand. Solid waste is a major environmental problem created and faced by the modern society. However, solid waste management is amongst the most poorly rendered services and negligence towards it causes environmental pollution and health hazards. Rapid urbanisation and growth in population has made the situation worst.

The solid waste management approach in most of the Indian cities, including Rajsamand (Rajasthan), is extremely inefficient, using old and obsolete system for storage, collection, processing, treatment and disposal. Land filling is one of the most widely used municipal solid waste (MSW) disposal methods worldwide. It is the necessary part of an integrated solid waste system, since all waste treatment processes have residues that cannot be further reused or recovered and are eventually land filled. The data concerning to SWM in Rajsamand city were obtained through questionnaire, individual field visit and record of municipal council. The study reveals that the present system of MSWM in Rajsamand city is not satisfactory according to Municipal Solid Waste (Management & Handling) Rules 2000.

Key words: Solid Waste, Storage, Processing, Recycling, Treatment, Disposal, Land filling.

I. INTRODUCTION

Solid waste is defined as the waste arising from domestic, commercial, industrial, institutional and agricultural activities. Waste (or garbage) is any material, non-hazardous or hazardous, that has no further use, and which is managed at recycling, processing, or disposal sites. The disposal of solid waste is one of the major environmental problems of most of the Indian cities. Problem associated with solid waste began with the dawn of civilization when humans started coming together in communities. This problem continues to grow with the growth of population, rapid urbanization and development of industries. Municipal solid waste management (MSWM) encompasses activities in which materials are identified as either being of value and are either thrown away or gathered together for disposal. Solid waste management includes the entire process of dealing with solid waste, starting from the collection from the primary source to ultimately disposing off it hygienically, so that it may not be a nuisance or create any harmful effect on society. The solid waste management involves, management at waste generation level, storage at the

source of generation, primary collection, street cleansing, temporary storage at locality level, regular and periodic transportation of this temporarily collected waste to disposal sites and treatment plants.

Classification of Solid Waste

Solid wastes are the organic and inorganic waste materials such as product packaging, grass clippings, furniture, clothing, bottles, kitchen refuse, paper, appliances, paint cans, batteries, etc., produced in a society, which do not generally carry any value to the first user(s). Solid wastes, thus, encompass both a heterogeneous mass of wastes from the urban community as well as a more homogeneous accumulation of agricultural, industrial and mineral wastes. While wastes have little or no value in one setting or to the one who wants to dispose them, the discharged wastes may gain significant value in another setting. Knowledge of the sources and types of solid wastes as well as the information on composition and the rate at which the wastes are generated or disposed off is, therefore, essential for the design and operation of the functional elements associated with the management of solid wastes.

Problems Associated with Solid Waste Management

- In most of the cities in India, the scientific and systematic storage of waste at source is not in practice.
- The waste is normally thrown in nearby vacant areas, government vacant land, drains, streets etc.
- Because the waste is thrown on streets the environment becomes ugly and unhygienic, so even in case of regular cleaning by Municipal Workers also, the city cannot be kept clean for more than 2-3 hours.
- At waste generation sources people generally don't arrange to provide proper dustbins, in residential, institutional and commercial areas.
- In case of open drains and large drains passing across the city, people throw waste and these drains are clogged, width of large drains are reduced because of continuous dumping
- People generally don't take the waste to the designated points. They carry it to nearby roads, railway tracks,

open plots etc and generally people avoid walking to the designated disposal points. So when wind blows the heap of solid waste get carried away by wind and spread in large areas and when there are rain the problem get aggravated.

- There is no system of keeping the Bio degradable and non Bio degradable waste separately
- No processing of waste is done in most of the cities. Very few cities have the organizational and administrative set up to subject the waste to treatment process like composting and that too on a very limited scale. Most of the wastes are disposed by the concerned agency at an open dump without going into the details of either site or wastes. There is no adherence to any standards or norms for disposal and the sites is not scientifically managed.
- The land filling practice in most Indian cities is one of the most unscientific and unhygienic practices with serious environmental implications. The wastes are brought to the site and dumped. There are no consideration for leachate and gases. The landfill sites are mostly accessible to scavengers, animals and vectors.

Solid Waste Disposal

Information on waste generation is important to determine the most suitable waste disposal options. Improper waste disposal may cause pollution. The main purpose in implementing best practice for solid waste management is to prevent pollution. Pollution is a threat to human and other living organism. It may also damage the ecosystem and disrupt the natural cycle and climate on earth. Despite the development of many waste disposal option, landfills remain the most prominent system applied worldwide. Incineration has been the choice for developed country as they have sufficient financial input and are looking into energy recovery from waste. However, many of the countries prefer waste minimization compared to waste treatment such as landfill or incineration.

II. LITERATURE REVIEW

Human activities have always generated waste. This was not a major issue when the human population was relatively small, but became a serious problem with urbanisation. Some of the direct health impacts of the mismanagement of waste are well known and can be observed especially in developing countries, Giusti [1]. Management of municipal solid waste is a major problem for most of the Indian cities due to the growing urban population and per capita waste generation rate, inadequate public participation and the deplorable organizational and financial capacities of urban local bodies, Joseph et al., [2]. Solid waste management has become one of a major concern in environmental issues, Mazzanti & Zoboli, [3]. This is particularly true to urban areas where population is rapidly growing and amount of waste

generated is increasing like never before, Kathiravale & Mohd Yunus, [4]. Urbanization contributes enhanced municipal solid waste (MSW) generation and unscientific handling of MSW degrades the urban environment and causes health hazards, Joshi and Ahmed, [5]. Moisture, nutrients and temperature are the most important factors that influence the growth of fungi on building materials, Rajasekar et al., [6]. Investigations for fungal contamination near different waste dumping sites and the health risk factors of rag pickers associated with collection of waste in Gwalior indicated that all the dumping sites are contaminated with different types of fungal pathogens, Sharma et al., [7].

The management of waste become complex and the facilities provided cannot cope with the increasing demand and needs. Therefore, best approach need to be implemented immediately while considering environmental, social and economic aspects, Aye & Widjaya, [8]. The drivers of sustainable waste management were clarified by Agamuthu et al. [9] which include human, economic, institutional and environmental aspect. The study suggests that each driving group should be considered in local context as managing solid waste for a particular society may differ from the others. Some of the countries are having specific national policy on solid waste management, some others experience problems such as increasing urban population, scarcity of land, services coverage area, inadequate resources and technology, and so on, Shekdar, [10]. Solid waste management in low and middle-income countries has a lot of potential for improvement. Understanding how a specific decision choice towards improvement will match to enabling local conditions and thereafter impact on the local context, is crucial when identifying the most sustainable solutions, Zurbrügg et al. [11].

III. METHODOLOGY

This is concerned mainly on the methods employed in data collection of the necessary information regarding solid waste management in Rajsamand city.

Collecting the Sample

The tipper of municipal council was used for sample collection from all the ten transfer stations. The vehicle (tipper) was weighed prior to sample collection so that the total weight of the collected sample can be obtained. Having collected the sample, the collection vehicle is driven back to the weighbridge and the weight of vehicle plus sample recorded. The weight of the total sample was obtained prior to sorting. The sample was brought to a covered shed of adequate size for sorting.

Reducing Sample Size

The sample should be reduced to a more manageable size as the actual classification of materials will be carried out by hand. The ideal sample size for characterisation is between

100 - 200 kg (minimum 100 kg) and the size reduction is achieved by a Coning and Quartering technique.

Two important variables in designing a sample are sample size and methods of characterizing refuse. The solid waste samples collected from the different locations and wards of the Rajsamand city were collected, mixed and one Kg sample was prepared by using quartering method. The waste was then characterized at College of Technology and Engineering (CTAE), MPUAT, Udaipur (Raj.).

IV. RESULTS AND DISCUSSION

Physical Characteristics

The waste was characterized to determine density, moisture content, percentage of Recyclable material like Paper, Rubber/Leather, Glass, Metals, Compostable Matter and inert material and the percentage of each constituent was calculated and tabulated in Table 1 and Table 2.

TABLE 1. Density and Moisture Content

S. No.	Location	Density, Kg/m ³	Moisture Content %
1.	Raj Nagar	470	24.87
2.	Kankroli	484	23.98
3.	Dhoinda	479	25.03
4.	Javad	467	27.12
5.	Sanwad	489	24.69
6.	Gadariyawass	458	24.48
7.	Koyad	482	26.23
8.	Gudali	493	24.81
9.	Aasotiya	491	25.88
10.	Hathinada	464	26.81

Density

It is expressed as mass per unit volume (kg/m³). This parameter is very important for designing a solid waste management program. A composite sample of MSW collected from different transfer stations should be taken in the smaller 1 ft³ box and weighed with the help of a spring balance (capacity 50 Kg). After weighing, contents of this smaller box (1 ft³) should be emptied into the bigger 1 m³ box. This is repeated until the larger box is filled to the top. Once the larger box is filled, the weight of the waste is noted. The waste should not be compacted by pressure. Repeat the entire procedure thrice and take the average weight.

Moisture Content

Moisture increases the weight of the solid wastes and therefore the cost of collection and transport increases. Consequently waste should be insulated from rain or other water source. Moisture content is critical determinant in the economic feasibility of waste treatment by incineration. During incineration energy must be supplied for

evaporation of water and raising the temperature of vapour. For optimizing moisture content, 20 gm of sample was taken in an aluminium box and kept in digital oven at 105°C for 24 hours till constant weight is achieved. Loss in weight (in gm) of the sample was used to calculate the percentage of moisture content in sample.

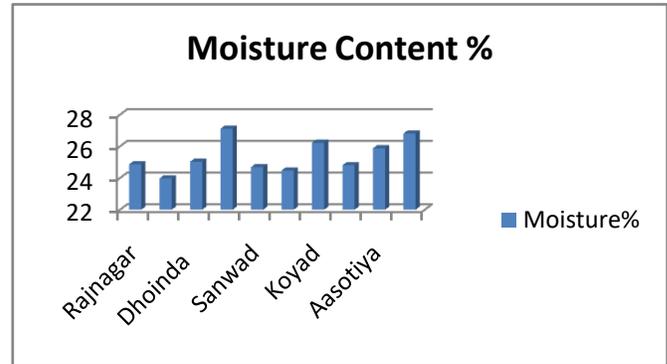


Fig. 1 Moisture Content of Solid Waste at Various Transfer Stations

A reduction in volume by 75% is achieved through normal compaction equipment, so that an initial density of 100kg/m³ may readily be increased to 400 kg/m³. Significant changes in the density occur as waste moves from sources to disposal site, as a result of scavenging, handling, wetting, and drying by the weather and vibration during transport. Density is critical in the design of sanitary landfill as well as for storage, collection and transport of wastes. Efficient operation of landfill requires compaction of wastes to optimum density

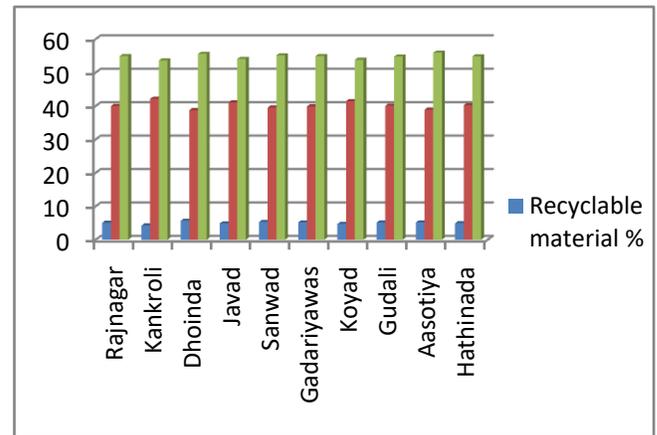


Fig. 2 Composition of Solid Waste at Various Transfer Stations

Table 2. Physical Characteristics of Solid Waste in Rajsamand City

Recyclable material %					Total Compostable Matter %	Inert %
Paper	Rubber/Leather	Glass	Metals	Total	54.93	40.04
2.85	0.87	0.63	0.68	5.03		

Waste Generation and Composition

As per the data provided by the municipal council, Rajsamand, the total quantity of waste collected per day is 27 metric tonne and the total quantity of waste which is disposed of at landfill site is 21 metric tonne per day. The composition of solid waste is as follows: Organic-54.77 %, Inorganic - 40.21 %, Plastic and Rubber etc. -5.02 %

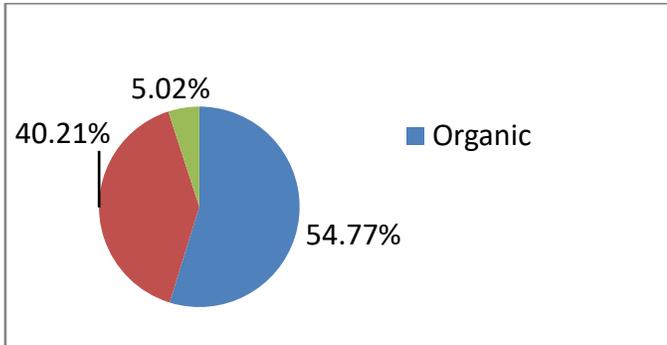


Fig. 3 Composition of solid waste

The collection of waste is the responsibility of the municipal council. The efforts to organize house to house collection are just started in Rajsamand city. At present in 14 wards whole area and in 7 wards partially area is covered under house to house collection system by municipal council. In Rajsamand city the total quantity of waste collected per day is 27.0 MT and total quantity of waste disposed at landfill is 21.0 MT per day. So a fraction of 6.0 MT remains untransported. The collection efficiency is the quantity of waste transported from streets to disposal sites divided by the total quantity of waste generated during the same period.

Cleaning Equipment

Long handled brooms are given to each sanitary worker for street sweeping. The equipments given to them are neither sufficient in quantity nor in quality in terms of improving work with efficiency and effectiveness. Street sweeping is done manually and main roads by road sweeping machine. The equipment used by sanitary workers continues to be of old age and no improvement has been introduced in the basic cleaning equipment, this definitely is one of the major reasons for low efficiency of sanitary workers. The concept of protective clothing like gloves, masks, raincoats & gumboots etc just does not exist. Resultantly the lowest level of workers continues to operate in unhealthy and unhygienic condition.

Storage of Waste at Source

Appropriate storage of waste at source of generation is the first necessary step towards effective solid waste management. It was observed that very few numbers of households have personal bins. Others throw the waste in the street as and when generated. Only few people go to the container if it is available nearby to dispose of the waste. It was found that schools, hotels, factories, hospitals, bus stand & railway station have their owned bins. In view of this prevailing situation, it is of utmost importance that people are first educated on the significance of maintaining bins at the

source of waste generation before other inputs are given. In fact, residents suggested that the municipality should make the bins compulsory for each establishment.

Primary Collection of Waste

It is the most labour intensive task and has been identified as a key problem area by the municipal council of Rajsamand. Primary collection of waste involves two components, first is the collection of waste from households and other establishments & the second is the removal and collection of waste from the roads. It is the second part that the municipal council considers main bottle neck in the system. Since there are no bins available at short distance, in major part of the town, people have no other alternative but to throw the waste on streets. During street sweeping, the waste is collected in heaps. In most of the town, due to lack of trolleys/ handcarts, the waste does not get lifted and over a period of time, heaps grows in size. In other cases, waste is lifted in trolleys or handcart. It is either carried to the containers or to the open dump area whichever is nearer.

Waste is thrown either directly or else wrapped in polythene bags or disposed off either in an open plot, street, back lane or drain. In most cases, women are responsible for disposing of waste. Unlifted waste stinks & attracts cattle and pigs. People do not prefer to keep private cleaners because they find it convenient to throw the waste nearby in vacant plots, open dumps, streets or drains. Moreover, they feel it is useless to pay to the private cleaners for waste disposal since they (private cleaners) too are going to dispose of the waste here & there only. However, in certain areas, private cleaners are hired for cleaning of streets and drains. They earn Rs 20 to 40 per month and one chappati per day.

It was very encouraging to note that most of the households covered under the study are inclined to separate the waste in two different consultations with the local people revealed that they are ready to hire the services of private cleaners provided there is a proper system of waste disposal that doesn't create insanitary conditions. Most of them are willing to pay Rs 20 to Rs 40 per month, provided the private cleaner are regular and throws the waste in the nearest container. People also suggested that they are willing to form users committees to monitor the sanitation work in their surroundings & also to manage the colony level waste management. People also indicated that any system of solid waste management that is put in place must integrate with the municipal council of Rajsamand.

Collection Routes

The waste collection system usually consists of a number of containers located at the sources of waste generation, a fleet of collection vehicles, and if the distance to the treatment facility is long a number of transfer stations. For optimum collection economy it is important to minimize the amount of driving necessary for servicing all collection points. Computer

based optimization of routes and pickup points should be used in collection planning. Determination of the best route layout should be done by trial and error approach where several combinations are proposed based on information on waste quantity, topography, etc. The most promising route combinations should then be tried out in the collection area to determine optimum route layout.

Transfer Stations

The use of a transfer station and larger capacity vehicles for long distance transport between the transfer station and the disposal facility can improve collection economy. In Rajsamand city the waste is unloaded from the collection vehicles directly onto the ground of the transfer stations. A bulldozer is then used to load it onto the larger long distance vehicles. A slightly more advanced design involving two levels should be used in which the collection vehicles enters on the upper level and unload the waste directly into the containers of the long distance vehicles located on the lower level. The transfer stations which were identified during the course of data collection include the following:- Rajnagar, Kankroli, Dhoinda, Javad, Sanwad, Gadariyawass, Koyad, Gudali, Aasotiya, Hathinada.



Fig. 4 Raj Nagar transfer station

Disposal of Solid Waste

The most innovative mechanisms of waste disposal are composting and waste to energy but the most popular, acceptable and recommended method for ultimate disposal of MSW is sanitary land filling. It is a necessary component of SWM, as all other options produce some residue that must be disposed of through land filling. The decomposition and stabilization of the organic waste by biological action forms the basis of composting.

Composting

All organic / biodegradable waste collected from households, shops, markets, hotels and other establishments shall first be composted by following suitable methods of composting with or without power generation. Only rejected and domestic hazardous waste shall be carefully land filled. All local bodies shall arrange for composting of all biodegradable waste by following

any (Vermi composting, Windrow composting, Aerated static pile composting, Anaerobic composting) process of composting of waste found suitable under local conditions.

Recycling by Informal Sector

In Rajsamand, large number of waste pickers earns their livelihood from waste picking from streets or waste dumps. The waste pickers pick about 10% of total waste produced in the city. Besides the waste pickers there are several waste purchasers who move from house to house for buying reusable materials. The informal survival strategies on which they depend are paper, plastics, iron and tin scraps, glass bottles, metallic items and rags. Women, children and men are involved in this sector. They start there day at 6A.M. in the morning and come back at 6 P.M. in the evening. They go to open dumping sites (transfer stations) to collect the recyclable waste.

Open Dumping and Sanitary Land Filling

Open dumping in low lying areas is the most common method of waste disposal in Rajsamand.

These sites are not permanent in nature. The sites keep changing according to the municipal staff and also contractor's convenience and requirements. Unhygienic and insanitary conditions prevail on dumping sites. This is not only creating surface pollution but also contributing to water pollution. In addition, one dumping site at Sanwad is also there which is at a distance of 7 km from the city.



Fig. 5 Heap of solid waste at land fill site

V. CONCLUSIONS

- From the findings of the study, it can be summarised that the systems and the methods employed by the municipal council to manage solid waste have not completely controlled its disposal. The system has not conformed to the minimum requirement of municipal solid waste (Management & Handling) rules 2000 and has not been operated economically, efficiently and effectively. As a result this has hindered efforts by the council in recent years to enhance cleanliness in the area. Waste prevention

remains weak; several illegal dumpsites have also sprung up in the area. Municipal council is trying its best to involve all the stakeholders in its efforts to make a clean Rajsamand city and healthy place to live in. Work order for Design, Construction, Operation and maintenance of processing facility at Rajsamand city has been given to Durga Impex, Udaipur.

- The disposal of wastes by open dumps is not effective; this is indicated by a number of illegal dumps in the area. Most residents are not aware of alternative solid waste management systems like composting. Some residents burn their waste to reduce the volume of waste. Although the gases produced are pollutants, this method rids the area of solid waste heaps for a period of time before the waste accumulates again.
- Residents and business owners do not put into practice solid waste management laws. Without comprehensive legal framework, solid waste management practices cannot be fully effective. The enforcement of the solid waste laws, acts and by-laws by the police and council officials through prosecution of offenders is not being carried out
- From the survey and verbal interview it was discovered that most of the people do not have the basic solid waste management skills; this has caused a lot of negligence from the public. The municipal council should launch an education and communication campaign informing the residents about the importance of solid waste management to the public health and also environment. This can be done by distributing pamphlets in a language that the residents are versed with. This pamphlet shall highlight basic solid waste management skills and the advantages of an effective solid waste management system.
- At the household-level proper segregation of waste has to be done and it should be ensured that all

organic matter is kept aside for composting, which is undoubtedly the best method for the correct disposal of this segment of the waste. In fact, the organic part of the waste that is generated decomposes more easily, attracts insects and causes disease. Organic waste can be composted and then used as a fertilizer.

REFERENCES

- [1]. L. Giusti, "A review of waste management practices and their impact on human health." *Waste management*, **2009**, 29, 2227-2239
- [2]. Kurian Joseph, Rajendiran, S., Senthilnathan R. and Rakesh, M. "Integrated approach to solid waste management in Chennai", *The Journal of Material Cycles and Waste Management*, **2012**, 14 (2), 75-84
- [3]. Mazzanti, M. and R. Zoboli. "Waste generation, waste disposal and policy effectiveness: Evidence on decoupling from the European Union." *Resource, Conservation, Recycling*, **2008**, 52, 1221-1234
- [4]. Kathiravale S, Muhd Yunus MN., "Waste to wealth." *Asia Europe Journal*, **2008**, 6(2), 359-371
- [5]. R. Joshi and S. Ahmed, "Status and challenges of municipal solid waste management in India: A review," *Cogent Environmental Science*, **2016**, 2, 1139434
- [6]. Rajasekar A. Balasubramanian R. "Assessment of airborne bacteria and fungi in food courts", *Building and Environment*, **2011**, 46 (10), 2081-87
- [7]. Harandra, K. Sharma.; Khurheed Ahmad Wani.; Aakash Ahmad Bhat, "Effects of occupational exposure on the health of rag pickers due to fungal contamination at waste dumping sites in Gwalior (India)," *Iranian Journal of Health, Safety and Environment*, **2017**, 4(2)
- [8]. Aye, L., Widjaya, E.R., "Environmental and economic analyses of waste disposal options for traditional markets in Indonesia", *Waste Management*, **2006**, 26, 1180 – 1191
- [9]. Agamuthu, P., Fauziah, S. H., Kahlil, K. "Evolution of solid waste management in Malaysia: impacts and implications of the Solid Waste Bill", *Journal of Material Cycles and Waste Management*, **2009**, 11, 96-103
- [10]. Shekdar Ashok, V. "Sustainable solid waste management: An integrated approach for Asian countries", *Waste Management*, **2009**, 29(4), 1438-1448
- [11]. Christian Zurbrugg, Marco Caniato and Mentore Vaccari, "How Assessment Methods Can Support Solid Waste Management in Developing Countries- A Critical Review", *Sustainability Review*, **2014**, 6, 545-570 ISSN 2071-1050