

Municipal solid waste management in Varanasi, India

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Abstract

Solid waste management is one of the major environmental challenges in India due to rapid urbanization and population explosion. Changing life style patterns, particularly in urban areas has led to increase in generation of municipal solid waste and also the waste composition. In Indian cities the proportion of organic matter in solid waste ranges between 40-60%. Windrows composting and biomethanization are the most suitable cost effective method for disposal of biodegradable waste. In the present study the existing state of solid waste management in Varanasi city has been reviewed for identification of major factors that affects the efficiency and end product recovery from waste. The present waste collection and processing efficiency of Varanasi is 95.88%. The existing processing plant can process 600 TPD mixed waste and 15 TPD organic wastes. The transportation of mixed waste cause health and sanitation related problems in urban area and also affect the quality of compost. Therefore it can be concluded that improvement in infrastructure for segregated waste collection and transportation is required to improve the quality of compost and its sale. This will also improve the financial health of Municipal Corporation

Keyword : Urbanization, Organic Matter, Windrows Composting, Biomethanization, Biodegradable Waste

1. Introduction

Rapid urban development and population explosion in India has led to generate thousands of tons of solid waste daily [1]. Inadequate vehicles for transportation of waste and unavailability of suitable land for establishment of waste processing unit in urban area have developed a critical situation for management of solid waste [2][3]. Disposal of waste on the streets, drains, open spaces, water bodies, etc., causing adverse impact on all components of the environment and human health. As per MSW Rule, 2016 it is an obligatory duty of municipal authorities to develop scientific landfill for disposal of municipal solid waste (MSW). Poor financial status of municipal corporations in India causes difficulties in providing the desired level of public services in the urban centers [4][5]. Therefore proper infrastructure and financial support is required for the management of MSW. The present case study aims to determine the current status of solid waste management in Varanasi. The study includes analysis of daily waste generation, waste composition, collection & transportation infrastructure and the existing waste processing facility. This study will be useful for Municipal Corporation to strengthen the performance of solid waste management.

2. Material and method

2.1. Study area

Varanasi is a city on the banks of the river Ganga in Uttar Pradesh. It is a pilgrimage place and a holy site for sacred baths in the river Ganga. As per census 2011, there are 1.91 lakh households in Varanasi with nearly 11.98 lakh population. Daily flow of tourists and pilgrims from all over the world to the city is constantly increasing city population from decade to decade. Varanasi city is geographically located at latitude and longitude of 25.2820° N, 82.9563° E with an elevation of 80.71 meters from the sea level[6][7]. The solid waste management system of Varanasi city is being managed by Varanasi Municipal Corporation (VMC). The municipal area of VMC is 82.1 km², which is divided in 90 administrative wards for management of basic services to citizens [8].

2.2. Data collection

The daily solid waste collection, transportation and processing related data were collected from health and transport department of VMC. The data regarding population is obtained from Census department, Varanasi. The collected data were analyzed to measure the efficiency of collection, transportation and processing using MS Excel 2010.

3. Result and Discussion

3.1. Quantity of Waste Generation

The per capita waste generation in the Indian cities ranges between 0.2 and 0.6 kg per day [9]–[11]. However, changes in lifestyle due to growth in economy and rapid urbanization have resulted in increasing per capita waste generation by about 1.3% per year [12][13]. The average waste generation of Varanasi is 0.50 kg per capita per day. The city at present generates 645 MT of waste per day at the rate of 0.50 Kg per capita per day and decadal population growth of 10% (Table-1) [14]. Another researcher have also reported 650 TPD waste generation in Varanasi [15], [16]

Table-1: Waste Generation

Year	Population	Waste generation	
		@ per capita per day	Based on Population MT/Day
2011	1198491*	0.45	539.32
2018	1284945#	0.50	642.47

* As per census data, # @ 10% decadal population growth

3.2. Characteristics of waste

Solid waste is generally classified in three major categories i.e. biodegradable, recyclable and other. As per Solid Waste Management Rules, 2016 (“MSW Rules”) biodegradable waste includes flower waste, garden waste, fruit waste, vegetable waste, food waste, cattle waste etc [17]. Recyclable waste includes plastic, glass, polythene, metal, paper etc [18]. Other category includes biomedical waste, sanitary napkins, slaughter waste, electronic waste, construction & demolition waste etc [19]–[21]. In that, the waste can be categorized by physical characteristics such as organics, paper, plastic, glass, metal, cloths and other residual wastes.

Waste characterization of Varanasi shows 51.25% biodegradable waste, 15.30% recyclable waste and 33.45% other waste. Recyclable category includes Paper (32.80%), polythene (25.60%), plastic (7.30%), glass (5.70%), metal (5.80%) and others (22.80%) [14].

Similar Varanasi based study on characterization of municipal solid waste showed food waste (31.90 %) plastic (22.00%), textile (10.60%), paper (9.60%), glass (6.70%), cardboard (6.20%), ash (5.30%), leather (5.70%) and metals waste (2.80%) [16]. Fig. 1a shows the composition of MSW of Varanasi and figure-1b shows composition of recyclable waste.

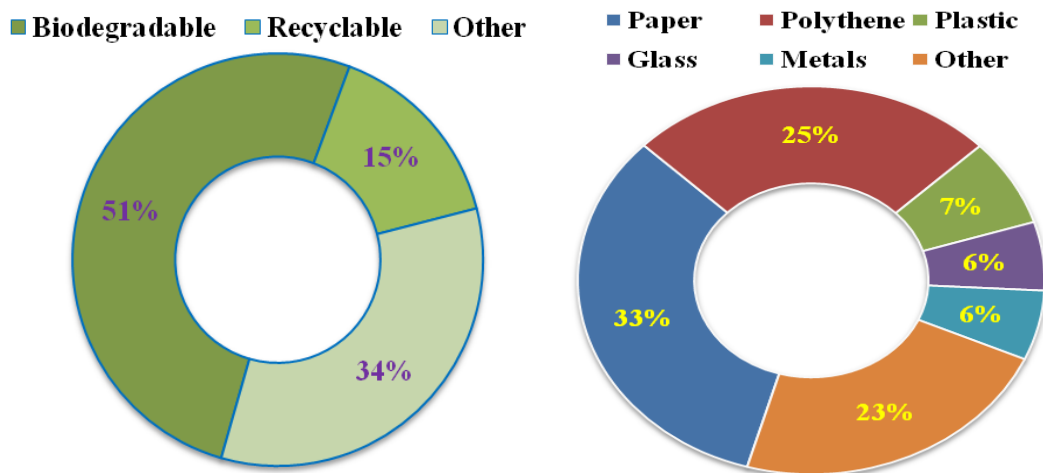


Figure-1a and 1b: Composition municipal solid waste

3.3. Waste Collection System

Door to door waste collection is functional in all 90 wards of Varanasi using hand carts, and rickshaws, auto trippers and four wheelers Tata Ace. Waste collected from total 2,13,450 households are transferred to roadside bins or nearby secondary storage point (Table-2) [14].

Table-2: Details of secondary waste storage facilities

Sr. No.	Type of secondary waste storage facility	Number
1.	Secondary waste storage points	30
2.	Plastic containers 1.1 m ³	750
3.	Metal containers 2-5 m ³	90
4.	Metal containers above 5 m ³	1550

Table-3: Details of vehicles used for waste transportation

Sr. No.	Type of vehicles	Number
1.	Refuse Compactor	24
2.	Tata Ace	72
3.	Dumper	28
4.	Dumper placer	8
5.	Tractor	27

Waste from roadside bins are collected by refuse compactor and transported to disposal site. Similarly waste from secondary storage points are collected by dumper placer and transported to disposal site (Table-3) (Figure-2). Presently 30 secondary waste storage points are operational in Varanasi. Similar observation made by other researcher also [15], [16], [22].

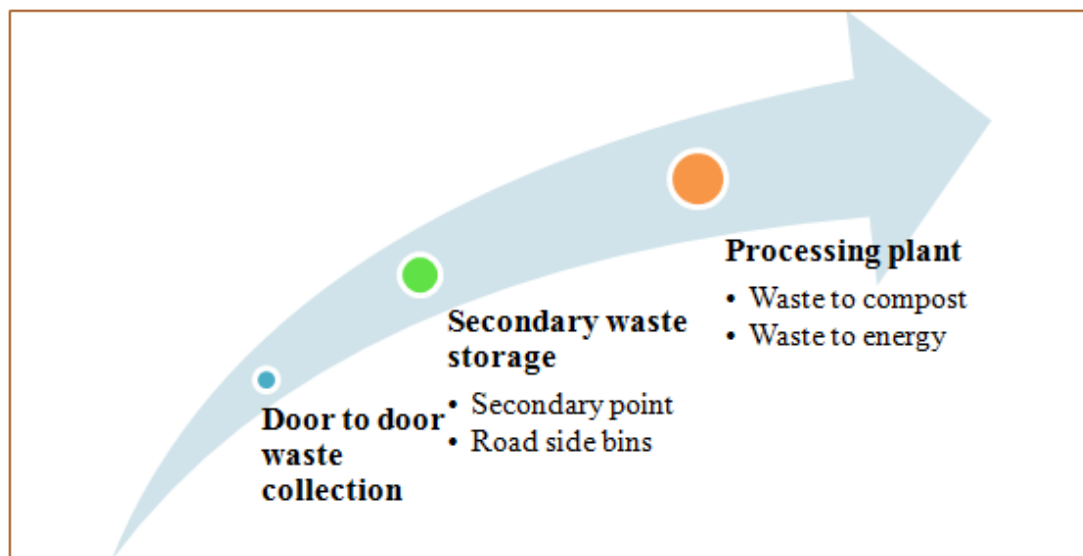


Figure-2: Flow sheet of waste collection and transportation

3.4. Waste Disposal System

Composting and waste to energy is a simplest way to restore compost and energy from MSW. Aerobic composting with windrows method is a cost effective method for waste processing that results compost as end product [23][19]. Waste to energy is a biomethanization based anaerobic method which produces both methane gas and digested sludge. Methane gas can be used to produce electricity and digested sludge can be used as soil amendment [12], [24]. Several researcher have also reported the beneficial effect of both the methods of waste processing [25]–[30].

Table-4: Details of waste processing facility

Sr. No.	Location of processing facility	Processing capacity	Category of waste process	Processing technology
1.	Karsada	600 TPD	Mixed waste	Windrows composting
2.	Bhawaniya Pokhari	5 TPD	Organic waste	Biomethanization
3.	Pahariya mandi	5 TPD	Organic waste	Biomethanization
4.	Near IDH hospital	5 TPD	Organic waste	Biomethanization
5.	Ram Ghat	1 TPD	Flower waste	Composting

Presently in Varanasi both centralized and decentralized system is functional for solid waste processing (Table-4). Centralized system for waste processing is operational at Karsada. This plant processes 600 tons waste per day (TPD) using windrows composting method. Scientific landfill site established in the area of 10000 m² and leachate treatment plant of 50 kilo liter per day capacity is also operational in the same premises. This unit produces 70 to 80 tons compost per day, which is being sold to farmers and also used by horticulture department and VMC [14].

Another three decentralized waste to energy plants of 5 ton per day capacity are also operational to process organic waste. These plants are located at Bhawaniya Pokhari, Pahariya mandi and Near IDH hospital. All these waste to energy plants work on the principle of biomethanization and produce methane gas. Each plant produces 800 units of electricity per day, which is used mainly for plant operation and rest for street lighting. These plants also produce 20 to 30 kg digested substrate per day. This digested substrate is passed through screw presses for dewatering and then subjected to solar drying to give high-quality organic fertilizer. Another one flower waste to compost plant of 1 ton per day is operational at Ram Ghat at the bank of river Ganga. This plant process flower waste collected from nearby temples in the area to produce compost [14].

Varanasi city generates total 642.47 tons municipal waste per day and process 616 tons per day. This results the improved waste collection and processing efficiency of 95.88%. The left over 26 TPD waste remains in the street as garbage vulnerable point. These points require immediate attention and have to be removed on daily basis.

4. Conclusions

Solid waste management is a challenging issue for all municipal corporations due to increasing population and changing composition of city waste. The present study reviewed the solid waste management system of Varanasi. The composition analysis of waste found more than 50% organic fraction (aprox 334 tons). The capacity of waste to energy plant in Varanasi for processing of pure organic fraction is only 15 TPD. Rest organic fraction of waste collected in un-segregated manner is processed at Karsada. This processing of un-segregated waste for composting affects the quality of compost. Therefore it can be concluded that source segregation and dedicated transport system for dry and wet waste is needed at Varanasi. This will not only help in improving the quality of compost but also improve the sanitation status near the waste processing facility.

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