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Micro- Level Audit of Segregation, Collection, Transportation, Treatment and Disposal of Municipal Solid Waste at Source of Dhantoli, Nagpur

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Abstract: A micro-level audit of the Municipal Solid Waste Management system was carried out for centrally situated Dhantoli locality of Nagpur, Maharashtra. Dhantoli being a very elite locality of Nagpur was facing problems due to increasing municipal solid waste. Waste quantification was carried out to find the total amount of waste generated per day from the locality and the percentage of biodegradable and non-biodegradable waste was also determined. The waste sample was analyzed for its characteristics and its results indicated that organic waste was highest among other components of the waste. The outcomes of the audit also highlighted the lacunae in the collection and transportation system of the locality. Considering all the parameters, a decentralized composting plant was suggested for the treatment and disposal of biodegradable waste; while for the non-biodegradable waste establishment of a Material Recovery Facility (MRF) center was proposed.

Keywords: Nagpur Municipal Corporation (NMC), Municipal Solid Waste (MSW), Solid Waste Management (SWM), Waste Audit, Micro-level audit.

I. INTRODUCTION

The Municipal solid waste (MSW) contains compostable organic matter (fruit and vegetable peels, food waste), recyclables (paper, plastic, glass, metals), and domestic hazardous waste (blood-stained cotton, sanitary napkins, disposable syringes, toxic substances like paints, pesticides, used batteries and expired medicines). The source of MSW majorly includes households (domestic) while other sources are commercial, institutional, street sweeping, and construction and demolition places [1]. The MSW is also called urban solid waste. A general solid waste management system is a combination of various functional elements associated with the management of solid wastes. These functional elements are waste storage which involves segregation, waste collection, transfer, and transport, treatment, and disposal [2]. The collection and transportation plans are based on the quantity of waste generated while the treatment and disposal methods are designed on the basis of the composition of waste. There are several factors that affect the present as well as the future waste quantity and composition, some of which are geographic location, season, collection frequency, and population diversity, the extent of salvage and recycling, and public attitude. The factors which affect the collection and transportation are collection points, collection frequency, storage containers, collection crew, and types of collection [3][4].

The sustainable municipal solid waste management system needs to be designed and established considering all the factors. But for that, a comprehensive micro-level waste audit is essential as every source of municipal solid waste generates waste of different composition which affects the treatment and disposal of waste. Efficient waste management is dependent on the systematic collection and transportation of waste; hence the study of logistics of these functional elements is also essential [5].

A. Dhantoli: Original Structure, Development and its Consequences

Dhantoli is a locality in Nagpur city in Maharashtra state, India. It is considered as the central area of Nagpur having a 50 lane matrix structure (5/10) with 15 feet wide roads, having a population of approximately 6800 persons within an area of 583 sq.m. It was seen as an upmarket residential area in the past but from a few years this area has turned into a hub for the hospital industry. Earlier a single family used to live in a 100 square feet plot; now most of the plots have been transformed into multi-storeyed flat schemes and multi-bedded hospitals which ultimately increased the population of the area. According to the current situation Dhantoli area is facing problems of traffic congestion, Noise Pollution, Water Pollution, Soil Pollution, Air pollution, and Solid Waste Pollution.



Image 1: Map of Dhantoli, Nagpur (Source: Google Earth)

B. Municipal Solid Waste- A major Problem in Dhantoli:

As stated earlier, multi-storeyed buildings and commercial activity increased the demand for food and other lifestyle products thus increasing waste generation. The problems associated with Municipal Solid waste are as follows:

- 1) The kerbside collection system was followed in this area. The problem with this collection system was that if the vehicle doesn't come to collect the waste then the dustbin is left unattended for a long time. This would result in the spreading of waste from the dustbins by cows, dogs, and other domestic animals.
- 2) Due to an inappropriate segregation and collection system, 6 to 8 illegal dumping spots were identified in the area where residents regularly threw their waste. Because of this, leaching of waste started at the location, eventually contributing to various types of pollution.
- 3) Lack of awareness was a major problem in this locality. People did not follow the practice of segregation.
- 4) Lack of the collection system also resulted in the open burning of waste.
- 5) Due to more number of hospitals in this area, sometimes biomedical waste like soiled cotton balls, pieces of syringes or catheters were also found mixed with municipal solid wastes.

II. AIMS AND OBJECTIVES OF THE STUDY

The main aim of the study was to conduct a micro-level audit of municipal solid waste management in Dhantoli, Nagpur. The objectives associated with the study were:

- A. Identification of problems related to municipal solid waste management in the locality.
- B. Estimation of the total quantity of MSW generated and estimation of the total quantity of biodegradable and non-biodegradable waste generated.
- C. Analysis of municipal solid waste for its physical and chemical characteristics.
- D. Study of waste segregation, collection, transportation, and disposal practices of the locality.
- E. Study of transportation routes of waste collecting vehicles.
- F. Suggesting method of treatment and disposal for the locality based on the micro-level audit.

III. METHODOLOGY ADOPTED

The present study came under Applied Research as well as Descriptive Research. It involved quantitative and qualitative research. The quantitative research method was used for waste quantification and Qualitative research involved an experimental approach used for waste characterization. To study the waste segregation, collection, and transportation practices, a descriptive research method is used. It involved interviews with the residents of the locality, waste collectors, and other officials of Nagpur Municipal Corporation (NMC). For the ease of data collection and analysis, the total study area was divided into 10 small areas and was marked as A1 to A10.

For estimation of the total number of Municipal solid waste generators they were further classified according to types and sources of MSW. For waste quantification, a series of data was collected by weighing the waste. According to that data, approximate values of quantity of waste generated per day by generators for each source of waste was estimated. Along with this, the quantity of biodegradable and non biodegradable waste was determined by segregation. The TABLE 1 below shows the type of Municipal solid waste generator, the quantity of waste generated per day in kilograms by a single house/generator and also the percentage of biodegradable and non-biodegradable waste generated per day by every generator. According to these values, the total quantity of waste was estimated for the total number of generators.

Table 1
Type Of Waste Generator And Range Of Waste Generated Per Day Per Generator

Sr. No.	Sources Of Waste	Type of waste generator	Waste generated (kg/generator/day)	Biodegradable waste generated (percentage)	Non-biodegradable waste generated (percentage)
1	Residential	Houses/ Bungalows	6.5 – 7.5	75 %	25%
		Buildings	4 – 5	60 – 70 %	30 – 40 %
		Hostels	10 -12	60 %	40 %
2	Commercial	Medical Shops	0.75 – 1.5	-	100%
		Pan Thela/ Tea stalls	1.5 – 3	90 %	10%
		Hawkers	8.5 – 10	70 – 80 %	30 – 40 %
		Bhojanalay/ snacks corner/ restaurants	28 – 30	60 %	40 %
		Vegetable/Fruit/Flowers	12 – 15	95 %	5 %
		Grocery shops/Dairy	1 – 1.5	-	100%
		Mangal Karyalaya	6 – 40	60 – 65 %	40 - 45 %
		Public worship places	12 – 15	90 – 95%	5 – 10 %
3	Institutional	Educational Institutes	10 – 20	45 – 50%	45 – 50 %
		Offices/ Banks	1 – 1.5	2 – 3%	97 – 98 %
4	Other generators		20- 23	15-18%	80 - 85%

The waste characterization exercise was carried out with the help of National Environmental Engineering Research Institute (NEERI), Nagpur. A total of 28 samples were collected from all the 10 areas of locality. The locations for waste sampling were selected to provide representative characteristics of wastes; hence sampling was done at the source of generation. For selection of sampling points, a simple random sampling method was used. Waste sample was analysed for its physical and chemical parameters. Physical analysis included determination of composition of waste while chemical analysis included both proximate and ultimate analysis. Waste sample was also analyzed for heavy metals.

To investigate the segregation of waste, the residents of the locality, as well as the waste-collecting workers of the private company named Kanak resources Private limited (KRML), were interviewed. For studying waste transportation practices, the KRML officials were interviewed. The GIS based vehicle route map of all the vehicles working in the locality was obtained from the KRML office. These maps were studied and a generalized map combining routes of all vehicles were plotted by using designing software called Photoshop CS5.

IV. RESULT AND DISCUSSION

The total quantity of MSW generated from all areas (Area 1 to 10) of the locality was approximately 6865 kg/day. The data analysis showed that the bulk generators of MSW of the locality were the Residential sources of waste that were individual houses, buildings, and hostels. Apart from these, commercial and institutional sources were also in considerable numbers.

TABLE 2
Total Quantity Of Waste Generated From Areas A1 To A10

Area	Total No. of sources of waste generators	Total Waste Generated (kg/d)	Qty of Biodegradable waste generated (kg/d)	Qty of Non-biodegradable waste generated (kg/d)
A1	137	593.5	321.2	272.3
A2	425	1163.3	733.4	429.9
A3	313	975.3	689	286.3
A4	213	664.5	467.1	197.4
A5	169	662	469.9	192.1
A6	222	705.8	455	250.8
A7	196	618.5	438.2	180.3
A8	286	781.3	558.2	223.1
A9	205	539.3	379	160.3
A10	23	161.5	111.1	50.4
Total	2189	6865	4622.1	2242.9

Waste characterization revealed that the amount of biodegradable waste (approx. 4622 kg/day) generated in the locality was more than non-biodegradable waste (approx. 2242 kg/day) generated in the locality. Waste sample was analyzed for physical, chemical and toxic metals. From the results of the physical analysis, the organic fraction was high in the MSW, which was around 68%. The remaining non-biodegradable waste contributed 32%, out of which 15.5% was plastic waste, 12.3% was paper waste, textile waste was 1.2% and the remaining were inert waste. Based on the chemical analysis carried out the moisture content was 75.62%, Total volatile solids was 20.72%, ash content 3.67% and calorific value was 4013 kcal/kg for waste sample from Dhantoli area. Also, C: N ratio found was approximately 25.93; and the result of heavy metal detection showed that amount of Boron (24062.67) and Iron (13045.40) was high as compared to other elements.

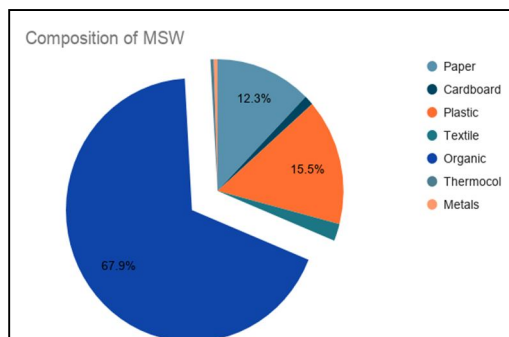


Fig. 2 Composition of MSW of Dhantoli

The collection and handling of MSW was carried out by Kanak Resources Private Limited. The kerbside collection method was adopted for the collection of waste, where mixed waste was collected. Collecting vehicles used were TATA Ace tipper trucks, muscle powered vehicles like rickshaw and truck of 2 ton capacity. The collected waste was taken to the transfer station situated at Rahate Colony. After studying the GIS based vehicle route map, it was found that collection of waste was not regular in lanes of A1 and A8 area, as no vehicle was employed to cover that part. Also some routes were repeated. This proves that collection was irregular in some areas of Dhantoli.

TABLE 3
Details Of Waste Collecting Vehicles Employed For Dhantoli

Sr. No.	Vehicle Type	Vehicle Number	Vehicle Capacity	Working hours	Number of trips daily	Total time required to collect waste (hrs)
1	TATA Ace	MH31 CQ3301	750 kg	7:30 am to 3:00 pm	3	7.5
2	TATA Ace	MH31 CQ3216	750 kg	7:30 am to 10:00 am	1	2.5
3	TATA Ace	MH31 CQ1134	750 kg	7:30 am to 10:00 am	1	2.5
4	Rickshaw	R.NO. 469	350 kg	7:30 am to 4:00 pm	4 to 5	8.5
5	Truck	MH31 DS161	2 ton	7:30 am to 12:00 pm	1	4.5



Image 2: GIS based route map of waste collecting vehicle (Source: Kanak Resources Management Ltd- KRML)

As there was no proper segregation, no specific treatment and disposal methods could be followed and waste was directly dumped into the dumpyard. From the above results, it was clear that a considerable large quantity of waste was generated from Dhantoli and a decentralized method of treatment and disposal of MSW was necessary.

Depending on the total quantity of biodegradable waste generated in the locality, decentralised bin composting or box composting unit can be designed and installed. And for non-biodegradable waste, Material Recovery Facility centre can be established and Informal sector can be involved for segregation of recyclable waste [3].

V. CONCLUSION

The micro-level audit of segregation, collection, transportation, treatment, and disposal of municipal solid waste at the source of Dhantoli, Nagpur was carried out in which the total number of waste generators, total quantity of waste generated per day from every generator, percentage of biodegradable and non-biodegradable waste generated each day by every generator was estimated. Municipal solid waste was also analyzed for its physical and chemical properties. The segregation, collection, and transportation practices were also studied. During the study, it was found that the waste generators are not following the regular practice of segregation of waste. Its effect can be seen in the collection and transportation of waste from the locality. 6-8 unauthorized dumping spots were identified. The waste collecting vehicles of KRML allotted to this area were insufficient for handling the total waste generated in the locality. From the total quantity of waste generated, biodegradable waste generated was more. Hence the organic fraction was more as compared to the inorganic fraction.

Considering the amount of waste generated from the locality, it was suggested that decentralized treatment should be adopted for treating biodegradable waste and for non-biodegradable waste Material Recovery facility should be established in the locality.

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