Municipal solid waste management in Bhubaneswar, India – A review

C.R. Mohanty
Department of Civil Engineering, VSSUT, Burla, India

U. Mishra
Department of Civil Engineering, NIT, Agartala, India

P.R. Beuria
Airport Authority of India, Bhubaneswar, India

Abstract-In view of fast paced economic growth accompanied with rapid urbanisation, management of municipal solid waste has emerged as one of the major environmental challenges of present times. Indian cities are often characterized by poorly rendered services including waste management-the most ignored of all basic services, on account of various reasons. The situation worsens with increasing population pressure in urban centers. Bhubaneswar is one such city of Eastern India, having an inefficient, outdated and unscientific waste management system. This paper attempts to assess the existing state of municipal solid waste management (MSWM) in Bhubaneswar city with the aim of identifying the main obstacles to its efficiency and the prospects for improvisation of the solid waste management system in the city. The existing solid waste management system in the city is found to be highly inefficient. Primary and secondary collection, transportation and open dumping are the only activities practiced that too in a nontechnical manner. This paper systematically assesses the obstacles in the existing solid waste management system in Bhubaneswar city and also tries to assess the potentials for its improvisation.

Keywords-Municipal Solid Waste Management, Collection, Tranportation, Dumping

I. INTRODUCTION

Solid waste has been produced since the beginning of civilization. During the earliest periods, solid wastes were conveniently and unobtrusively disposed of in large open land spaces, as the density of the population was low. However, today, one of the consequences of global urbanization is an increased amount of solid waste. About 1.3 x 109 t of municipal solid waste (MSW) was generated globally in 1990 (Beede and Bloom, 1995), and, at present, the annual generation is approximately 1.6 x 109 t. The urban population in Asia generates around 760 x 103 t of MSW per day, and this is expected to increase to 1.8 x 106 t by 2025 (Pokhrel and Viraraghavan, 2005).

Fast paced economic growth accompanied with rapid urbanisation, although a global phenomenon, their ramifications are more pronounced in developing countries. These are likely to account for 90% of the growth in urban population estimated to double between 1975 and 2015. Such rapid, unplanned and haphazard urbanisation brings challenges in the form of expansion of slums and additional pressure on the already overburdened urban infrastructure. One direct outcome of growth in urban population is the corresponding increase in the generation of municipal solid waste (MSW). At present, Indian cities generate an estimated 0.115 million metric tonnes of waste per day and 42 million metric tones annually (3iNetwork, 2006). The per capita waste generation ranges between 0.2 and 0.6 kg per day in the Indian cities that is lower than that in developed countries. However, lifestyle changes due to economic growth and fast rates of urbanization have resulted in per capita waste generation increasing by about 1.3% per year. The Tata Energy Resources Institute (TERI) has estimated that waste generation will exceed 260 million tones per year by the year 2047-more than five times the present level (3iNetwork, 2006; Metin et al. 2003; Sakai, 1996).

It is also a fact that bigger the size of the city (population and density wise) generates more quantity of waste (Petts and Edulijee, 1994; Aakeson and Nilsson, 1994). This is the phenomenon observed world over and India is no exception to this. Cities with population more than 0.1 million generate a major portion of this generated waste (Table 1). These contribute 72.5% of the waste generated in the country against the other 3955 urban centers producing only 17.5% of the total waste. Improper disposal of waste has huge social costs due to the spread of

communicable diseases and increased treatment costs for pollutants, and is an issue of increasing concern (Assmuth and Strandberg, 1993).

Table - 1 Waste generation in urban centers in India

Sl.No.	Type of cities	Tonnes/day	Percent of total garbage
1	The 7 mega cities	21,100	18.4
2	The 28 metro cities	19,643	17.1
3	The 388 class 1 cities	42,635	37.1
	Total	83,378	72.5
4	Other 3955 urban centers (population less than 100,000)	20,125	17.5

Source: MOUD Report (2005)

In India, collection, segregation, transportation, and disposal of solid waste are often unscientific and chaotic. Uncontrolled dumping of wastes on the outskirts of towns and cities has created overflowing landfills, which have environmental impacts in the form of pollution to soil, groundwater, and air, and also contribute to global warming. In the absence of formalized waste segregation practices, recycling has emerged only as an informal sector using outdated technology, which causes serious health problems to waste-pickers (Plastindia, 2006).

In this paper, Bhubaneswar's urban solid waste management (SWM) is introduced in detail with regard to the overview of the city, city's solid waste characteristics, management, collection system, treatment processes and the disposal methods. The major problems pertaining to SWM faced in the city have also been analyzed. An attempt is further made to explain the future challenges and opportunities for improving the SWM system in the city.

II. Overview of Bhubaneswar City

Bhubaneswar is is the capital of the state of Odisha in India. The city is centered on latitude 230 15' 20" North and longitude 850 5' 30" East, is approximately 35 km from the Bay of Bengal. The geographical area of the city is around 135 km2. Bhubaneswar is categorized as a Tier-2 city. An emerging Information Technology (IT) and education hub, Bhubaneswar is one of the fastest developing cities of India in recent years. Fig. 2 shows the city map with ward boundaries.

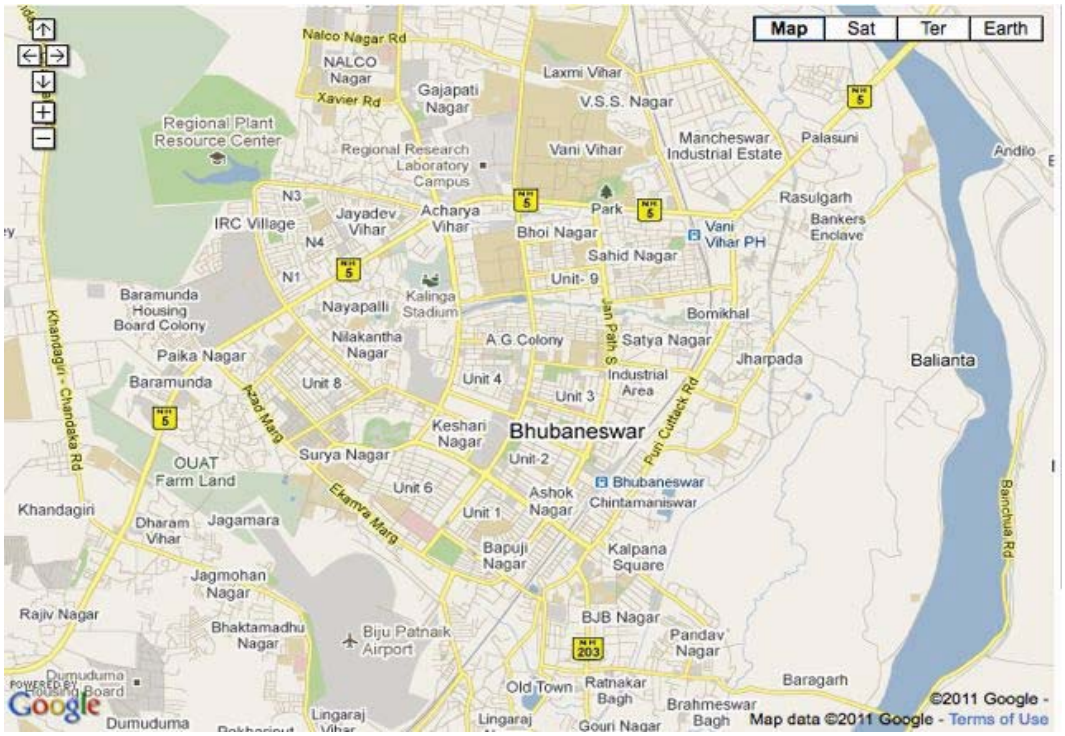

Figure 1. City map showing ward boundaries

Source: Bhubaneswar City Development Plan

As per the 2011 census of India, Bhubaneswar had a population of 8, 37,737, where the number of males was 445,233, while the number of females was 392,504. The decadal growth rate was 45.90 percent. Effective male literacy was 95.69 per cent, while female literacy was 90.26 per cent. About 75,237 persons was under six years of age. Bhubaneswar's literacy rate is 93.15 per cent-significantly higher than the national average of 74.04 per cent. According to 2001 census, 11.02 per cent of the population lived in 99 unauthorized slums and 47 authorized slums. However, in 2009, the number of slums in Bhubaneswar increased to increased to 377, with most of them being unauthorized. Migration from rural areas and neighboring states has led to the growth of slums, which are a major challenge to the city's growth.

A. Legal and institutional framework-

Bhubaneswar Municipal Corporation (BMC) is the waste managing authority of the city. The 74th Amendment of the Constitution, the Orissa Municipal Act, 1950 and the Orissa Municipal Rules, 1953 govern the constitution and functioning of Bhubaneswar Municipal Corporation (BMC). It functions under the overall administrative control of the State Housing and Urban Development Department (H&UDD) headed by the Director of Municipal Administration. The state government has the powers to call for information, conduct inspection, give direction, dissolve the ULB, cancel orders and even rescind resolutions of the council under specified circumstances. The functions of the Corporation fall under two categories - obligatory functions (such as maintenance of roads, street lights, sanitation, water supply, registration of births and deaths, public immunization and regulation of buildings); and discretionary functions (such as construction and maintenance of parks, schools, hospitals, and libraries). Separate departments perform these functions besides an administrative and a finance department.

Solid waste management is one of the obligatory functions of BMC. There are number of legislations at National, State and Local level, which govern the management of municipal solid waste in Bhubaneswar city like the Orissa Municipal Corporation Act of 1950, Hazardous Wastes (Management and Handling Rules), 1989, Bio-Medical Waste (Management and Handling) Rules, 1998, Municipal Waste (Management and Handling) Rules, 1999, Manual on municipal solid waste management, 2000, Plastic and other non-biodegradable garbage—Ordinance of July, 2000. However, even the latest manuals fail to solve the financial problems of local bodies and the status of MSWM as well as hazardous and bio-medical waste management continues to be deplorable.

B. Administrative Set-up-

For administrative purpose Bhubnaneswar Municipal Corporation (BMC) is divided with 60 wards. The ward areas and the size of the population vary. BMC has an elected and an executive wing. The elected body comprises public representatives, known as Councillors, one for each ward, who hold office for a period of five years. The wing is headed by a Mayer. This council is the policy-making body assisted by various standing committees (such as finance, public health, hospitals and dispensaries, public works) for rendering specialised functions. The administrative head of the Corporation is called Municipal Commissioner. Two departments of BMC are involved in SWM, and are:

1. Health & Sanitaion department: Solid waste management comes under the purview of this department. Bhubaneswar city has sixty wards out of which sanitation in forty wards hav been privatized and twenty wards are with BMC.
2. Engineering department: This section deals with the repair and maintenance of roads, drains, vehicles etc.

Fig. 2 gives the organogram of BMC with details of the above-mentioned departments.

The formal municipal solid waste management in Bhubaneswar city includes mainly primary and secondary collection, transportation and final disposal of collected waste.

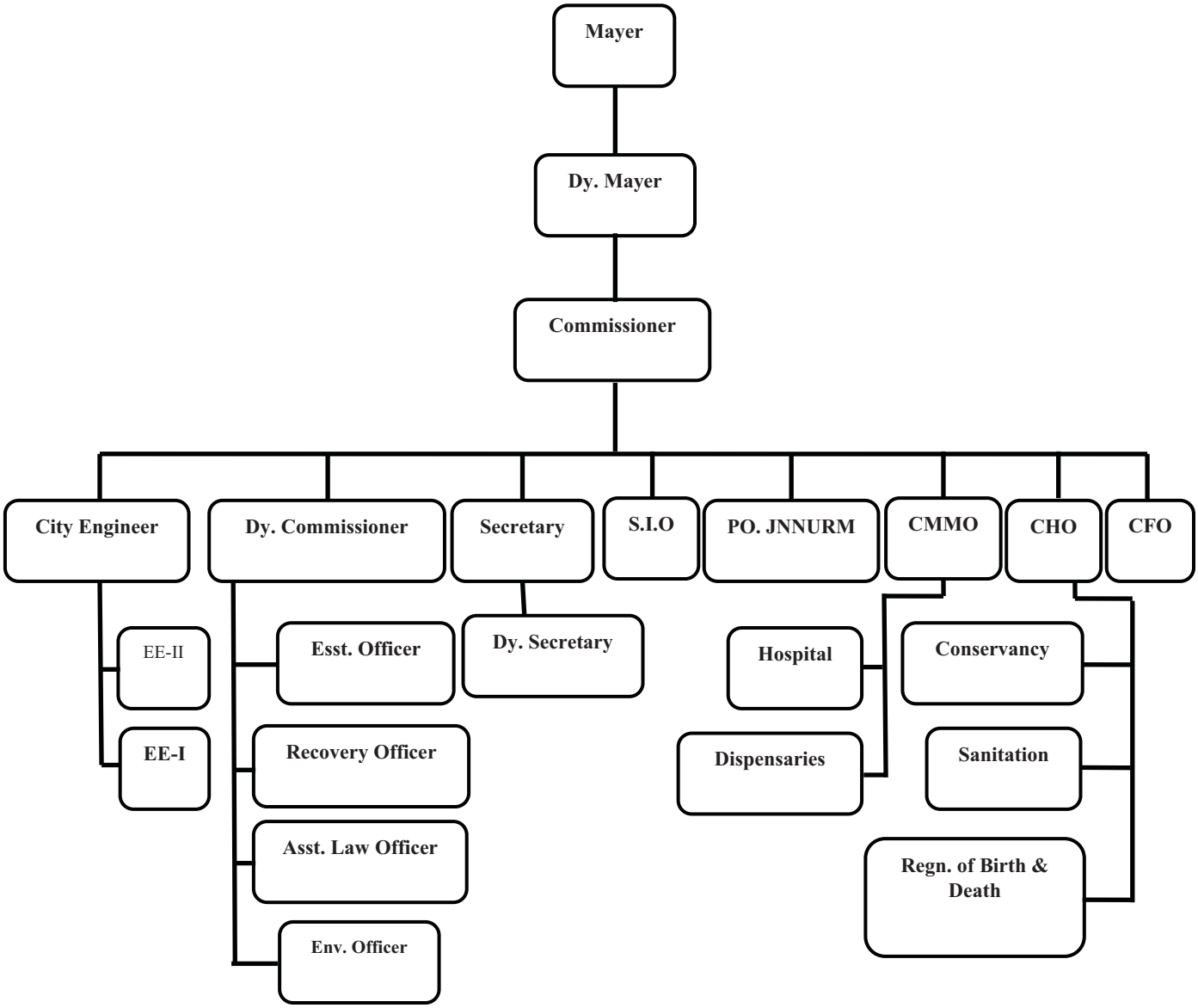

Figure 2. Organogram of Bhubaneswar Municipal Corporation (BMC)

III. METHODOLOGY

This study is based on both quantitative and qualitative data from primary and secondary sources. To investigate the issue, a case study approach has been adopted by studying the situation in Bhubaneswar city in the state of Orissa, India. The selection of Bhubaneswar for the purpose of this study was based on basic criteria: it is a fast developing city in the state of Orissa and both, the city as well as the state have not been covered by existing literature on MSW. Yet another critical reason for the selection of this city for case study is the fact that the city through its private service provider is keen on developing a robust waste management plan in the near future. Therefore findings from this research will feed into the process and facilitate taking informed decisions. As a methodology, in the absence of any existing information on MSW in Bhubaneswar, a citywide profiling was taken up to understand the solid waste characteristics, collection system, treatment processes, disposal methods and other management issues. The profiling was based on the primary information collected during interviews with stakeholders namely Bhubaneswar Municipal Corporation (BMC), Private Service provider, NGOs, Service Users, Informal Recycling sector, District Administration, and Regulatory Agency. Information about policy, legislation and general information on waste management was collected from various government reports and Bhubaneswar Municipal Corporation. Information

about waste quantities and characteristics was collected from the Corporation, based on a survey conducted by the I.I.T-Roorkee. The information was supplemented with observation visits to the wards and other sites and field studies were also conducted by the Authors to understand the various issues regarding collection, transportation and disposal of municipal waste.

Survey research method is employed to collect data at the household level. The city is sub-divided into five zones for administrative purpose. All the five zones have their own special features. These five sub-divisions together have 60 wards. An attempt was made to select households from selected wards from all five zones.

Purposive sampling technique has been employed for the selection of 12 wards. Wardwise list of households were obtained from the Municipal Corporation and simple random sampling technique was employed for the selection of 300 households from the selected wards.

IV. MUNICIPAL SOLID WASTE MANAGEMENT OF BHUBANESWAR

Urbanization and industrialization influence the quantity of city garbage produced. In India, Mumbai, with a population of 13.8 million, is the largest (8,000 t d-1) MSW generator. Delhi generates 6,000 t d-1 of MSW for a population of 10 million, Chennai generates 4,000 t d-1 for a 5.8 million population, and Hyderabad produces 2,200 t d-1 for a 4.2 million population (Chattopadhyay et al., 2007). The MSW generation rate in Bhubaneswar is about 360 g per capita per day (gpcd) and the total generation is about 3,00 t d-1 .

A. Physical and chemical characteristics of solid waste-

Waste generation is the first element of waste management. It is a prerequisite to any waste management plan to have adequate knowledge of the generators of waste, its physical and chemical characteristics. The waste characteristics vary not only from city to city but even within the same city, as it depends on factors such as the nature of local activities, food habits, cultural traditions, socio-economic factors, climatic conditions, and seasons. The physical and chemical characteristics aid in deciding the desired frequency of collection, precautions to be taken during transportation, and methods of processing and disposal. The major generators and types of waste generated in the study area are given in Table 2.

Table-2 Generators of waste and types of waste

Sl.No	Sources	Types of waste
1	Households and institutions	Mostly organic with some plastics, glass, metals, inert materials and hazardous waste
2	Schools and colleges	Mostly papers
3	Vegetable/fruit markets, restaurants, etc.	Mostly organic
4	Commercial centers	Mostly paper and plastics
5	Healthcare facilities	Infectious and non-infectious waste
6	Industries	Leather wastes, metals, plastics, etc.
7	Slaughterhouses	Bones, blood, intestines, carcasses, etc.
8	Animal husbandry and diaries	Dung and used straw, kanaa (used to feed pigs)

Source: BMC

To analyze the physical and chemical composition of wastes in Bhubaneswar city, wastes generated from different sources, such as, different income-groups, commercial waste, waste from industries, waste from vegetable markets, collection depots and disposal site have been considered. Variation of physical composition of MSW in Bhubaneswar is presented in Fig. 3 and Fig. 4. It has also been observed that the average density of municipal wastes in the city based on test results is found to be 480 kg/m3 & 600 kg/m3 wet & dry weather respectively. This average density is close to that in other Indian cities of comparable size whose average waste density is 425 kg/m3 (MOUDPA, 2000). However the possible reasons of variation in density of wastes might be due to the small sample size, and secondly due to the higher amount of cow dung, wet waste and inert materials in the containers at the time of sampling.

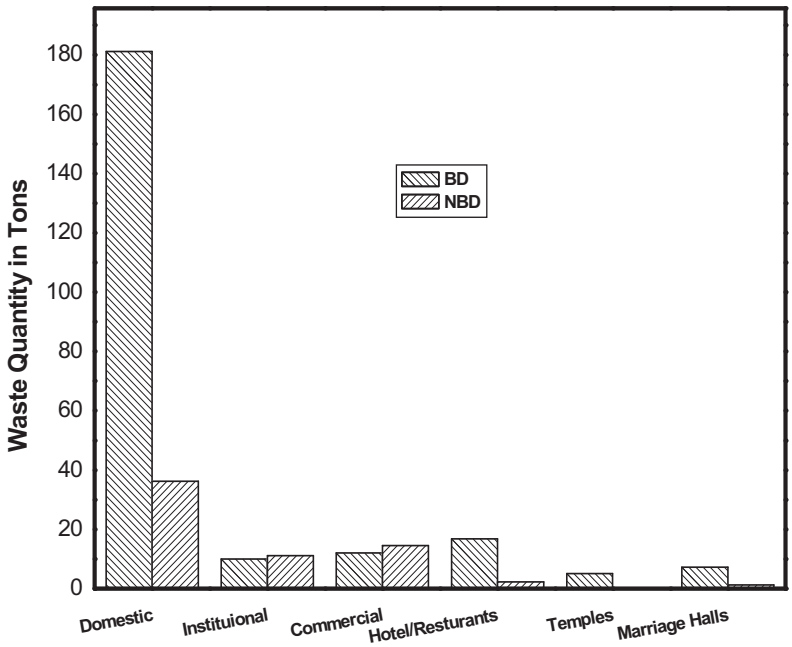

Figure 3. Comparision of Bio-degradable (BD) and Non-biodegradable (NBD) Waste at different sources in Bhubaneswar

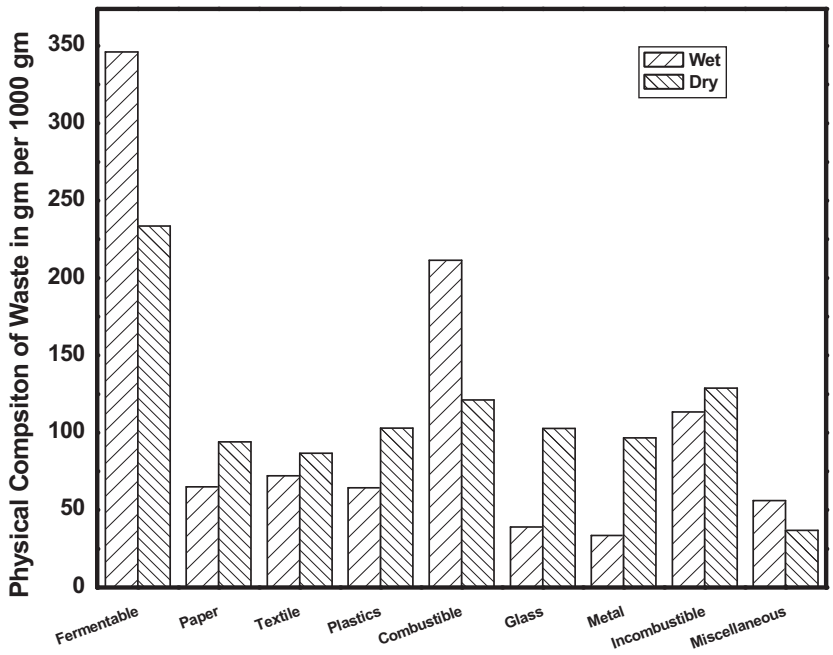

Figure 4. Physical composition of different type of wastes in MSW (Wet and Dry condition) in Bhubaneswar

Table 3 shows the chemical composition of MSW. The carbon/nitrogen (C/N) ratio is within the ideal range (26–31) for composting (CPHEEO, 2000) except the residential area.

Table 3 -Source wise chemical composition of MSW

	pH	Conductivity (dsm-1)	Available Nitrogen in %	Available Phosphorus in %	Available Potash in %	Moisture % by weight	Volatile %	% Of Organic Carbon	C/N Ratio
Industrial	6.61	0.93	0.117	0.009	0.064	25.79	5.22	3.34	28.66
Commercial	6.66	1.02	0.144	0.008	0.059	38.43	5.22	3.34	28.66
Institutional	6.73	1.10	0.124	0.007	0.039	36.02	5.88	3.478	27.99
Residential	6.68	1.09	0.143	0.006	0.067	37.76	6.68	2.45	18.30

B. Waste collection-

Source-separated collection means that the generated waste is first classified and stored separately as biodegradable and recyclables of different types and collected separately for further treatment/reuse/recycle/disposal. However, in the study area segregation of waste is absent at generators level and collection level. The collection of generated waste and its overall management is shown in Fig. 5.

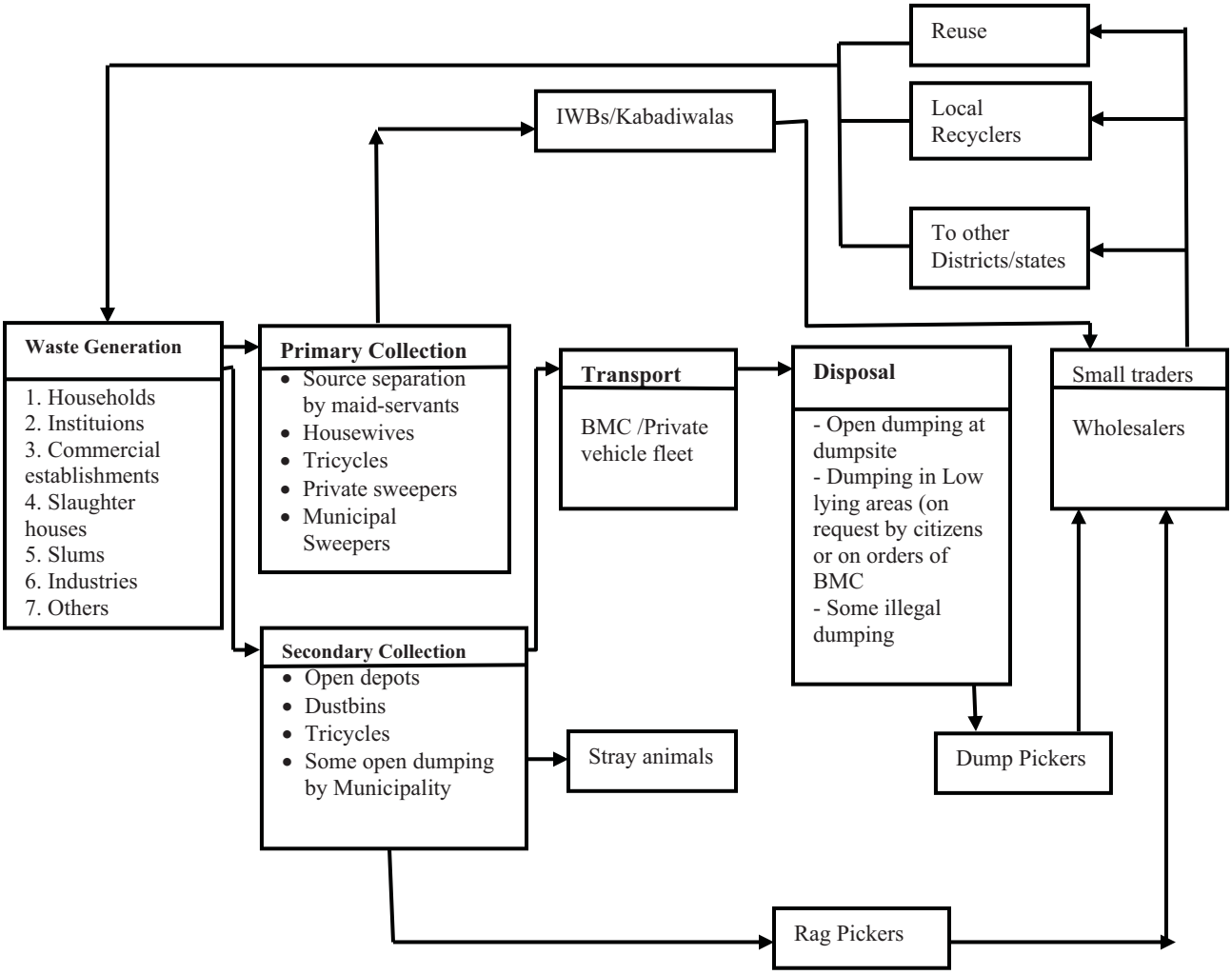

Figure 5. Waste collection and its management in Bhubaneswar

(a) Residential: Households throw the daily waste generated on the roads or nearby containers (collection depots-reinforced concrete containers, open depots, etc.) from where it is collected and taken in hand carts by the municipal sweepers to the secondary storage points or directly transported to the dump site. Door-to-door collection is practiced in few wards.

(b) Commercial and market waste: Commercial waste is dumped at various collection points or just thrown away along roadside. Market waste and waste generated by the street-food vendors, which is highly organic in nature is littered. The clearance of such waste is the responsibility of the Corporation.
(c) Bio-medical: All the biomedical wastes from the hospitals and nurshing homes are being collected , treated and disposed by a biomedical waste processing facility which has been authorized by Orissa Pollution Control Board Bhubaneswar. However some non-hazardous bio-medical waste along with the municipal waste is collected by by the municipality.
(d) Industrial: Hazardous industrial waste though comes in separate category and is not included in municipal waste. However, it is observed that in the study area industrial units discard their hazardous and nonhazardous waste along with the municipal waste.
(e) Institutions: These organizations also throw the waste generated in nearby collection depots/storage points from where it is collected by the municipal crew for further transportation and disposal.
(f) Road clearing and public places: Municipal sweepers collect the road clearing waste in handcarts and waste from public places to the nearest secondary collection depot for further transportation to disposal site.
(g) Construction waste: The city is littered with huge heaps of construction waste like ballast, sand, bricks, or other leftover materials, which the owners feel may come in handy sometime. It lies unattended for days and months together or is lifted by the private contractors on payment basis. Thus, currently all the waste is collected in a mixed state.

Primary collection

Primary collection of wastes comes under the purview of the Health department of BMC. The primary waste collection of the city is headed by a Chief Health Officer. Twelve Sanitary Inspectors are assigned to different zones, reporting directly to the Chief Health Officer. Each Sanitary Inspector presides over Zamadars. The Zamadars are assigned to a number of wards. The sweepers and loaders are assigned to beats and report to the Zamadars.

Four different types of containers with varying capacities are used for waste storage. BMC has provided cylindrical bottomless and lidless concete waste bins of 91.5 cm height and 83.9 cm diameter having 5 cm thickness. In addition to that opentype containers with capacity of 1.0 m3, 3.0 m3 and 4.5 m3 have been provided on wide roads sides which are taken by dumper placer to the transfer station or disposal sites. The civic body has also 30 big bins for waste collection. The research study reveals that there are 348 collection points available in the city. At present, only one sweeping machine is operating in the city.

Secondary collection

The Sanitation department of the Municipal Corporation looks after also the task of secondary collection and disposal of wastes. Various types of vehicles such as trucks of 6 MT capacity, minitrucks of 4MT capacity and tractors with trailers of 3MT capacity are used for secondary collection and disposal of wastes in Bhubaneswar city. At present, the civic body has six mechanized vehicles (hook loader lorries) for disposal of solid waste.

C. Treatment and processing-

There is no treatment facility for treatment of municipal solid waste in Bhubaneswar. The corporation also currently does not involve any waste processing. Whatever little waste processing that takes place is for the recyclables through a chain of informal recyclers operating in the city. There are 60-70 small waste dealers who collect the recyclable waste (glass, paper, metal, plastics, and electronics) either using their own network of people going door-to-door or buying it from waste pickers paying on a per unit basis. This acts as an incentive for the waste generator to segregate and store the waste and for the waste picker to scavenge the waste dumps. A very rough estimate is 30-40 kg of recyclable waste per dealer per day. These dealers further sell the recyclables to big dealers.

D.Disposal-

There is no sanitary landfill in Bhubaneswar city. The city does not have even controlled dumps. Waste is simply dumped at two designated sites (Tulasadeipur and Salia Sahi) without compaction where no soil cover is used. No visual or environmental barriers and no provision for leachate checking is available. Besides the above official dump sites, it is observed that the city is also having few unofficial dumpsites. Burning of waste in containers, on roadsides and small dumps is often practised by the residents and also by the municipal sweepers.

E.Problematic areas -

1. Improper disposal practice: Identification of the site(s) for landfill and dumping is currently being practiced in Bhubaneswar purely on the basis of easy availability of open spaces, without any scientific land-suitability

considerations at all. Landfills do not exist and give way to more dangerous and polluting open dumps. The current practices of open dumping often leads to a number of problems like air, water and ground pollution, spread of diseases through rodents and other vector carriers, increased risk of respiratory diseases, increased emission of greenhouse gases, loss of real estate value of adjacent land, poor esthetics and built environment. All these problems pertaining to open dumping is observed in the study area.

2. No treatment facility for MSW: There is no treatment facility for the processing of collected waste in the study area.

3. Ineffective collection system: The existing collection system in Bhubaneswar city suffers from many problems. Some of them are illustrated as under:

(a) It is observed that collection points are not conveniently located and the surroundings of containers are very dirty as heaps of garbage is seen lying all around them. The problem is compounded by residents' apathy on their role in waste management. Throwing of waste on the streets and outside home, shops, etc., is a common practice.

(b) The walls and floors of the concrte containers are mostly damaged or broken, which makes the lifting of waste by loader difficult. Besides, the depots become inaccessible during monsoons.

(c) Municipal workers, especially sweepers are found to be ill-equipped. The handcarts are usually in poor shape due to lack of maintenance. Besides, it is extremely difficult for women sweepers to handle the handcarts due to its poor design and small capacity.

(d) Rag-pickers who collect recyclables from the secondary storage containers often result in spreading of waste outside the waste collection points leading to further littering.

(e) Field studies show that there is shortage of vehicles resulting in low collection of wastes.

(f) There is also shortage of manpowers such as sanitary staffs, sweepers etc.

(g) Route planning is not observed.

(h) Only day shifts is practiced in Bhubaneswar city, which often results in road blockages and longer time for waste collection in busy and congested areas.

(i) Waste transportation in open trucks result in lot of littering.

V. RECOMMENDATIONS

1. Segregation of waste at source: Source-segregation of the waste under various heads-biodegradable, recyclables and hazardous should be implemented immediately. To improve awareness among the residents about the importance of source-segregation, a proper Information Educational Campaign to sensitize the people through print and multi-media, educational campaigns in schools and colleges, etc., and through religious leaders, is simultaneously required.

2. User-fee system : Owing to the poor financial status of the Corporation and to make SWM more economically sustainable, it is required to introduce a user-fee for waste collection and management. However, the fee must be charged in accordance with the income-groups so that the poor section is not deprived of the facilities, as most of the people are willing to pay user fee if the waste collection facility is improved.

3. Improving the collection system: There is an immediate requirement to improvise the primary and secondary collection system with or without the participation of private contractors.

4. Adoption of an integrated waste management system: There is an urgent need to appoint SWM expert to look for optimal solutions for an integrated SWM plan of the city. Use of geographic information system (GIS) facility in the Corporation is recommended for optimal route planning and networking of collection and transportation of waste.

5. Database generation: Formation of database on the waste quantity, quality from various sources separately is also recommended in the study area with regular updating to keep a track on the achievements/obstacles. The corporation requires computerized weighbridges to weigh the quanity of wastes collected & disposed per day.

6. Participation of all stakeholders: Stakeholders in an integrated SWM include participation of residents, Resident welfare associations (RWAs), Non-governmental organizations (NGOs), Community-based organizations (CBOs), private contractors/ organizations, government authorities and the informal waste-recycling sector. Stakeholder's participation is strongly recommended for better implementation of various programs and policies and improvement in waste management in a cost-effective manner.

7. Decentralized treatment plants: Under the existing conditions, composting is the most recommended method for treatment of organic wastes in the study area.

8. Compliance of MSW rules: To achieve better compliance of MSW rules by people, powers need to be given to the Corporation to levy spot fines on the polluters. Increase in awareness among the people about the ill-effects of mismanagement of solid waste can also result in better compliance and cooperation for implementing various programs and is therefore, recommended.

VI. BIOMEDICA WASTE OVERVIEW

Biomedical wastes (BMW) are potentially hazardous and the environmental impacts of biomedical wastes are interdependent and cumulative. Surveys carried out by various agencies show that healthcare establishments in India are not giving due attention to their waste management. Since notification by the Biomedical Waste (Management and Handling) Rules in 1998 (CPHEEO, 2000), these establishments are slowly streamlining the process of waste segregation, collection, treatment, and disposal.

There are 141 healthcare clinics in operation within the city. Many of the larger hospitals have either installed primary treatment facilities or are in the process of doing so. Solid waste from the hospitals consists of human anatomical wastes, microbiological wastes, animal wastes along with bandages, linens and other infectious waste (30–35%), plastics (7–10%), disposable syringes (0.3–0.5%), glass (3–5%), and other general wastes including food waste (40–45%) (Patil and Shekdar, 2001). It is estimated that about 0.33 x 106 t of biomedical wastes are generated annually in India. At Bhubaneswar, the generation ranges from 1 to 1.4 kg of BMW per bed per day, and in district hospitals, it is around 0.4 kg of BMW per bed per day (OPCB, 2006).

Previously, BMC collected waste from those BMW generators and disposed of it alongwith municipal solid waste. Now, a private entrepreneur, M/s.Sani Clean Pvt. Ltd. has established a common incinerator at Tangiapada, Khurda in 2001, with a capacity to treat 3 tons of BMW in 8 h. However, it is currently running below capacity

VII.CONCLUSIONS

Rapid urbanization and population growth of Bhubaneswar city is bound to bring an increase in the overall waste generation in the coming years. In the city, solid waste management falls short of the desired level as the systems adopted are out-dated and inefficient. Further institutional weakness, shortage of human and financial resources, improper choice of technology, inadequate coverage and lack of short and long term planning are responsible for the poor state of affairs. The city is facing these deficiencies in varying degrees and there is a need to make substantial improvement in the MSW practices prevailing in the city to raise the standards of health, sanitation and urban environment keeping pace with the rapid urbanization and growing population. There is therefore, an urgent need to improvise the situation to stop further decay and deterioration of the city. Concerning the hierarchy of the principles and the methods for MSW management defined by the national legislation, Bhubaneswar has a long way to go and, therefore, there is a considerable amount of effort to be done in order to obtain real and significant positive evolution in MSW prevention, reduction and recovery.

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