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An Overview and Challenges of Municipal Solid waste Management in Kolkata Metropolitan Area

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Abstract: Municipal Solid Waste Management (MSWM), is a key component of sustainable urban development, and involves segregation, storage, collection, relocation, transportation, treatment, and disposal. With the growing number of urban population, Indian cities will have to face different challenges ranging from environmental pollution to solid waste management. The three megacities of Mumbai, Delhi and Kolkata generate thousands of tons of Municipal Solid Waste (MSW) every day. The amount of Municipal Solid Waste (MSW) is expected to increase significantly in the near future as the country becomes more urbanized. Within this context, this paper made an attempt to assess the solid waste management situation in ULBs of Kolkata Metropolitan Area (KMA). It is found that there is a huge gap between waste generation and collection between the different local bodies. Most municipalities do not segregate their waste while collecting waste from the household. As a result, processing of waste has become impossible. Apart from this, almost 50 percent of municipalities do not have a dumpsite. Only a few municipalities have a composting plant in operation.

Keywords: Segregation, Municipal Solid Waste, Disposal, Collection

I. INTRODUCTION

With the growing number of urban population, Indian cities will have to face different challenges ranging from environmental pollution to solid waste management. About 31.2 percent of the population is now living in urban areas of India. The three megacities of Mumbai, Delhi and Kolkata generate thousands of tons of Municipal Solid Waste (MSW) every day. The amount of MSW is expected to increase significantly in the near future as the country becomes more urbanized (Sharma and Shah, 2005). The annual amount of solid waste generated in Indian cities is expected to increase to 300 million tons by 2047, increasing from 6 million tons in 1947 to 48 million tons in 1997 at a Compound Annual Growth Rate (CAGR) of 4.25% (Agarwal, Chaudhary and Singh, 2015; CPCB, 1998).

Municipal Solid Waste Management (MSWM), is a key component of sustainable urban development, and involves segregation, storage, collection, relocation, transportation, treatment, and disposal. Unmanaged municipal waste is contributing to the spread of countless diseases (Kumar et al., 2009). Poor collection and inadequate transportation lead to the accumulation of household waste on every corner of the street. Municipal solid waste management is at a critical stage as

adequate facilities are not available to treat and dispose of the large amount of municipal solid waste that is generated daily in metropolitan cities (Sharholly et al. 2005). Unscientific disposal adversely affects all components of the environment and human health (Rathi, 2006). Improperly managed waste systems also miss out on economic growth opportunities, such as rising property values and tourism benefits from clean streets and beaches. Waste reduction programs, when properly implemented, can lead to transportation and fuel savings and cost recovery. Improved waste management benefits particularly vulnerable populations through cost reductions in public health systems by preventing respiratory, skin and other health problems associated with good waste management (ISWA, 2015). Normally, municipal solid waste is disposed of in low-lying areas without precautions or operational controls. Therefore, MSWM is one of the biggest challenges in big cities in India. However, in most cities, the MSWM system includes only four activities: waste generation, collection, transportation and disposal. Management of MSW requires proper infrastructure, maintenance and updating for all activities. This has become increasingly costly and complex due to the continued and unplanned growth of cities. The difficulty in providing the desired level of public service in cities is often due to the poor financial condition of the urban local bodies (Sharholly et al. 2008). MSWM continues to be a major issue

facing countries around the world. This is especially true in developing countries where growing urban populations have dramatically increased the total amount of municipal solid waste (MSW). Due to limited resources, only basic technology for treatment and disposal, and related regulations not being implemented, MSWM is a serious problem in developing countries, especially regarding the safe disposal and recycling of MSW (ISWA and UNEP, 2002).

Within this broad context, an attempt has been made to provide a comprehensive review of municipal solid waste management for Kolkata Metropolitan Area (KMA) as well as evaluate the current status and identify the problems of MSWM. After the introductory section, second section explains the methodology includes study area, database and methods. Third section analyze the overview and current situation of solid waste management in Kolkata metropolitan area. Thereafter, challenges of solid waste disposal are discussed. In the concluding section way forward of municipal solid waste management in Kolkata metropolitan area are covered.

II. MATERIALS AND METHOD

The details of the methodology are covered in following different sub-section.

Study Area

Kolkata metropolitan area (KMA) comprised of 4 municipal corporations, 41 municipalities, 70 non municipal urban areas, 14 out growths and 422 rural area. KMA spreads across 1851.41 sq. km. with a population of 14.69 million in 2011. The Hooghly River is flowing in the middle of the KMA as a result municipal corporations and municipalities are spread across the east and west bank of the river. Eastern bank municipalities are Kolkata municipal corporation, Bidhannagar municipal corporation, Dum Dum, North and South DumDum, Baranagar, Kamarhati, Panihati, Khardah, Titagarh, Barrackpore, North Barrackpore, Garulia, Bhatpara, Naihati, Kanchrapara, Halisahar, Kalyani, Mahyamgram, New Barrackpore, Gayeshpur, Haringhata, Budge Budge, Pujali, Maheshtala, Rajpur-sonarpur and Baruipur.

The western bank municipalities are Howrah Municipal Corporation, Chandannagore municipal corporations, Uttarpara-Kotrung, Konnagar, Rishra, Serampore, Bhadreswar, Baidyabati, Uluberia, Dankuni, Champdany, Hooghly-Chinsura and Bansheria municipality. Both the eastern and western bank municipalities are situated across six districts include Kolkata, North and South 24 Parganas, Howrah, Hooghly and Nadia. Though, most of the municipalities are old but most of them lacks in the sewage treatment plants (Karmakar, 2021). Following table 1 shows the demographic details of the Kolkata Metropolitan Area (KMA).

The Kolkata Municipal Corporation (KMC) is the largest local authority in terms of population size and land area. Titagarh is the smallest municipality in terms of area while Pujali is the smallest in terms of population size. It is worthwhile to note that population size and density are directly related with municipal solid waste generation. In fact, the size

of the Urban Local Body (ULB) also plays a role in providing dumpsite as well as sanitary landfill site close to ULBs. It is important here to note that Rajarhat-Goalpur municipality have been merged with Bidhannagar municipality in 2015 to form Bidhannagar Municipal Corporation. Likewise Bally municipality merged with Howrah Municipal Corporation in 2015. Haringhata and Dankuni gained municipal status in 2015 and 2010 respectively.

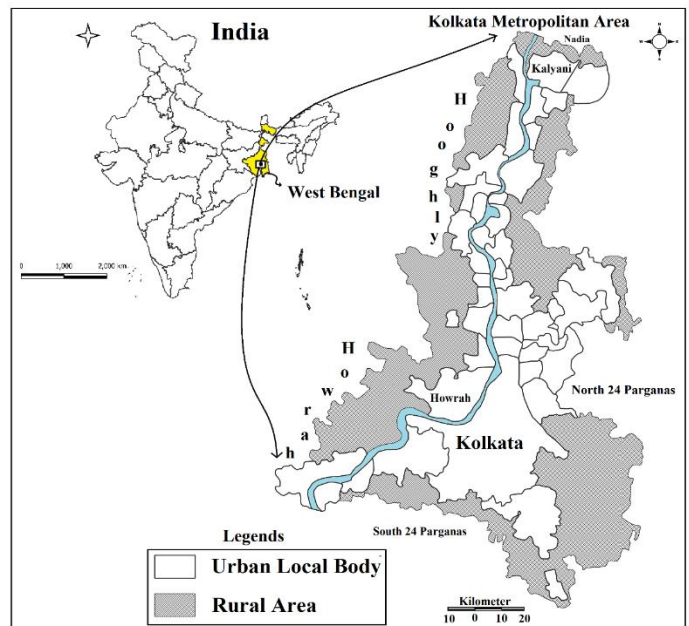


Fig 1: Kolkata Metropolitan Area (KMA)

Database and Methods

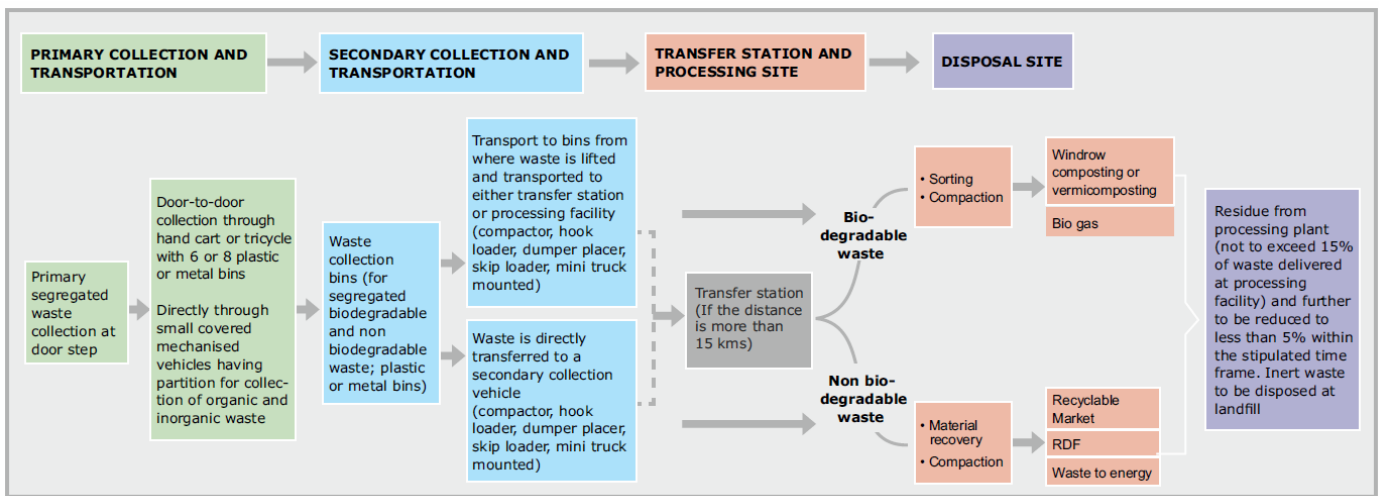
To analyze the municipal solid waste management across the 42 municipalities of KMA data have been acquired from West Bengal State Environment Plan prepared by department of environment in 2021. Waste generation, collection, segregation, treatment and dumping data of different municipalities have been taken into consideration for the analysis. 2011 and 2020 data of solid waste generation, collection and collection efficiency have compared across the municipalities. Collection efficiency have been calculated by dividing waste collection from waste generation. Per capita waste generation and collection is also used for the analysis. Composition of the waste is also studied for better understanding of the management process. Following figure 2 shows the whole process of municipal solid waste management into a flow a chart.

The process of municipal solid waste management is categorized into three major stages includes collection, transportation and disposal. Each stage have unique challenges. Moreover, each stage is also subdivided into separate stages. For instance, collection incorporates both primary and secondary collection. Segregation of waste at the household is a process comes under collection. In fact segregation has a major roles in the subsequent stages of waste management. Likewise, transportation vehicle also effects the waste management procedure.

TABLE 1
Demographic Details of Kolkata Metropolitan Area, 2011

Municipality	Population	Area in sq. km	Density Per sq. km	Municipality	Population	Area in sq. km	Density Per sq. km
Baidyabati	121110	12.03	10067	Kanchrapara	129576	9.07	14286
Bansberia	103920	9.07	11458	Khardah	109342	6.87	15916
Baranagar	292637	7.12	41101	Kolkata	4486679	206.08	21772
Barasat	278435	34.5	8071	Konnagar	76152	4.67	16307
Barrackpore	152783	10.61	14400	Madhyamgram	220000	21.5	10233
Baruipur	53128	9.07	5858	Maheshtala	449423	44.18	10173
Bhadreswar	101477	8.28	12256	Haringhata	45953	35	1313
Bhatpara	385867	27.02	14281	Naihati	256447	11.55	22203
Bidhannagar	634107	61.48	10314	New Barrackpore	76879	8.69	8847
Budge Budge	76858	9.06	8483	Barrackpore (N)	132806	13.6	9765
Champdany	111251	605	184	Dum Dum (N)	249142	20	12457
Chandannagore	166771	22.03	7570	Panihati	422000	19.38	21775
Dankuni	103466	19.5	5306	Pujali	37100	8.33	4454
Dum Dum	114786	9.73	11797	Rajpur-Sonarpur	423724	49.25	8604
Garulia	85336	4.96	17205	Rishra	124585	6.763	18422
Gayeshpur	58998	22.63	2607	Serampore	183339	17.6	10417
Halisahar	124851	8.29	15060	Dum Dum (S)	403316	17.25	23381
Hooghly-Chinsurah	177259	17.29	10252	Titagarh	116520	3.39	34372
Howrah	1370448	63.55	21565	Uluberia	232290	34.1	6812
Kalyani	100620	29.14	3453	Uttarpara-Kotrung	162386	12.58	12908
Kamarhati	331163	10.9	30382	Rajarhat-Gopalpur	402844	28	14387

Source: Census of India, 2011, Town Directory



Source: Handbook on solid waste management by Government of West Bengal

Fig 2: Flow Chart for Household Waste Collection, Transportation and Disposal

Following section analyzed the each stages and its challenges in the KMA.

Overview and Current Situation

Broadly, there are two models for the operationalization of solid waste management at the municipal level. In the centralized method, urban solid waste is collected from the entire city and dumped outside the city limits for disposal. This process deals with door-to-door collection by waste pickers. The waste pickers will hand it over to the collection team and the collected waste will be disposed of in a landfill. A waste collector is an employee of the urban local body. On the contrary, in de-centralized method waste is collected ward-wise and divided into biodegradable and non-biodegradable at source. Biodegradable waste is composted at nearby facilities using a variety of aerobic and anaerobic composting methods. Non-biodegradable waste is further categorized as paper, plastic, metal and other waste, and is further collected by recyclers for the up-cycling or down-cycling of products. Kolkata Metropolitan Area follow centralize method for solid waste management.

To address the issues of solid waste, the Ministry of Environment, Forestry and Climate Change (MoEF & CC), Government of India has enacted the Municipal Solid Waste (Management and Disposal) Rules, 2000. These rules set out a set of guidelines for the scientific handling and disposal of waste. Then, 16 years later, the rules were revised in 2016 by government, issuing the latest SWM Rules in 2016, to govern the collection, disposal, efficient management of municipal solid waste in India. Under these rules, responsibility for solid waste management is delegated to urban development departments and local municipal governments. The main difference between the two rules is that the new rules hold waste producers accountable for implementing integrated waste management. For example, waste producers are required to separate waste into two or three streams - biodegradable, non-biodegradable and hazardous to the household, otherwise the producer is subject to fines.

In KMA all municipal authorities are responsible for collection, treatment and disposal of municipal solid waste.

Waste Generation

As cities grow, land use becomes more complex, and the waste generated increases in volume and variety (Omuta, 1987). The amount of MSW produced in a ULB depends on several factors such as eating habits, standard of living, commercial activity level, and season. Quantity variation and generation of MSW data are useful for planning collection and disposal systems. Municipal solid waste generally comes from different sources namely household, commercial activity and institutional.

It was reported that KMC alone produced 1300 tons waste per day in the early 1960s to about 2000 tons in the late 1980s (Giri and De, 1992). It is evident from the table 2 that in 2011 KMC generated more than 2240 tons waste and in 2020 it become more than 4000 tons. Howrah Municipal Corporation

(HMC) is the second largest waste producer in the KMA. Apart from KMC and HMC other ULBs also generates huge amount of refuse. Baranagar, Barasat, Bhatpara, Bidhannagar, Mahestala, Naihati, Dum Dum (N) and Panihati generated more than 100 metric tons of waste in a year.

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Haringhata, Pujali, Dankuni and Uluberia produced less than 20 metric tons waste per year. It is remarkable that Bhadreswar, Champdani and Pujali have negative growth of solid waste. Bhatpara and Bidhannagar registered the highest amount of growth of waste. In case of Bidhannagar it is high due to the merger of Rajarhat-Gopalpur municipality with Bidhannagar municipality. The average growth of waste in KMA is more than 7 percent while average waste generated in 2011 was 90 metric ton and in 2020 it became 132 tons. Per capita waste generation is highest in South Dum Dum municipality and lowest in Uluberia municipality. Average per-capita waste generated in the KMA is 468.86 gram in a day. There are 24 municipalities which produce less than 468.86 gram wastes per day.

Composition of the Waste

The composition and quantity of municipal solid waste generated is the basis for planning, designing and operating management systems. In fact it enable the ULBs to decide desired frequency of collection as well as precautions to be taken during its transportation and method of processing and disposal. The composition of waste can vary significantly between municipalities due to differences in living standards, dietary habits, etc. The physical and chemical characteristics of MSW in KMA are presented in Table 3.

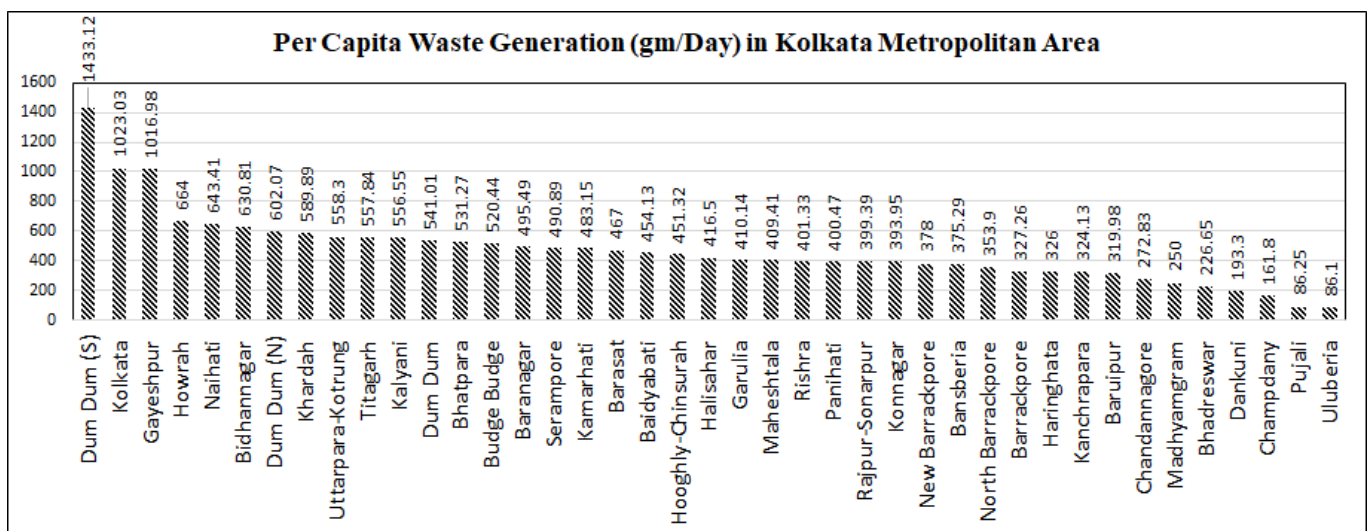
TABLE 3
Composition of Solid Waste in Kolkata Metropolitan Area

Physical Properties	2009	2020	Chemical Properties	2009	2020
Biodegradable	41	50.56	Moisture	42.84	46
Paper	3.18	6.07	pH	7.31	8.07
Plastic	0.65	4.88	Loss of ignition	35.24	38.53
Glass and crockery	0.58	0.34	Carbon	19.58	22.35
Metal	0.66	0.19	Nitrogen	0.55	0.76
Inert	37.9	29.60	Phosphorous	0.57	0.77
Wood Matter and coal	8.08	1.15	Potassium	0.40	0.52
Rubber	--	0.68	C/N Ratio	35.6	31.81
Rags	--	1.87	LCV Kcal/Kg	549.32	1201
Coconut	4.95	4.50			
Others	3.00	0.18			

TABLE 2
Waste Generation in Kolkata Metropolitan Area

Municipality	Waste Generation (MT)			Municipality	Waste Generation (MT)		
	2011	2020	Growth %		2011	2020	Growth %
Baidyabati	NA	55	----	Kanchrapara	NA	42	----
Bansberia	NA	39	----	Khardah	NA	64.5	----
Baranagar	79.69	145	8.2	Kolkata	2248.45	4590	10.4
Barasat	90.49	130	4.4	Konnagar	19.04	30	5.8
Barrackpore	38.2	50	3.1	Madhyamgram	49.03	55	1.2
Baruipur	13.28	17	2.8	Maheshtala	145.7	184	2.6
Bhadreswar	25.37	23	-0.9	Haringhata	NA	0.15	----
Bhatpara	125.46	205	63	Naihati	70.82	165	13.3
Bidhannagar	70.04	400	46.8	New Barrackpore	19.21	29.06	5.1
Budge Budge	NA	40	----	North Barrackpore	33.2	47	4.2
Chamdany	27.81	18	-3.5	Dum Dum (N)	80.97	150	8.5
Chandannagore	41.72	45.5	0.9	Panihati	122.64	169	3.8
Dankuni	NA	20	----	Pujali	9.26	3.2	-6.5
Dum Dum	28.7	62.1	11.6	Rajpur-Sonarpur	137.92	169.23	2.3
Garulia	21.33	35	6.4	Rishra	31.14	50	6.1
Gayeshpur	14.75	60	30.7	Serampore	45.46	90	9.8
Halisahar	31.23	52	6.7	Dum Dum (S)	NA	578	----
Hooghly-Chinsurah	NA	80	----	Titagarh	NA	65	----
Howrah	NA	910	-----	Uluberia	NA	20	----
Kalyani	25.14	56	12.3	Uttarpara-Kotrung	39.79	90.66	12.8
Kamarhati	NA	160	----	Mean	89.89	131.63	7.68

Source: State Environment Plan: West Bengal, 2020, Ministry of Urban Development, 2011 NA: Not Available, MT: Metric Tons



Source: State Environment Plan: West Bengal, 2020

Fig 3: Per Capita Waste Generated (gm/day) in Kolkata Metropolitan Area

The composition of MSW at source consists mainly of a large biodegradable matter (50%), inert (30%), paper (6%) and plastic (4.48%), glass, rubber and metals (each less than 1%), coconut (4.50%). The C/N ratio is about 32, and the lower calorific value is 1201 kcal/kg. It is apparent that most non-degradable waste consists of potentially recyclable materials, and the degradable portion can be composted. Furthermore, that it is noticeable that biodegradable matter has increased over the last decade but share of plastic in degradable matter has also increased in the municipal waste.

Collection

This starts at the households as well as at the community lines. Though, few years' back house to house collection was almost non-existent. After 2016 enactment, segregation of waste at the household has been mandated to transform the waste into wealth by '*recovery, reuse and recycle*'. In fact, responsibilities of generator or household have been introduced to segregate waste into three different forms Wet (Biodegradable), Dry (Plastic, Paper, metal, wood, etc.) and domestic hazardous wastes (diapers, napkins, empty containers of cleaning agents, mosquito repellents, etc.) and handover segregated wastes to authorized rag-pickers or waste collectors or local bodies.

From the table 4 it is evident that collection efficiency varies across the municipalities, ranging from 7 percent to 100 percent. Baidyabati, Bhadreswar, Bhatpara, Bidhannagar, Dankuni, Dum Dum, Haringhata and Pujali are some of the municipalities where collection efficiency is 100 percent. Konnagar, Maheshtala, Gayeshpur are the municipalities where collection efficiency is less than 50 percent. Average waste collection efficiency in KMA is 85 percent.

It is reported that door to door collection is practiced fully in some ULBs while in some municipalities it is practised partially. Most of the collection takes place within the period of 7 am to 10 am and preferred modes of collection include wheelbarrows, tricycle and push carts. It is remarkable that most of the vessel are not compartmentalised which means waste cannot be stored in a segregated manner. Each worker engaged in collection of waste from household is assigned to a beat. The number of household covered by such a collector in one beat varies from as low as 10 household to 60 household, which depend on the size of the beat. The waste collected from household is deposited at a designated common points within the collection area comprising of several beats either into a large vehicles such as dump truck or tipper anchored to a tractor.

Waste storage depot is placed at ward level for household garbage collection. It is a place where primary collection equipment could be stored and labours could assemble for duty allotment. This is the concept of ward Depot system for primary collection of garbage. Only 22 ULBs out of 41 segregate waste.

Most of the informal agglomeration of waste done by the residents or private person engaged by residents to dump waste collected from households in the open plots which are socially acknowledged as places to dump waste. Many of these are

cleaned up but in case of large vacant tracts of land the simply accumulates.

Per capita waste collected also varies across the municipalities of KMA. Highest amount of per capita waste is collected by South Dum Dum municipality while least amount of per capita waste is collected by Uluberia municipality. Average per capita waste collection is only 427.90 grams per day. Therefore, average per capita 40.96 grams of waste remain uncollected per day.

Transport

The second phase of the solid waste removal is transportation to the disposal site. Equipment used for the primary collection include hand cart, Tricycle van, battery operated hydraulic dumper, auto tipper etc. Loader, dumper placer are used for secondary collection while tractor and compactor and dumper are used in the sanitary landfills as well as in the composting site.

Equipment used for street sweeping mainly in major roads, lanes. By-lanes manpower is used for sweeping and in high speed roads mechanical sweepers are used (CMDA, 1990). To improve the air quality in traffic congested areas some street watering and washing vehicles are also used. It is remarkable that vehicles are not uniformly available across the municipality. The following table 5 presents different types of vehicle available across the different municipalities.

It's evident that tractors are available across the municipalities but there inadequate number of dumper placer, compactor and loaders. It is reported that trucks which are used for transportation to garbage disposal site have been found to be very inefficient because excessive height of the body makes manual loading difficult. They cannot carry 3 to 4 tons of garbage due to its low density and high bulk although their rated capacity is 8-10 tons. To overcome this difficulties roll-on-off tipper type of container with prime mover has been prescribed.

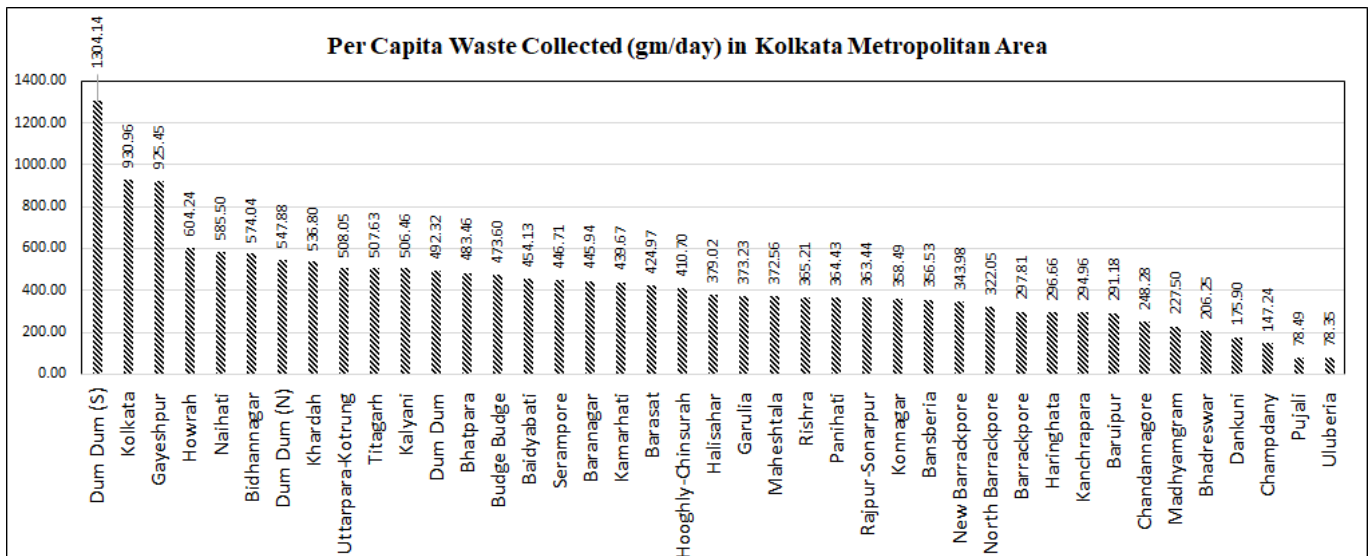
Disposal and Treatment

The third phase of solid waste management is disposal of the garbage is done by dumping of the garbage in low marshy lands acquired by different urban local body. Waste storage depot varies across the ULBs and per thousand household it ranges from 0 to 13.39. Barrackpore, Chandannagore, New Barrackpore, Kolkata and Serampore have more than 10 waste storage depot per thousand household. Baranagar, Barasat, Gayeshpur, Kalyani, Konnagar, Madhyamgram, Maheshtala, Haringhata and Dum Dum (N) have less than one waste storage depot per thousand household. Mean storage depot in KMA is 3.89 per thousand household. Landfilled infrastructure also varies across the ULBs and only 20 municipalities have landfill site where waste is allowed to decompose into biologically and chemically inert material in a setting isolated from the outside the ULBs.

TABLE 4
Waste Collected in Kolkata Metropolitan Area

Municipality	Collected (MT)	Uncollected (MT)	Collection Efficiency %	Municipality	Collected (MT)	Uncollected (MT)	Collection Efficiency%
Baidyabati	55	0	100	Kanchrapara	40	2	95
Bansberia	37	2	95	Khardah	53	11.5	82
Baranagar	130	15	90	Kolkata	4500	90	98
Barasat	118	12	91	Konnagar	2	28	7
Barrackpore	45	5	90	Madhyamgram	46	9	84
Baruipur	15	2	88	Maheshtala	36.3	147.7	20
Bhadreswar	23	0	100	Haringhata	0.15	0	100
Bhatpara	205	0	100	Naihati	148.5	16.5	90
Bidhannagar	400	0	100	New Barrackpore	27.08	1.98	93
Budge Budge	25	15	63	North Barrackpore	43	4	91
Chamdany	13	5	72	Dum Dum (N)	135	15	90
Chandannagore	40.95	4.55	90	Panihati	152	17	90
Dankuni	20	0	100	Pujali	3.2	0	100
Dum Dum	62.1	0	100	Rajpur-Sonarpur	147.1	22.13	87
Garulia	25	10	71	Rishra	45	5	90
Gayeshpur	25	35	42	Serampore	80	10	89
Halisahar	47.5	4.5	91	Dum Dum (S)	520	58	90
Hooghly-Chinsurah	65	15	81	Titagarh	59	6	91
Howrah	885	25	97	Uluberia	12	8	60
Kalyani	51	5	91	Uttarpara-Kotrung	89.81	0.85	99
Kamarhati	140	20	88	Mean	---	15.31	85.02

Source: State Environment Plan: West Bengal, 2020



Source: State Environment Plan: West Bengal, 2020

Fig-4: Per Capita Waste Collected (gm/day) in Kolkata Metropolitan Area

TABLE 6
Disposal Infrastructure of KMA

Municipality	Waste storage depot per 1000 household	(Quantity of waste Landfilled (MT/Day)	Dumpsite	Sanitary Landfill (No)	Municipality	Waste storage depot per 1000 household	(Quantity of waste Landfilled ((MT/Day)	Dumpsite	Sanitary Landfill (Nos)
Baidyabati	1.67	40	2	1	Kanchrapara	1.32	40	1	0
Bansberia	9.72	0	2	0	Khardah	4.62	0	1	0
Baranagar	0.90	0	1	1	Kolkata	12.15	4234	2	0
Barasat	0.32	0	0	0	Konnagar	0.00	200	1	1
Barrackpore	16.33	45	1	1	Madhyamgram	0.37	46	1	0
Baruipur	5.38	0	1	1	Maheshtala	0.00	54	1	1
Bhadreswar	1.53	11.38	1	1	Haringhata	0.07	0.15	0	0
Bhatpara	6.75	0	2	2	Naihati	4.12	0	2	0
Bidhannagar	1.24	0	1	0	New Barrackpore	13.39	0	2	2
Budge Budge	3.05	0	1	0	North Barrackpore	4.91	42	0	0
Champdany	3.37	15	1	1	Dum Dum (N)	0.34	0	0	0
Chandannagore	12.64	0	1	0	Panihati	3.08	0	1	0
Dankuni	0.00	0	1	0	Pujali	0.00	0	0	1
Dum Dum	1.56	62.1	1	1	Rajpur-Sonarpur	0.00	0	1	1
Garulia	7.43	0	1	0	Rishra	1.02	35	0	0
Gayeshpur	0.17	30	1	1	Serampore	13.73	30	2	1
Halisahar	2.38	20	1	2	Dum Dum (S)	0.21	0	1	1
Hooghly-Chinsurah	1.78	0	1	1	Titagarh	9.22	50	1	0
Howrah	5.46	10	2	0	Uluberia	5.81	12	0	2
Kalyani	0.32	52	1	0	Uttarpara-Kotrung	1.31	52.81	1	0
Kamarhati	1.88	116	1	1	Mean	3.89	126.77	1.44	0.59

Source: State Environment Plan: West Bengal, 2020

In KMA only 34 municipalities have dump site and some of the ULBs have more than dumpsite. Barasat, Haringhata, North Barrackpore, Dum Dum (N), Pujali, Rishra, Uluberia have no dumpsite under their control. However, there are municipalities which share common dump site. For instance Serampore, Konnagar, Rishra, Uttarpara-Kotrung, Chandannagore and Baidyabati have common regional landfill facilities. The landfill capacity of these common place is 210 tons per day. Each municipality has different capacity of landfill and table 7 gives an idea about that.

The data shows that there are some municipalities which have composting facilities but all of them are not in operation. Composting facilities are in operation in Baidyabati, Champdany, Chandannagore, Serampore, Uttarpara-Kotrung, and Rishra. The Solid waste Management (SWM) Rules, 2016 maintains that all Class I cities in the state shall have both compost plants and landfill sites, while other cities or towns with a population of less than 1 lakh shall have only suitable engineered landfill sites. However, in reality only few municipalities have these facilities.

TABLE 7
Composting and Landfill Facilities in KMA

Municipality	Landfills Capacity TPD	Composting TPD
Baidyabati	48	20
Champdany	15	30
Chandannagore	30	35
Serampore	30	38
Uttarpara-Kotrung	22.81	28
Konnagar	12.5	15
Kolkata	NA	500
Rajpur-Sonarpur	NA	1
Rishra	45	25
Bhadreswar	11.38	10

Source: West Bengal Pollution Control Board, 2021, NA= Data Not Available

Challenges of Collection, Transportation and Disposal

From the above discussion some of the common challenges across the municipalities of KMA can be identified. As noted earlier that most of the municipalities do not segregate the waste while collecting from household. Subsequently, mixed waste is transported to the dumpsite and it is difficult to segregate the material there for further processing. Secondly, municipalities do not have adequate number of different types of specialized vehicles and equipment to collect waste from the household as well as from community bins. Thirdly, per capita collection of waste is also inadequate across the ULBs. Fourthly, availability of dumpsite is also very few in number. In fact, some of ULBs do not have dumpsite. In addition there are only few municipalities where landfill and composting are in operation. Another significant challenge is workers' lack of training and equipment facilities. Studies show that a high percentage of workers who handle waste, and individuals who live near disposal sites, are at risk of being infected with worms or parasites (UNEP, 2005).

Way Forward

How to manage the municipal solid waste in a developing country is a major issue from policymakers to urban managers. Waste management in large cities is particularly challenging due to the sheer volume of waste. Since this paper focuses only on household waste, so our suggestions are confined to management of household waste generated in local bodies. All the municipalities in KMA follows the centralized model of waste collection under the supervision of local body. To manage waste local bodies can develop public private partnership (PPP) for collection, transportation and waste processing. Waste collection can be done through decentralized model. It reduces the cost incurred for the collection, transportation, and disposal of waste by the ULBs. Trainings of the worker should be given so that they can collect the waste appropriately. Moreover, training should be given to the household members so that they can segregate the household waste. To manage biodegradable waste composting plan could be developed through PPP and biogas could be sold at the market.

Options for private sector involvement in municipal solid waste management (MSWM) span the entire MSW value chain. At one end of the spectrum, ULBs can invest across the value chain by creating the fixed & movable assets and outsourcing management of the entire value chain to private operators through service contracts. At the other end of the spectrum is ULB inviting private developers to invest in and maintain MSW's value chain via concession or his BOT (Build-Operate-Transfer) contract. It is essential for ULB to understand project requirements and deliverables based on its own internal project analysis and desired outcomes.

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