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Municipal Solid Waste Management of Barrackpore Sub-division, West Bengal, India: Challenges and Prospects

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Abstract

Municipal Solid Waste Management (MSWM) is a complex, crucial and comprehensive process, associated with the public health and economy. In the Indian context, increasing population pressure and consumerism, exerting an everyday challenge of managing huge volume of solid waste, especially for the Urban Local Bodies (ULB). This study attempted to observe the MSWM models followed by the six municipalities- North Barrackpore, Barrackpore, Titagarh, Khardah, Panihati and Kamarhati, under the Barrackpore sub-division and Kolkata Metropolitan Area (KMA) of West Bengal, India, from 2011 to 2022. Analyses of the municipal data and surveys showed that, rapid increase in the annual solid waste volume ranging from 57.53% to 81.10% over a decade, for each of the ULBs. Despite development in the infrastructural facilities, a gap between the demand and availability of solid waste dumping grounds and management strategies was observed. Unavailability of the proper segregation strategy, plastic recycling facility, engineered sanitary landfilling, scientific incineration, along with the human resources and funding make the MSWM more challenging. Huge production of the biodegradable waste from the households generates a potential for the compost and biogas production, yet to be implemented. Modification in the management strategies, policy reforms along with the public awareness are significant for all the stakeholders. Implementation of Public Private Partnership (PPP) model can boost the strategies overcoming the challenges and risks.

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KEYWORDS: Municipal solid waste management, dumping grounds, municipalities, Barrackpore sub-division, Kolkata.

1. INTRODUCTION

Municipal Solid Waste Management (MSWM) is considered as one of the fundamental public services provided by the Government Urban Local Bodies (ULBs) in India. Hoornweg and Bhada (2012) [11] estimated for approximately 2.2 billion tons global municipal solid waste production per annum by the year 2025, whereas in Indian cities it is predicted to be 300 million tons by 2047, from just 6 million tons as of 1947 (Agarwal, Chaudhary and Singh, 2015) [2]. As per the report of UN DESA (2018) [22], currently 55% of the population live in urban areas and will constitute 68% of the total population by 2050. Along with this, the global trend of consumerism has tripled the utilization of natural resources of this planet (UNEP, 2015) [23]. Thus, MSWM is a complex and comprehensive process with multiple stakeholders (Bhardwaj and Rai, 2021) [4].

Kolkata Metropolitan Area (KMA), is the extended metropolitan outfit of Kolkata, under the control of the Kolkata Metropolitan Development Authority (KMDA), consisting of 1876 sq.km. of area of six sharing districts, at the bank of river Hooghly- Ganga (Chatterjee, 2008) [6]. KMA shared around 55% of total urban population of the Indian state of West Bengal (Census, 2011) and projected as 21.1 million by 2025, with a population density of 8500 persons per sq. km. (KMDA, 2026) [14]. Karmakar (2023) [13] highlighted a huge production of solid waste from the KMA, every day. This trend was observed at the Kolkata Municipal Corporation (KMC) and 24 municipal zones adjacent to the KMC by Sanyal *et al*. (2010) [17] and in the Salt Lake City, Kolkata by Maity *et al*. (2011) [15] and also discussed the MSWM strategies.

This study attempted for a comparative account of the solid waste production and MSWM across the six municipal zones of Barrackpore subdivision over a decade, i.e., years 2011 and 2022. Das *et al*. (2010) [8] studied the MSWM of the KMA including the six ULBs selected in this study and observed a gap between the per day waste generation and management at the stages of segregation, collection, transport, infrastructure, hygiene etc. They also recommended for the organized involvement of rag-pickers, public awareness and adoption of PPP model. Challenges of accelerated solid waste production with the population increase are subject to implementation of well-designed solid waste management strategies.

2. METHODS

2.1 STUDY AREA

Barrackpore subdivision had been historically significant and populated zone of the North Twenty Four Parganas district and Kolkata Metropolitan Area (KMA) of West Bengal, India. The subdivision has two administrative blocks- Barrackpore-I and II, having 16 municipal areas. This study was conducted with the six municipalities- North Barrackpore, Barrackpore, Titagarh, Khardah, Panihati and Kamarhati (22.7955ºN, 88.3728ºE to 22.6847ºN, 88.3706ºE). The studied ULBs cover about 19.37% (64.77 sq. km.) of the total area (334.51 sq. km.) but holding 33.25% (12,19,965 people) of the total population (36,68,653 people) of the subdivision (Census, 2011). Municipalities, divided into wards, were considered for the sources of the MSW productions. The solid waste dumping grounds, as a part of MSWM were also visited along with the surveys at the municipal areas.

Table 1: Particulars of the municipalities and dumping grounds

Municipality	Area Cover (in sq. km.)	No. of Wards	Dumping Ground	Area Cover of the Dumping Ground (in Acre)
North Barrackpore	12.22	23	Titagarh Municipality Dumping Ground, Kolkata- 700119 (TMDG)	7.88
Barrackpore	10.61	24		
Titagarh	3.24	23		
Khardah	6.87	11	Khardah Municipality Dumping Ground, Dangadighila, Doperia, Bandipur, Kolkata- 700119 (KHMDG)	4.50
Panihati	19.38	35	Panihati Municipality Dumping Ground, Ramchandrapur, Sodepur, Kolkata- 700110 (PMDG)	3.43
Kamarhati	10.96	35	Kamarhati Municipality Dumping Ground, Agarpara, Kolkata- 700109 s(KMDG)	8.70

2.1 DATA COLLECTION AND ANALYSIS:

Municipal authorities of the six selected zones were communicated for obtaining the data from the respective municipal records or databases. A questionnaire was prepared based on the primary surveys at the selected zones along with the bibliographic studies. This consists of questions related to population parameters, parameters related to the quantity of the total solid waste, quality type of waste- biodegradable, non-biodegradable, plastics etc., strategies for solid waste management like- man power involved, machines and technologies used, number of dumping grounds, disposal strategies, incineration methods, major government or non-government projects and budg*et al*locations.

Solid waste management strategies practiced by the ULBs, were observed by random on-site surveys at different wards or localities. The dumping grounds (Table- 1) were also visited to observe the solid waste dumping strategies, incineration, segregation of wastes etc. factors.

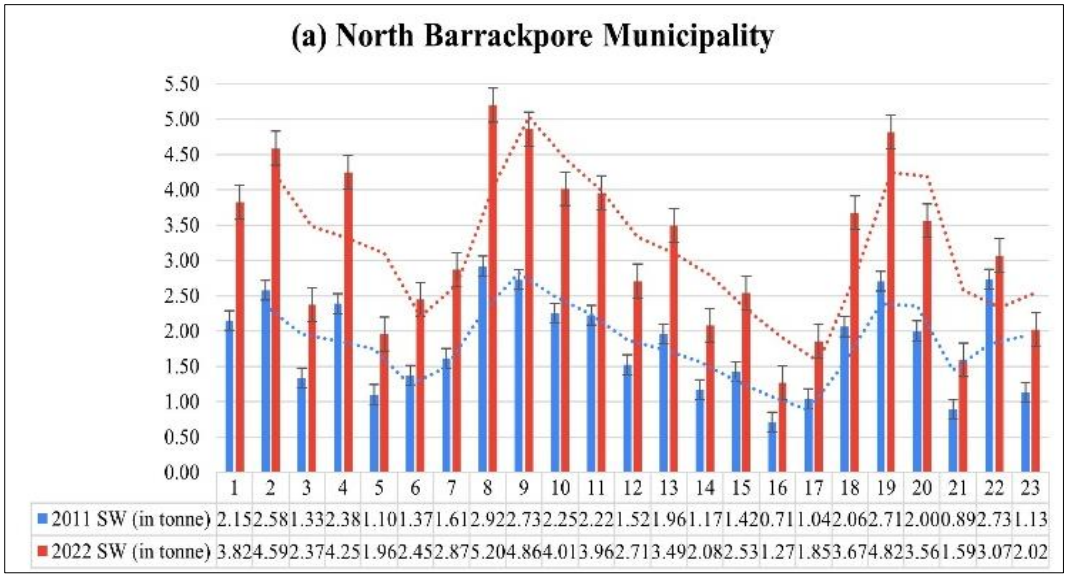
The data provided by the municipal offices were analysed to draw a comparative account of changes in the solid waste production along with the changes in the population parameters within the decade. The differences in the management strategies by the adjacent six municipal authorities were taken into account, as observed from the surveys and the municipal records.

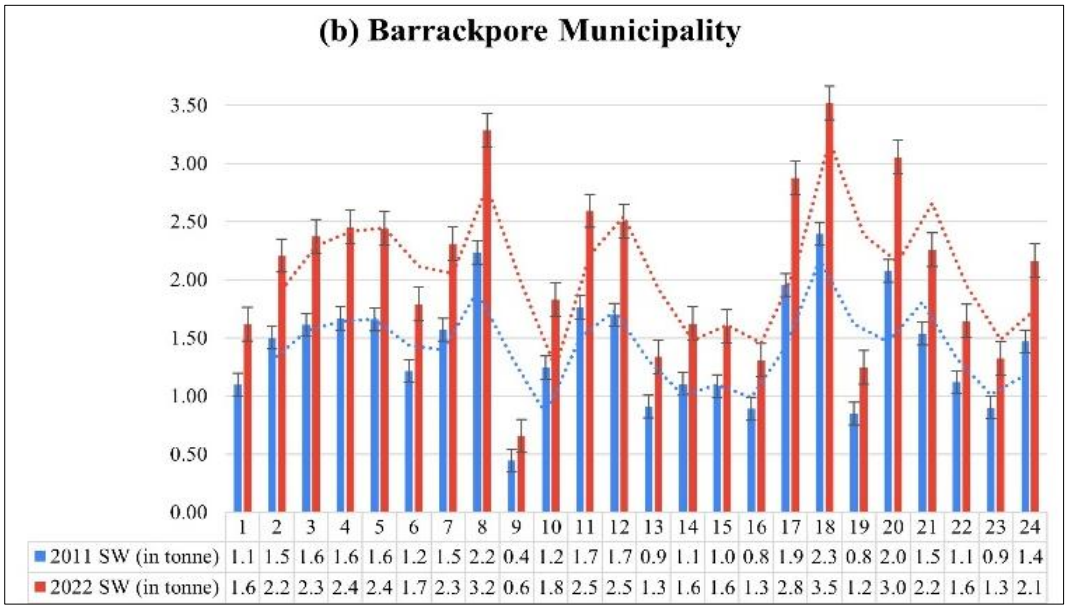
3. RESULTS AND DISCUSSION

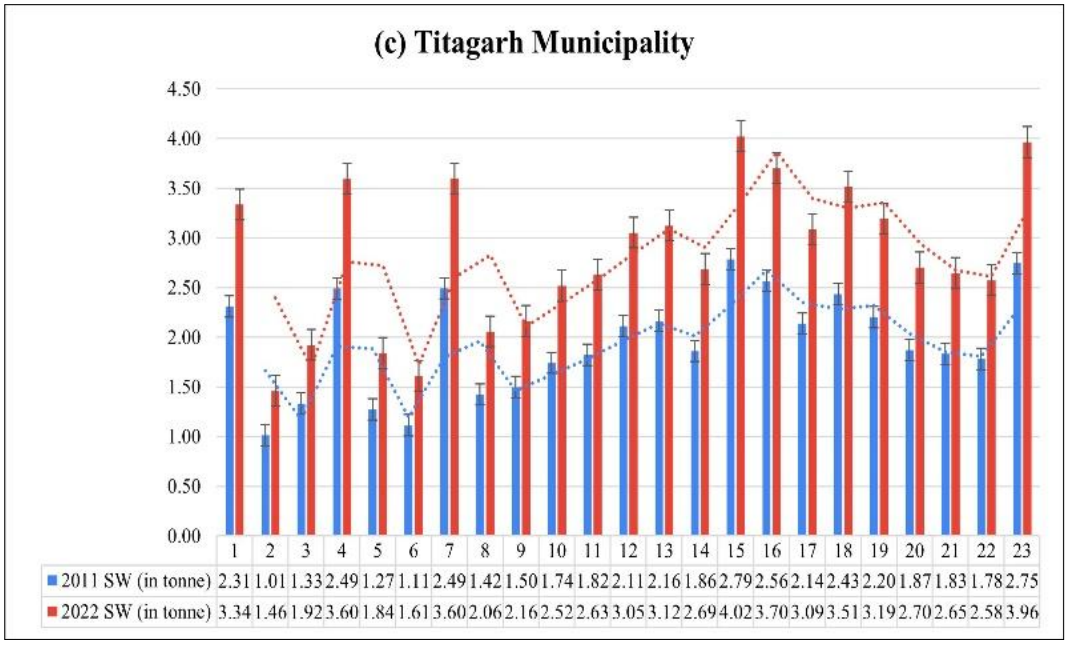
3.1 Solid Waste Production:

Average solid waste productions chiefly from the domestic sources by different municipal wards of the selected ULBs were

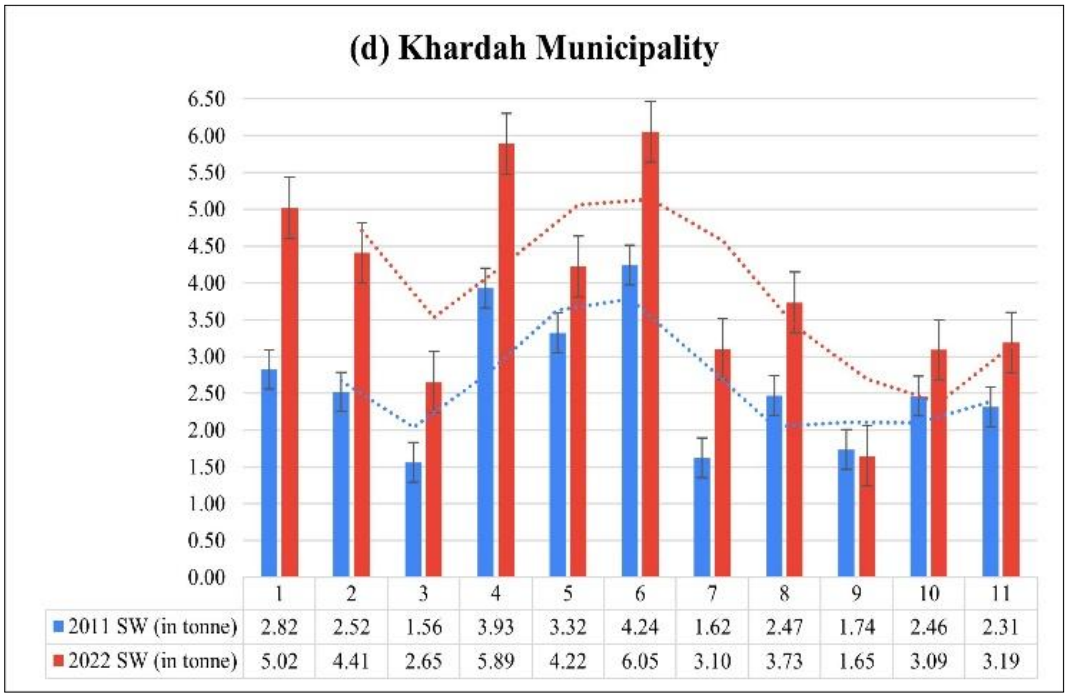
calculated on the basis of the data furnished by the municipal authorities in response to the questionnaire. Changes in the average production by the wards were compared between 2011 and 2022 (Fig. 1a-f) which showed significant increase over a decade. Annual average productions of the solid waste by the six municipal zones were also calculated. It showed 57.53% increase in the MSW production in North Barrackpore, 68% in Barrackpore, 69.23% in Titagarh, 67.44% in Khardah, 80.16% in Panihati and 67.74% in Kamarhati municipality (Fig. 2).



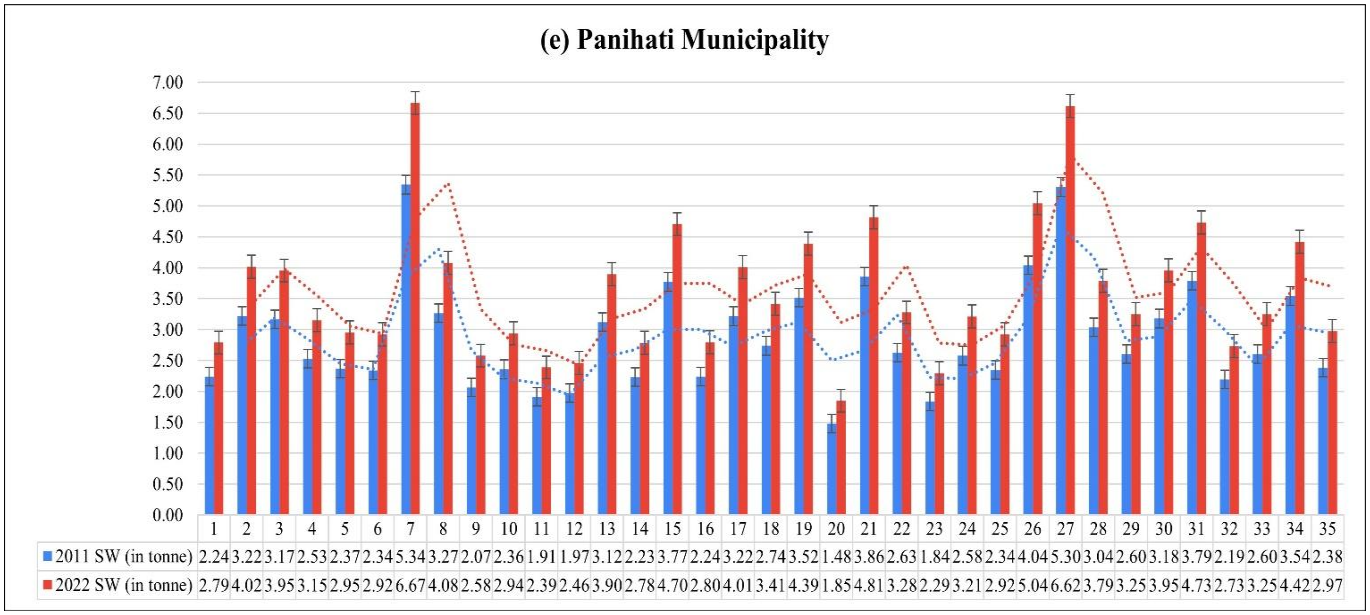




	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2011 SW (in tonne)	2.31	1.01	1.33	2.49	1.27	1.11	2.49	1.42	1.50	1.74	1.82	2.11	2.16	1.86	2.79	2.56	2.14	2.43	2.20	1.87	1.83	1.78	2.75
2022 SW (in tonne)	3.34	1.46	1.92	3.60	1.84	1.61	3.60	2.06	2.16	2.52	2.63	3.05	3.12	2.69	4.02	3.70	3.09	3.51	3.19	2.70	2.65	2.58	3.96



	1	2	3	4	5	6	7	8	9	10	11
2011 SW (in tonne)	2.82	2.52	1.56	3.93	3.32	4.24	1.62	2.47	1.74	2.46	2.31
2022 SW (in tonne)	5.02	4.41	2.65	5.89	4.22	6.05	3.10	3.73	1.65	3.09	3.19



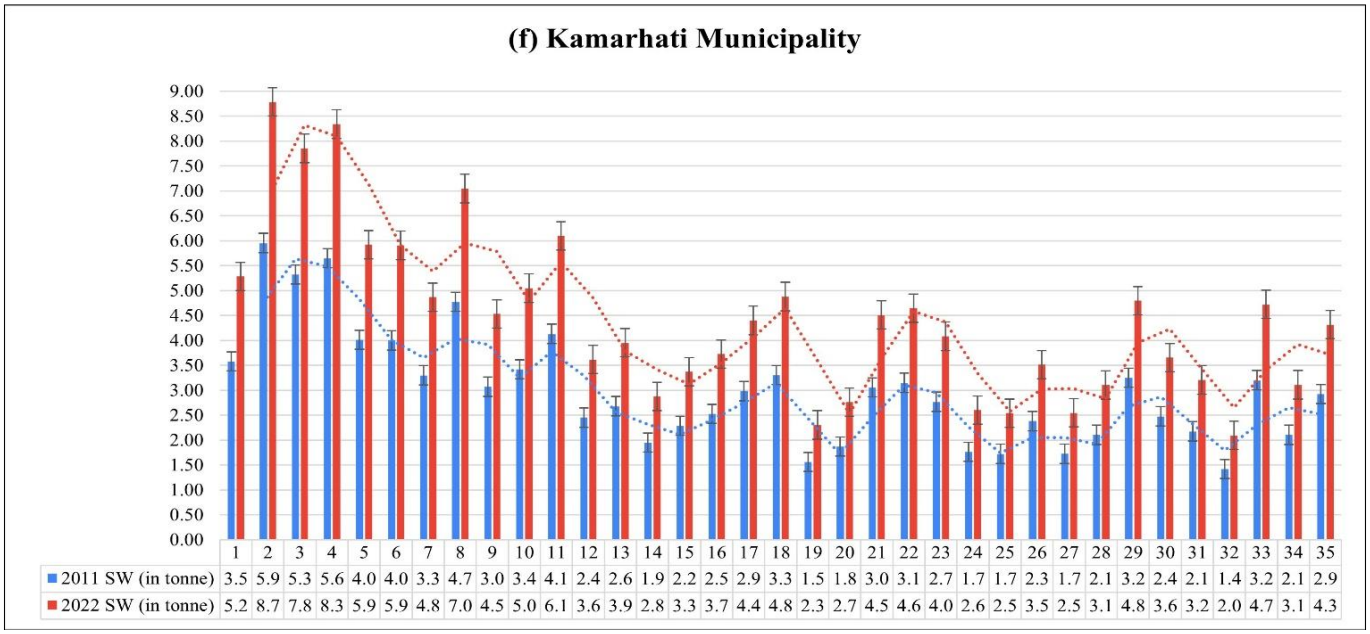


Fig 1a-f: ward wise per day SW production by municipalities in 2011 and 2022

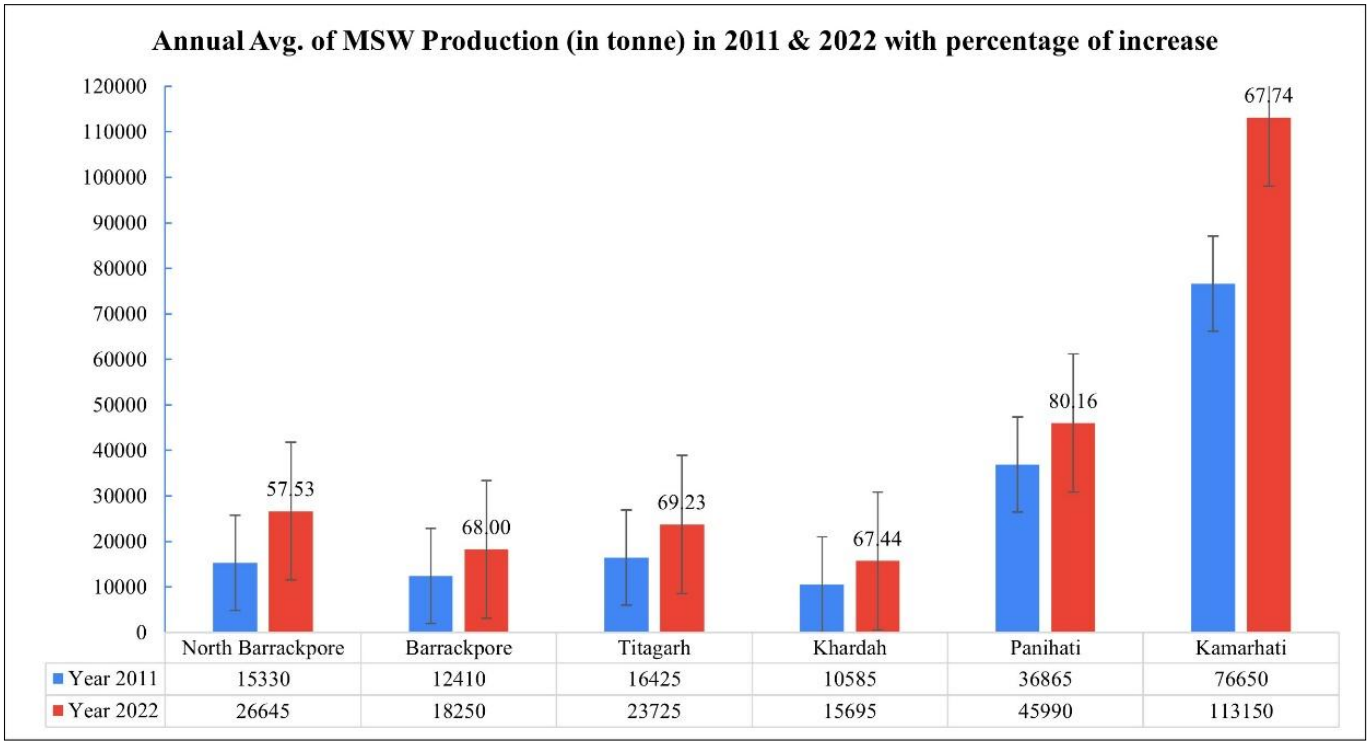


Fig 2: Annual average of MSW production by the municipalities in 2011 and 2022 with percentage of increase

3.2 Solid Waste Management

3.2.1 Collection of Solid Waste

Collection of the solid waste starts from the household level. The collectors, recruited by the municipalities on contractual or permanent basis, practice door to door collection in ward specific zones in between 07:00 a.m. and 10:00 a.m. Municipalities, as per the policy, distribute green and blue coloured collection buckets to every household in order to segregate the wet and dry wastes, respectively. Municipalities have also identified of some of the most common waste items from households (Table- 2) and suggested the citizens to segregate at very primary level or point sources in order to exercise better management techniques. The collectors are also provided with similar collecting bins by the municipalities in order to maintain the segregation of the wet and dry waste. Collections are also done from the community dust-bins of the zones, gathering wastes from shops, restaurants, markets, domestic animal husbandry, households etc. Tricycle vans, wheelbarrows, backhoe loader, push carts etc. are used to collect the wastes.

Table 2: Common waste items and WB SUDA (2019) [19] recommended bucket/bin/bag for segregated disposal

Type of Waste	Recommended Bucket/Bin/Bag	Common Waste Items
Wet Waste	Green Bucket/Bin	Surplus waste foods (veg' and non-veg'), fruit peels, vegetable peels, rotten fruits and vegetables, discarded egg-shells, discarded parts or pieces of fish, meat, bones etc., toilet paper, tissue paper etc. different types of waste papers, used tea and coffee bags, leaf-plates and bowls, earthen plates, glasses etc., waste flowers, waste from garden, faecal waste of pets etc.
Dry Waste	Blue Bucket/Bin	Newspapers, magazines, notebooks etc. dry paper wastes, glass bottles and other items, various plastic items, cardboard boxes, cartoons etc., plastic carry bags (> 50 micron), plastic wrappers of grocery and daily use products like milk, curd, spices, biscuits etc., balloons and rubber products, metal items, wooden items, old clothes etc.
Household Hazardous Waste	Black Bag	Containers of colours, varnishes, pesticides, household used chemicals, discarded batteries, bulbs, lights, thermometers, expired medicines, blades etc.
Household Sanitary Waste	Separate Wrapper	Used diapers, sanitary napkins, condoms, syringes, needles etc.

3.2.2 Human Resources and Finances

The collectors, assigned in at different municipal wards, divided into beats where work-load varies on the basis of number of wards of that municipal zone. Deployment of the human resources, consisting of both the contractual and permanently recruited employees, as collection staffs, transportation staffs, staffs at processing plants, designated as *Nirmal Sathi*, *Nirmal Bondhu*, Ward Supervisors etc. Recruitment depends on the area cover, population size, solid waste load, funding policies and administrative regulations at municipal and state government level. Each of the six municipalities has one sanitary inspector for overall supervision of the MSWM.

Elected public representatives or councillors also play vital role in monitoring the MSWM processes.

Wages of the contractual employees of the six ULBs, are mainly funded by the West Bengal Urban Employment Scheme (WBUES) of the Department of Urban Development and Municipal Affairs (UDMA), Government of West Bengal. As per the information from the municipal authorities, the combined strength of the human resources, both contractual and permanent, associated with the collection to disposal of overall solid waste management, as in 2022, is as shown in Table 4.

The WB SUAD (2019)[19]UDMA of the Government of West Bengal (2019), advisory states that the MSWM plan of the ULBs should involve following costs- front-end costs for land purchase or acquisition, building, permits etc., capital cost for infrastructures, operational costs, costs for remediation, property damage, personal injury etc. as contingency, environmental costs for formulating Environment Management Plan (EMP), downstream impacts, social costs for the maintenance of community images, aesthetics, property values, quality life etc. and the back-end costs for the financial assistance to the contractual retired employees, closure of dumping sites, demolition of structures etc. These costs to be incurred from different taxes under the jurisdiction of the municipalities like- property tax, conservancy tax, water tax, development fees, user charges etc. Fundings on MSWM from different government initiatives such as *Swachh Bharat Abhiyan*, *Mission Nirmal Bangla* etc. also aid a part. The advisory also suggests for the loans from Housing and Urban Development Corporation (HUDCO), National Bank for Agriculture and Rural Development (NABARD) of India, along with different international and national public sector banks, as per requirement. It also encourages for the PPP models and revenue generation from the solid waste treatment plants.

Table 3: Percentage of biodegradable and non-degradable waste produced by the municipalities in 2022

Municipality	Biodegradable (%)	Non-Biodegradable (%)
North Barrackpore	80	20
Barrackpore	60	40
Titagarh	65	35
Khardah	61	39
Kamarhati	60	40

Table 4: Human resources as per municipal data as on 2022

Municipality	Human Resources
North Barrackpore	500
Barrackpore	430
Titagarh	284
Khardah	184
Panihati	995
Kamarhati	300

3.2.3 Disposal of Solid Waste:

Waste collected by the collectors from different wards mostly by tri-cycle carts. Tipper trucks and tractors are then loaded to transport the waste to the disposal sites. Loaders, dumper placers, auto tippers etc. are commonly used to dispose the wastes to the designated dumping sites (Table 1 Fig 3).

The dumping ground of the Titagarh Municipality (ward no:23) is used jointly by the North Barrackpore, Barrackpore and Titagarh municipalities. Khardaha, Panihati and Kamarhati municipalities use their own dumping grounds. The dumping grounds vary in area cover, which is not proportional to the per day waste generation.

The practice of waste landfill to the open dumping sites allows waste to decompose and convert into chemically simpler molecules, not hazardous for the environment. As per the information from the ULBs, no facilities for engineered sanitary landfilling or composting plant, so the volume reduction of the waste depends on the natural decaying. The municipalities also lack organized incineration facility, energy production like bio-methanation, plastic segregation and recycling etc. required for scientific MSWM.

Fig 3: Google Earth image (15.02.2026) showing the dumping grounds of the municipalities as mentioned in Table 1

4. CONCLUSION

Global trend of increase in urban population, economic development and consumerism is leading to the huge production of solid waste every day and so are the challenges of management (Suocheng et al., 2001; Tyagi et al., 2014) [20, 21]. The selected six ULBs of Barrackpore subdivision, being in the vicinity of the core Kolkata metropolis and part of the KMA, showing rapid increase in the population and so the solid waste production. The instruments, vehicles and other infrastructural facilities of the municipalities have developed much over a decade, as per the municipal information. Digitization, web-portal based system etc. have improved the documentation and record keeping facility, impacting on the policy reform and implementation.

However, to combat the challenge of population dependent waste load increase, municipalities require expansion of the

solid waste dumping grounds, subject to the land acquisition and urban planning. North Barrackpore, Barrackpore and Titagarh municipalities using same dumping ground face a challenge to the space constraint. The locations of the dumping sites being nearby to the residential setups seem to be risky for the human health and environment. Moreover, the towns being older, the narrow lanes in many wards and traffic congestion of the Barrackpore Trunk (BT) Road, impose difficulty in transporting the waste to the dumping grounds. Sanyal et al. (2010) [17] studied the MSWM of three ULBs, including Titagarh- and recommended for eco-friendly disposal and solid waste treatment procedure along with the sanitary landfills to combat increasing load of solid waste every day.

According to Akolkar (2005) [1], the MSW disposal practice is not scientific in India which can be hazardous for human health and environment (Vergara, 2012) [24], causing fire hazards, unpleasant odour, irritability etc. (Jilani, 2002) [12] and attracting multiple vectors like- fleas, rodents, scavenging birds, pigs etc. to the waste site (Suchitra, 2007) [18] and cause occupational hazards to the municipal solid waste workers (Fleming and Bean, 1999) [9]. Bhattacharya (2022) [5] found that open dumping grounds at Kolkata metro-city are subject to health hazards, littering and visually unpleasant, as per public perception.

As per the information provided by the ULBs, there is no special planning or provision for the plastic waste recycling or scientific management. Bhardwaj and Rai (2021) [4] reviewed multiple dimensions of plastic waste management strategies, suitable for the Indian MSWM context.

Analysis of the composition of the generated waste is very important for the designing the MSWM strategies (Gomez et al., 2011; Dangi et al., 2011) [10, 7]. It was observed that, huge proportion of biodegradable waste (Table- 3) is being generated which has potential for the biofuel production, composting plant settlement, but not yet been implemented. Provisions for the engineered sanitary landfills, scientific incineration, plastic recycling industry are also there. Bera et al. (2012) [3] showed that composting heterogenous mixture of biodegradable solid waste, separated from the non-biodegradables from the 15 MSW heaps of Garulia and North Barrackpore municipalities using 'Novcom Composting Method' could produce a usable good quality compost free from phytotoxicity. However, Saha et al. (2010) [16], analysing MSW composts from 29 cities of India, found that those contain lower amount of nutrients and higher percentage of heavy metals in comparison to those produced from rural waste. So, they recommended for procedural modification during MSW compost productions.

The municipal zones, sharing the eastern bank of the river Hooghly-Ganga, directly or indirectly impact on the management of the solid waste mediated riverine pollution. More initiatives on the public awareness are required. Recommended '3Rs- recovery, reuse, recycle' policy implementation is very much dependent on scientific urban planning and waste management strategies.

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