

An Audit of Municipal Solid Waste Management in a Mega-City (East Delhi): Challenges and Opportunities



Sourabh Manuja, Suneel Pandey, Pallavi Gulati

Abstract: Municipal Solid waste management in developing countries is a gigantic task and its improper management can lead to severe environmental concerns and immense economic loss. However, many urban local bodies are not fully aware of the existing gaps in infrastructure and MSW management services that should be provided to make the system run efficiently and ensuring compliance to the national rules for waste management. The scale of the problem is huge as the reported annual MSW generation in India is about 58.87 Million tonnes (2016-2018) with an estimated annual increase of about 5%. We all know that inadequate collection of municipal solid waste results in local and global environmental problems, including air pollution (local health and global climate change) and water pollution (local water bodies and marine litter). The Solid Waste Management Rules of 2016 issued by the Government of India requires source segregation and collection; and identifies specific roles and responsibilities for stakeholders, including waste generators, collectors, and local government. The main objectives of the study were to conduct a gap analysis of the existing municipal waste management system in East Delhi Municipal Corporation (EDMC) area and to assist in ensuring proper implementation of Solid Waste Management Rules 2016. This paper presents the relevant national rules and the current collection practices in East Delhi based on the results of a recent survey of waste management practices. The survey revealed that much of the waste was not segregated, and found that lack of awareness, infrastructure, monitoring, incentives and penalties were the primary reasons for inadequate collection practices in the city. Door-to-door campaigns, television advertisements, and penalties for noncompliance were identified as some of the key measures to improve segregation and collection. The methodology used for the study was a mix of primary and secondary research tools like, transect walks, personal interviews with stakeholders, focus group discussions and literature review; in sample wards of the city to ensure a 90% confidence level. Such a study shall be useful for other developing countries to help identify priority areas of action and achieve sustainable MSW management.

Keywords- Municipal solid waste management, Source Segregation, Solid Waste Management Rules 2016, Waste Collection, Waste Survey

I. INTRODUCTION

Rapid population growth and increased urbanization over the past few decades has led to a tremendous increase in Municipal Solid waste (MSW) in many developing countries [1], [2],[3]. The amount of MSW in the world cities is expected to double by 2025 and reach 2.2 Billion tonnes a year [3],[4]. In India, the annual MSW generation is reported to be 58.87 Million tonnes for year 2016-2018 [5], [6], [7]. The annual increase in per capita waste generation is estimated about 1.33 % and on further accounting the increase in the population, the annual increase in waste generation quantity is estimated to be about 5% [8],[9]. This showcases an urgent need to properly manage the growing MSW in the country.

In developing countries, effective management of MSW is a gigantic task and improper management can lead to severe environmental concerns and immense economic loss [10], [11]. India as well as other developing countries are continuously looking forward for effective ways to establish a reliable, sustainable and an integrated waste management system. However, the fact is, in many countries, neither the waste generators are willing to adopt solutions like source segregation (separation of waste in dry and wet categories at its source of generation), nor the urban local bodies have clearly identified the existing gaps in waste management infrastructure and service.

This study is aimed at analyzing the existing status of MSW management in East Delhi Municipal Corporation (EDMC), particularly waste collection systems. Based on extensive field surveys, literature reviews, and analysis of collected data, this study analyzes the existing MSW management system and identifies the gaps in existing system to help EDMC in finding opportunities for improvement.

This paper explains the methodology, questionnaire and findings of the study and demonstrates the level /status of services currently provided by EDMC. Such a study can help other urban local bodies in developing countries across the globe to identify the gaps and help establish a baseline for the level of services provided and management of MSW.

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II. BACKGROUND AND METHODOLOGY

Delhi generates approximately 9620 tonnes of MSW d⁻¹ and is bifurcated into jurisdictions of five municipal corporations. The EDMC area supports about 23.5% of Delhi’s population (4.5 million in 2017) and generates on an average about 2310 tonnes of MSW d⁻¹ [12]. EDMC has one Waste to Electricity (W-E) plant of capacity 1300 Tonnes MSW d⁻¹ and one Ghazipur disposal site which has already exhausted its utilization capacity few years back (in 2002), but is still used for disposal.

According to the Solid Waste Management (SWM) Rules 2016, issued by Ministry of Environment Forest and Climate Change (MoEF&CC), GoI, waste generators are supposed to segregate and store their MSW generated in three streams, namely, bio-degradable, non-bio-degradable and domestic hazardous, and handover the segregated waste to waste collectors.

To analyze the current MSW management practices, a first of its kind of study was initiated in first week of June 2018 by The Energy and Resources Institute (TERI). Questionnaires were prepared keeping in mind the stipulated SWM Rules 2016 and various related stakeholders like waste generators, waste collectors, street sweepers and sanitary inspectors. The prepared questionnaire was tested on ground and reviewed before finalization in the pre-audit phase itself. The identified MSW management practices in EDMC has also been shown in Figure 1 for readers’ reference.

The study methodology involved: data collection regarding existing systems through personal interviews with officials and existing database of the Urban Local Body. For primary survey, stakeholder mapping was done on a power interest matrix. For achieving >90% confidence level and 10% acceptable margin of error about 60 colonies were selected spread across 40 wards, out of total 469 colonies and 64 Wards under EDMC’s jurisdiction. As EDMC categorizes colonies into category C, D, E, F, G, H, based on property tax, a proportionate number of samples for analysis were selected from each category. A random selection of colonies from different categories was done keeping in mind that the whole EDMC area was represented geographically. The colonies selected were surveyed based on a 200m x 200m grid. Table I depicts the selection process of various colonies.

Table 1: Sample of colonies from different property circles in EDMC

Category	No of existing colonies	Percentage	Sample Size (n= 60)	Round Off
C	2	0.43	0.3	1
D	52	11.09	6.7	7
E	9	1.92	1.2	1
F	239	50.96	30.6	30
G	144	30.70	18.4	18
H	23	4.90%	2.9	3
Total	469	100%		60

Based on a power interest matrix (categorization of project stakeholders with increasing power and interest in the project), stakeholders were interviewed as per the questionnaire prepared by the TERI team. The final survey was conducted in the EDMC area with 282 households, 57 institutions, 89 markets, 87 street vendors, 49 street sweepers, 45 waste collectors, 5 heavy truck transporters, 5 Resident Welfare Associations and 12 waste supervisors, to analyze the existing system of waste management in EDMC area. The survey, starting from June 2018, continued for 3 months till August 2018. The survey tried to identify the mechanism of street sweeping and drain cleaning, willingness of inhabitants to segregate and capture possible reasons for non-segregation, appropriateness of infrastructure for waste management, involvement of informal sector etc. The basic aim was to identify areas of priority for EDMC for proper waste management and help them implement SWM Rules 2016 effectively in their jurisdiction.

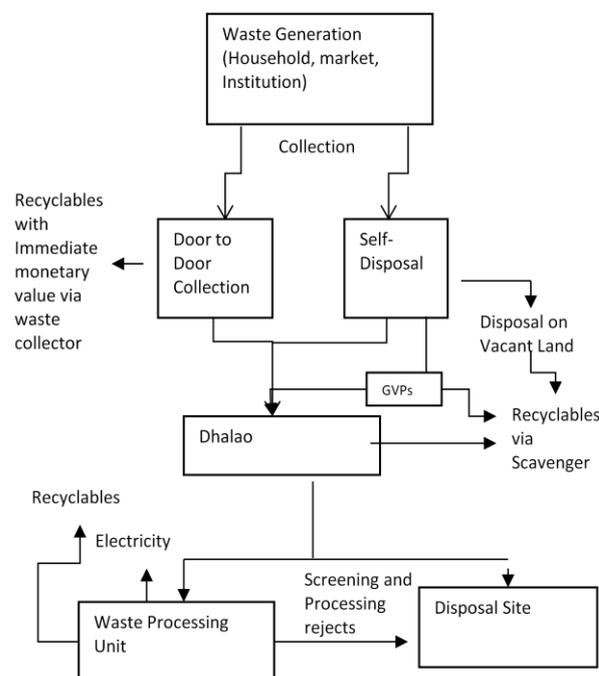


Figure 1: Existing MSW Management in EDMC area

III. RESULTS & DISCUSSIONS

The survey and analysis of collected data revealed the following status of street cleaning in the areas: about 73% of households and 81% of street vendors reported regular street cleaning; however, out of these only about 56% of households and 62% street vendors found the streets actually clean after sweeping operation was undertaken. In markets; 6% respondents reported street cleaning frequency as twice a day; 79% reported only once a day, 7% reported of this being done occasionally and 6% reported that street cleaning was not undertaken in their market area at all.

Further, when asked about status of night sweeping, majority (about 98%) denied of any such instances in their market area. However, about 48% respondents felt that night sweeping should be done. However, SWM 2016 rules stipulate daily cleaning of market areas, residential streets, minor streets and sub-urban shopping streets. City center-shopping areas are to be swept daily or even twice a day.

On the issues like open burning of MSW, 85% of market respondents denied any such event for managing waste and 13% pointed out such occurrences on a rare basis. Only 2% of surveyed respondents reported open burning events of waste on a frequent basis. This reduction in open burning can be attributed to the SWM Rules, 2016 imposing a heavy penalty for open burning of waste [13].

Survey revealed, about 38% of households were doing partial segregation of waste into wet and dry at point of generation. This segregation was mostly based on the physical state of waste i.e. wet or dry. E.g., dry leaves were considered as dry waste by many respondents. The wet waste was disposed either outside the house, in an open drain or in nearby garbage vulnerable points or being packed and sealed in a polybag for disposal with other waste. In a similar fashion only 22% of markets respondents were segregating waste into dry and wet categories. One of the reasons identified for low segregation levels at households was lack of awareness (63%), lack of space for 2 bins (23%), unwillingness to segregate (40%), concept of segregation being not helpful (17%), improper infrastructure for the waste collector (waste picker will mix it anyway) (58%) and difficulty to segregate waste (7%) (Multiple reasons for non-segregation were picked by the respondent). It was revealed by the survey that 57% of households, 50% of markets, 45% of institutions and 55% of street vendors were not aware about source segregation of MSW and a strong need for capacity building and awareness at these levels was felt.

Collection of waste plays a major role in MSW management system and is also a major issue for EDMC. Table 2 depicts the MSW collection practices and mode of primary collection used in EDMC area. It was observed that informal sector had a very important role to play in collection of waste and there is a need to integrate them into formal setup through partner NGOs / societies.

Table 2: Status of MSW Collection services in EDMC area (in percentage).

Waste Collection method	Households	Markets	Street Vendors	Institutions
Informal Collector	49	21	6	21
EDMC door to door collection	11	25	23	16
GDMC Ghantagadi	18	34	32	26
Self-disposing at Dhalaos	13	10	38	21

Waste Collection method	Households	Markets	Street Vendors	Institutions
(municipality's waste collection vessels)				
Open Dumping	9	--	--	---
Other	---	10	--	16

About 37% market respondents were giving user fee for waste collection from their premises. This user fee was being collected by various dis-aggregated informal waste collectors for providing door to door waste collection services.

Figure 2 depicts a clear picture of the level of waste collection.

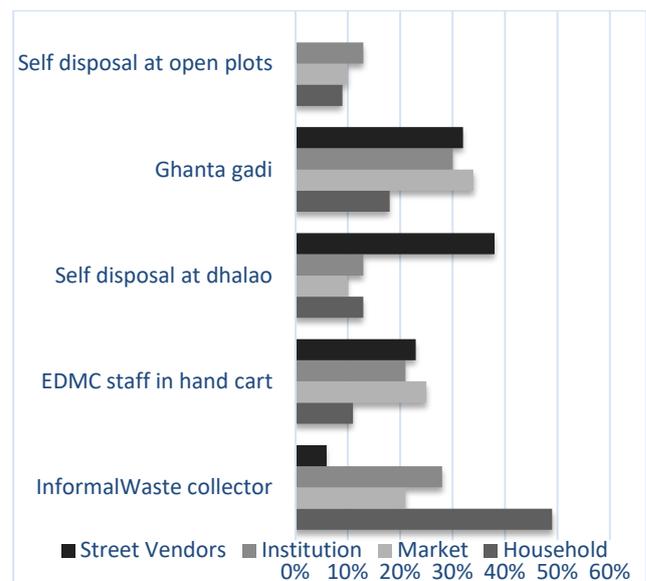


Figure 2: Status of MSW collection services in EDMC area

Further, respondents were asked about the fate of organic waste generated; only 15% of institutes and 1% of households were managing organic waste within their premises. About 8% of institutes and 13% of households were feeding organic waste to animals or giving it to animal farms. And surprisingly, about 77% of institutes and 79% of households reported disposing organic waste along with MSW. Surprisingly, As per SWM Rules 2016, institutions are responsible to segregate waste and manage their organic waste within their premises. Furthermore, 91% of the organic waste collected by the collectors is disposed at the dhalaos and only 9% of it is taken for composting. This clearly indicates lack of training and means for segregation as well as its collection in EDMC. Remarkably, 78% of the surveyed waste collectors reported not receiving any training on waste segregation.

Figure 2 showcases the fate of organic waste generated in EDMC area.

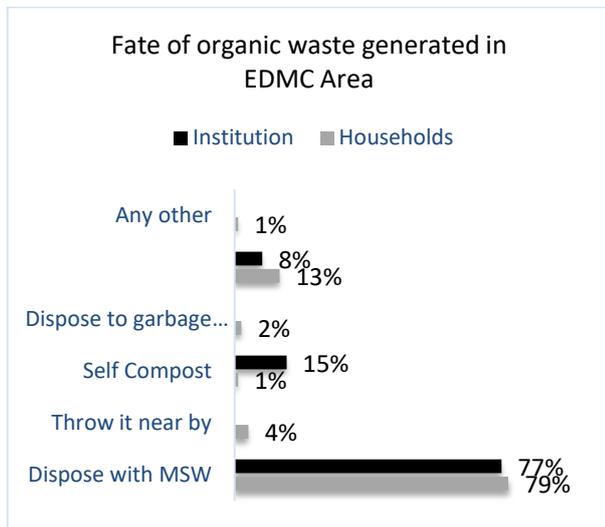


Figure 2: Fate of Organic Waste generated in EDMC area

It then became clear that there is a lack of awareness and capacity among citizens and EDMC staff and to ensure the most effective means of awareness generation, respondents chose multiple options, with most of the household respondents selecting as door to door campaigns (27%), advertisements on television (21%), penalty for noncompliance (15%), notices on the notice boards of localities and educational campaigns in schools/ higher educational institutions (12%), newspaper advertisements (9%), training waste collection staff to inform residents (8%), radio campaigns (5%) and brochures (4%).

As per the new SWMRules 2016, Institutions are liable to manage their green waste within the premises, when asked about the status of green waste being managed, 47% reported as being collected by EDMC, and 24% managed within their premises, 4% reported their green waste being directly taken for landfilling and 25% of institutions did not generated green waste including horticulture waste.

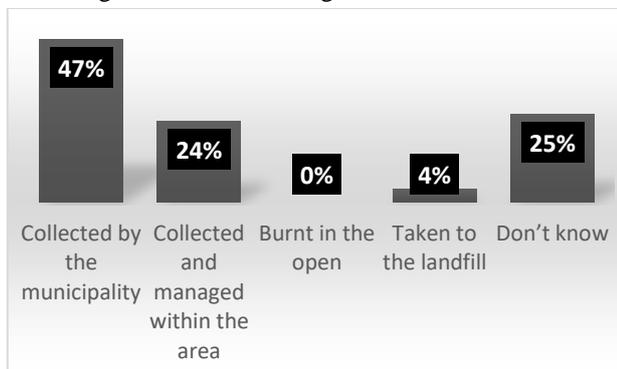


Figure 4: Collection and waste management of garden waste from institutions in EDMC area

When respondents were asked about the fate of special waste like batteries, cells, electrical and electronic waste, discarded syringes, needles etc.; about 66% of households and 55% of market respondents reported to dispose special wastes along with MSW and only 7% households and 13% of market respondents reported giving special wastes to waste aggregators (kabadi). None of the surveyed candidate reported disposal of special waste at hazardous waste collection center/treatment facility. Furthermore, in case of

domestic hazardous wastes, 83% of the waste collectors responded that they dispose it with the MSW at the dhalao and even 8% responded of not being aware of what domestic hazardous waste was. There was a dearth of infrastructure to collect domestic hazardous waste in EDMC.

Upon surveying the institutions across the city it was revealed that majority of the institutions (69%) do not have a two bin system for waste collection and only 40% complying with labelling it as green and recyclable, to achieve segregated waste collection. Around 8% Institutions were not even aware of such requirements. Most of the Institutions reported frequency of waste collection/ disposal as: once a day (68%), twice a day (11%) and on alternate days (9%). About 53% reported areas around the institutions as: clean, 9% reported areas as occasionally clean and 39% did not find areas as clean. On asking further, if the institutions were ever fined for non-segregation or improper management of waste, 84% of the institutions denied and only 11% agreed of being fined in the past. There was a clear message that the institutions were not monitored strictly for compliance of SWM Rules, 2016.

Street sweepers were surveyed in each colony to understand the mechanism and timings of street sweeping, about 57% respondents reported that they undertake sweeping twice a day on same stretch and 14% sweep thrice a day, 24% sweep once a day the same stretch allocated to them. When the respondents were asked about the mechanism to collect the street sweepings, it was found that 76% of sweeping staff collects sweepings on side of the streets and only 22% had handcarts to collect the sweepings for disposal at dhalao. This again was a major drawback as the accumulated street sweepings will again spread on road with vehicular movement if not collected in time. This is also the case with drain cleaning, when drains are cleaned, the drain silt is kept on the sides of the streets for days together for reducing the moisture content. This usually results in the drain silt being moving back in to the drains by the vehicular movement/ rain/ street sweepers.

During survey in colonies it was revealed that 58% of waste collectors were not municipal employees, as a huge informal as well as contractual workforce is involved in collection of waste and of the EDMC employees only 21% of waste collectors had Identity cards issued by EDMC. These waste collectors informed that they either play music (40%), call out (18%), and even ring doorbell (10%) to announce their arrival. About 23% don't announce their arrival in community. Only half of the vehicles used for collection of waste had partition for collection of dry and wet waste but only 17% of the respondents reported receiving segregated wet and dry waste for collection. There was a clear message that multiple responsibilities and lack of ownership among EDMC staff was a reason for low level of services in EDMC area.

Further, there was a serious lack of health checkups for the waste collection workforce and only 12% could recall any such checkup in past by local NGOs. About 91% of the respondents also reported they had never received any training on the need to use personal protective equipment, or the ill health impacts that they might face from the lack of it. It was also revealed during survey that about 84% of the surveyed colonies did not have municipal bins and lack of means to collect and dispose segregated waste. It turned out to be a major drawback in EDMC area.

During survey, perception of stakeholders were recorded on cleanliness of nearby dhalaos, Only 36% of households, 39% of markets and 63% of street vendors reported the nearby dhalaos as clean. Only 20% of the respondents were aware that they have a feedback/complaint number for complaining waste spillovers / Garbage Vulnerable Points (GVPs) in their areas.

To complete the chain of primary waste collection the waste supervisors and sanitary inspectors were also surveyed and survey revealed; that garbage vulnerable points (GVPs) in the areas are vacant/disputed plots (33%) or empty areas near markets (27%). In 20% of the surveyed colonies no GVPs were reported because of appropriate storage infrastructure in the wards. Most supervisors allow informal waste collectors to recover recyclables from the dhalaos. However, there is no mechanism to integrate informal sector in MSW management. In EDMC areas no supervisor (except at Shivaji park) reported daily washing of dhalaos after the waste being lifted. Neither, any of the dhalaos were being painted annually. These are the guidelines of Central Public Health and Environmental Engineering Organization (CPHEEO) manual for maintaining infrastructure.

IV. CONCLUSION:

This was a first of its kind study conducted in an Indian Mega City (East Delhi) and it helped the urban local body to formulate necessary plans and actions for improving their service levels. Solid Waste Management Rules 2016, even though being enforced by the central government and ULB, were not being followed by the waste generators. The municipality was working towards ensuring the infrastructure to be in place for segregation (by distributing twin bins in households and installing on streets), segregated transportation (ghanta-gaadis with two compartments for dry and wet waste), treatment facilities like waste to energy plant and developing compost pits in colonies. An increased focus was required to be placed on behavior change of the stakeholders including waste generators and collectors. Effective behavior change techniques can help in ensuring proper segregation of the municipal solid waste that eventually also have positive financial implications of the ULB. The techniques to be employed should be a mix of positive and negative reinforcements methods including rewarding the front runners in the society and fining the defaulters.

Based on the findings of survey, gaps identified at each functional element of waste management are explained in greater detail in the Table 3 below.

Table 3: Identified challenges and opportunities

Functional element of waste management	Challenges /Gaps identified	Opportunities for improvement/ corrective actions suggested for EDMC
Waste Generation	Lack of segregation of waste	Capacity building, training and awareness generation among citizens and waste collectors. Incentives and recognition for performers with penalties for non-performers.
	Improper organic waste management	Promotion of in-house treatments / decentralized treatment options along with awareness generation and capacity building
	Lack of penalty and user fee for non-segregation/improper management of waste	Proper formulation of municipal bylaws and enforcement.
	Inappropriate frequency of street cleaning	ULBs should enforce proper street cleaning and stipulate heavy penalties for non-compliance. Night sweeping should also be initiated in market areas.
Collection	Insufficient services by ULB for waste collection	Aggressive collection of waste from door to door and proper intimation for collection.
	Inappropriate mechanism to collect street sweepings and drain silt	Appropriate handcart/tricycles with street sweepers for collection of accumulated street sweepings and drain silts
	Non integration of informal sector	Mechanisms should be sought with local NGOs to have MRFs and integration of informal sector
	Lack of mechanism to enable segregated waste collection	Proper infrastructure for segregated collection, appropriate vehicles for synchronization between primary and secondary collection

	Lack of PPEs with EDMC staff and health checkups	EDMC should enforce strict norms for staff to use PPEs and penalize non-compliance. Although training and capacity building is foremost requirement for PPEs. Health checkups should also be undertaken regularly.
	Lack of awareness for special waste or domestic hazardous waste disposal	Capacity building and awareness generation
Storage	Lack of twin bin system	Two bin system also needs to be enforced strongly along with management for separate storages at dhalaos.
	Lack of cleanliness at dhalaos	ULBs should take necessary actions to follow the bylaws and provide appropriate services.
	Prevalent GVPs	Appropriate services and infrastructure along with penalties for non-compliance.
	Absence of storage facility for domestic hazardous waste	Appropriate infrastructure and capacity building among staff and citizens.
	Lack of feedback mechanism	Awareness generation among public and encouragements to provide proper feedback along with necessary corrective actions.
	Lack of spot fines on non-segregation and improper management of waste	Institutes should be properly trained and strong and appropriate mechanisms should be implemented
Transport/transfer	Under-utilized capacity of collection fleet	Waste should be compacted and transported to utilize full capacity of transportation fleet.
	Lack of segregated transportation and color coded waste collection fleet	Appropriate infrastructure and management with penalties for non-compliance.
Treatment	Lack of decentralized	Capacity building of residents and

	system	institutions to self-manage organic and green waste within premises and installation of decentralized treatment units in city
	Lack of organic waste management facility	Waste from vegetable, fruit, flower, meat, poultry and fish market should be collected on day to day basis for processing in a compost plant or bio-methanation plant.
	Lack of MRFs in the city	With integration of informal sector, MRFs should be created to promote recycling of waste and reduce waste to disposal facilities.
Disposal	Lack of capacity to manage generated MSW	Disposal site has already utilized its full capacity and hence appropriate measures to divert waste for treatment or recycling chain should be adopted.

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