



SOLID WASTE GENERATION, COLLECTION, TRANSPORTATION, PROCESSING AND DISPOSAL IN PRAYAGRAJ CITY**Jai Kumar Verma****Research Scholar, D.D.U Gorakhpur University U.P.****ABSTRACT:**

Waste management is a critical process that involves the collection, transportation, processing and disposal of waste materials produced by human activities. If not managed properly, these wastes can have an adverse impact on the environment and public health arising from contamination of soil, water and pollution of air and through spread of diseases via vectors living on waste. The aim of this study was to evaluate the present scenario of the procedure for managing municipal solid waste (MSW) in Prayagraj City. The data collected from various secondary sources, such as Prayagraj Municipal Corporation (PMC), Smart City Building, research paper, web sources and private company which is involved in solid waste collection, transportation and processing. A detailed study was conducted on solid waste generation, collection, transportation, processing and disposal, through personal interviews with the sanitary staffs and officers of the concerned authority.

The research has shown that there is need to waste segregation at the source is most important for resource recovery through different methods of processing. There is need to be integrate mechanize tools for segregation of waste. Use at large scale AI driven and real time monitoring system for collection and transportation of waste. Install AI power CCTV cameras in the street and chauraha (crossroads) to surveillance of illegal waste dumping that help in robust the infrastructure of solid waste collection and transportation systems.



KEYWORDS: Solid waste, Human health, Environment degradation, AI driven, Real time monitoring.

1. INTRODUCTION

Increasing rate of solid waste generation due to exponentially increasing population in the cities. Effective solid waste management is crucial not only for public health and well-being but also for environmental sustainability and economic development. In India solid waste management (SWM) is now realized as one of the major environmental problems and without an effective and efficient solid-waste management program, the waste generated from various human activities, both industrial and domestic, is resulting in health hazards and having a negative impact on the environment. Rapid urbanization and economic growth are the main factors of increasing solid waste generation and it has also started gaining attention in the developing economies. One of the major challenges in big cities is planning and implementation of an optimized, integrated solid waste management system. Effective waste management prevents the spread of disease, reduces [environmental pollution](#), and minimizes the impact on natural environment. Effective waste management strategies are essential to mitigate these

impacts. Integrated waste management systems, waste reduction, segregation, recycling, and proper disposal are crucial components of sustainable waste management. The importance of waste management cannot be avoided, as it directly affects human health and the environment.

2. Literature Review

The purpose of the review is to highlight the background knowledge of the research topic. In the present study, related literature has been carefully reviewed in order to represent the actual scenario of the nature of the problem. Municipal Solid Waste Management process consists of several interconnected stages: waste generation, storage, collection, transportation, recycling, and recovery. Solid Waste faces numerous challenges, including the growing volume of waste due to increasing urbanization and population growth. Inefficient waste segregation and inadequate recycling infrastructure often result in significant waste diverting to landfills. Municipal Solid Waste (MSW) is waste collected by local authority. It basically comprises waste generated from household, commercial building and institution. These wastes are often wet or dry waste. Many methods can be used to categorize the typical elements present in MSW. Solid and semisolid waste produced in the urban environment, including construction and demolition, residential, commercial, institutional, and industrial waste, is called Municipal Solid Waste (MSW). The environmental problems created by landfills are multidimensional as they affect all the three ways viz. air, water and land. Pointed out that the environmental degradation caused by inadequate disposal of waste can be expressed by the contamination of surface and ground water through leachate, soil contamination through direct waste contact or leachate, air pollution by burning of wastes and uncontrolled release of methane by the anaerobic decomposition of waste, spreading of diseases by different vectors like birds, insects and rodents

3. Study Area

Prayagraj (Allahabad) is one of the largest cities of Uttar Pradesh in terms of area and population. Prayagraj is situated eastern Part of the state of Uttar Pradesh. Prayagraj is located at 22° 92' - 25° 28' N latitude and 81° 52' - 82° 08' East Longitude and elevation at sea level is 98 M. Total area of the city is 365 km² and population is 1.5 million approx. Geographically it is part of the Ganga-Yamuna doab lies in the upper Ganga plain. Prayagraj city itself is built on the higher ground near the confluence of the rivers. The urban area is characterized by a mix of residential, commercial, and institutional zones. Some parts of Prayagraj may be more prone to flooding during monsoon seasons due to the low-lying nature of certain areas, especially those closer to the riverbanks. It's consisted of 100 electoral wards for administrative convenience, 20 sanitary wards and 8 zone. In Prayagraj city solid waste has been generated 850-950 tonne per day and average generation rate of solid waste per capita is 0.60 kg per day. On average 22% of budget spend on solid waste management.

Number of zones, name and No. of wards in Prayagraj city (Table 1)

Zone No.	Zone Name	No. of Wards
01	Khuldabad	11
02	Mutthiganj	16
03	Katra	18
04	Allahpur	14
05	Naini	15
06	Transport Nagar	10
07	Phaphamau	6
08	Jhusi	10
	Total	100

4. Objective and Methodology

To analyse solid waste Generation, Collection, Transportation and Processing method in Prayagraj city.

To find out (investigate the) factors which constrain in solid waste Collection, Transportation and Processing in Prayagraj city.

The main objective of this paper is to investigate city's solid waste generation, collection, transportation, processing, and disposal methods. We have evaluated the present scenario of mechanism for managing municipal solid waste in Prayagraj city and apart from this, recommends some suggestions for an efficient waste management system. The research data has carried out from primary and secondary data, including Prayagraj Municipal Corporation (PMC), Smart city building, research papers, and e-Newspaper etc. The explanatory Research Method is used in the study areas. Primary data is collected through personal interviews with the sanitary officers and staff of Prayagraj Municipality. The authors also conducted personal observations in the city of processing site and published information.

5. Result and Discussion

Generation & Composition of Waste: Prayagraj city has approximately 2.81 lakh household. which is divided into 8 Zones. Solid Waste generation in Prayagraj city is 850 – 950 metric tonnes (MTD) of waste per days and per capita solid waste generation is 0.60 kg/day. Each and every household have been generating waste such as wet waste, dry waste, recyclable waste, and hazardous waste etc. Other than the residential waste, Restaurants & hotels, Street sweeping, Market, Offices and horticulture waste are generated.

Solid waste generation in Prayagraj (Table 2)

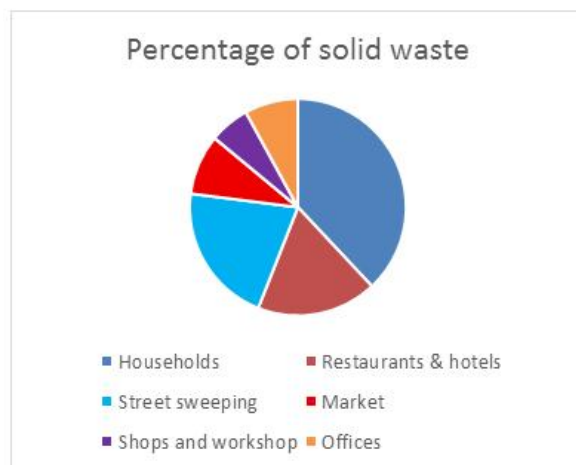
S.N	Type of solid waste	Generation in Metric Tonne per day (MTD)
1	Wet waste	200
2	Dry waste	70
3	Mixed waste	400-500
4	Bio sanitary	1
5	Domestic hazards waste	1
6	Construction & Demolition waste	200

Source: Municipal Corporation Prayagraj

Composition and percentage of solid waste in Prayagraj city (Table 3)

S.N	Type of major waste	Percentage of solid waste
1	Households	38
2	Restaurants & hotels	18
3	Street sweeping	21
4	Market	9
5	Shops and workshop	6
6	Offices	8

Source: Nagar Nigam Prayagraj



Collection

The term collection includes not only the gathering or picking up of solid wastes from the various sources but also the handling of these wastes to the location where the contents of the collection vehicles are emptied. Nagar Nigam is not involved in door-to-door waste collection, but it hired private contractors for door-to-door collection of waste from Residential Area like Residential Home and Residential Apartment, moreover Commercial building like Restaurants, Hotels & Shops and fish & vegetable market. Nagar Nigam involved in Street or Road Sweeping waste, Horticulture waste, Dead Animals and Construction and Demolition (C&D) waste collection. Despite all local authorities' efforts, 20 –25 percent of daily generated solid waste is not collected for many reasons. In Prayagraj City, Solid Waste is being collected in three ways

Door-to-Door Collection: Door to door collection of waste in Prayagraj city is conducted by 3 private company on the basis of public-private partnership (PPP) model, such as Prayagraj Lion Waste Management Pvt. Ltd. Company, Om Swachh Waste Management Pvt Ltd and Lion Enviro Prayagraj Pvt Ltd performs door- to-door garbage collection. Prayagraj Lion Waste Management Pvt. Ltd has allotted 1.25 lakhs household to collect door to door garbage in 41 wards of Mutthiganj, Katra, Allahpur and Jhusi zone. Total waste collection by this company is 175 MTD approx., which is 38-40 MTD Wet waste, 35-40 MTD Dry waste and 98 MTD Mixed waste, the Om Swachh Waste Management Pvt Ltd has allotted 86500 household to collect door to door garbage in 37 wards of Khuldabad, Mutthiganj, Allahpur, Naini and Jhusi zone. Total waste collection by this company is 160 MTD approx., which is 20-25 MTD Wet waste, 25-28 MTD Dry waste and 111 MTD Mixed waste, the Lion Enviro Prayagraj Pvt Ltd has allotted 69500 household to collect door to door garbage in 22 wards of Naini, Transport Nagar, Phaphamau and Jhusi zone. Total waste collection by this company is 65 MTD approx., which is 15 MTD Wet waste, 5-10 MTD Dry waste and 35-45 MTD Mixed waste. Sanitary workers of the company, wearing special dresses, by whistling manually collect waste every day from house to house during morning. Further, it is transferred to secondary storage depots (commonly known as Kuda-ghars) by sanitary workers through small vehicles (Trippers). For this service, sanitary workers of three company are taking a nominal fee collection of 30 rupees/household/month.

Community Bin Collection: Besides the door-to-door collection of solid waste, community bin collection is also practised in Prayagraj Municipal Corporation. Household waste is collected through door-to-door collection (DTDC), and other types of waste, i.e., institutional, commercial, Apartment and market etc., are collected through community bins. At the primary stage, waste is dumped by the public in containers provided by PMC. Waste is collected and transported by small vehicles (Trippers) to deport station for secondary transportation. Some of community bin, waste collection frequency is

irregular. Apart from this, despite sufficient storage capacity, waste remains littered here and there on the road and lanes and has hardly been removed by PMC.

Waste Collection by Rag Picker: 1500 street waste pickers collect recyclable materials like bottle, plastic materials etc. from 10 to 15 kg every day by each rag picker. Some of recyclable waste is collected by rag/waste pickers in Prayagraj city, which indicates the need to consider integrating in the informal sector of solid waste management to collect solid waste effectively.

Collection by PMC: Prayagraj Municipal Corporation involved in collection of horticulture waste, Dead Animals, and Street or Road Sweeping waste. PMC has Deployed 3397 Employee (Permanent and Outsourced) for manual sweeping for Public and Commercial areas conduct sweeping daily. Two Road-Sweeper machines are deployed for road sweeping.

Transportation

Transportation is the most crucial segment of solid waste management. Transportation of waste involves two phases:

Transfer of collected waste from bins to a secondary storage depot

There are 14 Port Station or Secondary Storage Depot (known as kuda ghar) is a secondary collection point in which 30 Portable Compactor (PC), carrying capacity is 5 tonnes is installed. Apart from this 77 Refuse Compactor (RC), carrying capacity is 12 tonnes of waste in which 32 RC used by private company and 45 RC used by PMC are deployed.

Name of Port Station in Prayagraj city (Table 4)

S.No.	Port Station Name /Place	Distance from Baswar
1	Mundera	20 km.
2	Lakdi mandi	15 Km.
3	Karganj/ fish market	16 Km.
4	Karael bagh	16 Km.
5	Leader Road	15 Km.
6	Gulab Badi	14 Km.
7	Gol Park Atala	14 Km.
8	A.G. Office	18 Km.
9	Teliyarganj	20 Km.
10	Lakshmi Talkies	17 Km.
11	Haiza Hospital	15 Km.
12	Bakhashi Bandh	17 Km.
13	Sangam	20 Km.
14	Shankar Dhal Naini	12 km.

Source: Nagar Nigam Prayagraj city

All three waste collection company and Nagar Nigam have been deployed 800 waste collection trolleys and Mini Collection Trucks (Trippers) with separate compartments for door to door to collection (DTDC) as well as 16 Tractor, 15 JCB, 18 JCB Robot, and 13 Cattle Van etc. All wastes are collected in compartmentalized/separate vehicles with closed lids to prevent the foul odour, littering and unsightly conditions. The trolleys and Mini Collection Trucks (Trippers) collect waste from door-to-door and Street or Road Sweeping waste to Port Station and empty in Refuse Compactor (RC) and Portable Compactor (PC) for secondary transportation to processing plant and landfill site.

Transfer of waste from depot to processing plant and disposal sites

Prayagraj Municipal Corporation and Private company like Prayagraj Lion Waste Management Pvt. Ltd., Om Swachh Waste Management Pvt Ltd and Lion Enviro Prayagraj Pvt Ltd are responsible for waste collection and transportation to processing plant and landfill site. The Private company collect waste door to door and transport depot station to processing site & landfill site. PMC also involved in collection and transportation of Construction and Demolition (C&D) waste.

Processing

Waste processing methods are different for different types of solid waste according to the nature of the waste. Treatment facilities are situated at Naini, Arail and Banswar in Prayagraj city. Prayagraj Municipal Corporation monitors all types of recyclable waste facilities run by different companies such as Ecostan Infra Pvt. Ltd. For Composting, BVG India limited & Ecostan Infra for RDF, Ankit Traders for Material Recovery Facility (MRF), AFR Center for Refuse Derived fuel (RDF), Orbit Build and Clean India for Interlocking Bricks making, Adarsh Bharat for Leachate water treatment and Ever Enviro Resource Management for Biogas CNG.

Composting: Ecostan Infra Private Limited is responsible for converting mixed waste into compost (fertilizer). It is received fresh mixed municipal solid waste around 750 MT on daily basis from the city. Ecostan is producing around 1000-1200 MT per month Compost and supply to Hariyalli company & local farmers. These composts are being consumed by farmers occupying around 20,000 Acres around the solid waste processing plants.

Refuse Derived Fuel (RDF) from legacy waste: There are two private company namely Ecostan Infra Private Limited and BVG India Limited involved in the processing of legacy waste or old waste. Total accumulation of legacy waste was 24.7 lakhs metric tonne (MT) in 2022, and cover area was approx. 14-15 acre they started processing of old waste by both companies in three phases. Ecostan Infra Private Limited had allocated 14.8 lakhs MT and BVG India Limited had allocated 9.9 lakhs MT. Both companies have processed 14 lakh MT and 9.5 lakh MT respectively. Total legacy or old waste left over around 1.20 lakhs MT, that will be processed till November 2025. Bio mining technique is used for clearing legacy waste, after processing of legacy waste bio-soils, construction and demolition waste and RDF are produced. Which is used by Cement company like Ultra tech, ACC Cement, Dalmia Cement and Aditya Cement company etc.

Alternate Fuel Recovery (ARF) center at Basawar produced plastic shredded material known as RDF from fresh waste or segregated plastic waste. Its produced 120-150 MTD RDF and send to cement factories for use as a fuel .

Material Recovery facility (MRF): Material Recovery Facility, popularly also known as MRF, is a mechanized facility to recovery valuable recyclable material from mixed waste stream. MRF ensures that minimum waste is sent to landfill and maximum resource potential is recovered from the dry waste stream. Four MRF centres for dry waste and wet waste segregation and processing have been installed at Ashok Nagar, Jhunsu, Baghara and Naini. First three MRF capacity is 50 MTD each and involved only waste segregation and Naini MRF centre has 100 MTD capacity. Naini MRF produced around 8-10 MTD recyclable material from segregated dry waste. Baghara MRF centre has not yet functional. The recycle plastic material used for making plastic granules and bars which are being used to produce packing covers, carry bags, buckets and mugs etc.

Biogas CNG: Prayagraj generates around 200 tonnes of wet waste daily from households, hotels, restaurants, and temples. Biogas plant has been established in Arail. In the first phase, the work of making bio CNG from urban waste of 200 tons capacity was completed. The plant is producing 21.5 tonnes of bio-CNG, 100 tonnes of solid organic manure, and 100 tonnes of liquid organic manure daily.

The work of making gas from the remaining 143 tonnes of paddy straw and cow dung is in progress. The biogas project will benefit 45,000 domestic consumers as well as farmers.

Construction and Demolition (C&D) Waste: Orbit Build and Clean India company is recycling C&D Waste. Total C&D Waste generation is 200 MTD and the company has capacity to recycled all C&D Waste per day. Construction and Demolition Plant at Baswar, this is the first of its kind of manufacturing unit in the state municipal corporation, that uses debris and construction waste that lies unused on the roads and causes air pollution, to make bricks and interlocking tiles. The company has capacity to produced 15000 cement concrete bricks and 7000 interlocking tiles per day.

Leachate Treatment Plate (LTP): Prayagraj Municipal Corporation has set up a modern leachate treatment plant (LTP) with a capacity of 150 kilolitres per day (KLD) in Baswar. The main objective of this plant is to treat the harmful leachate generated from the decomposition of waste, so that it can become safe for the environment and water sources. The amount of TDS (total dissolved solids), pH (potential of hydrogen) and TSS (total suspended solids) in leachate is very high, which pollutes the water. If this polluted water is used or gets mixed with any other water source, it can cause serious health problems. Also, the risk of water-borne diseases can increase. The treated water can be used for agricultural purposes, ensuring better use of water resources. This plant yet not to be functional.

Methods of Disposal

Prayagraj Municipal Corporation is responsible for final disposal into landfill site. All types of waste that is non-recyclable, non-reactive and non-biodegradable or residual part of recycle waste dump into landfill site.

Sanitary Landfill: Scientific landfilling is a method of waste disposal that focuses on engineered design and management to minimise environmental impact and health risks. It involves constructing a landfill with multiple layers, including a basal lining, leachate collection system, and capping system, to prevent contamination of soil and groundwater. Additionally, scientific landfills can also include features like vegetative cover, vertical wells for methane extraction.

The garbage collected from lakhs of households of Prayagraj city is being successfully recycled and converted into useful resource like wet waste to compost, dry waste to Refused Derived Fuel (RDF), Plastic waste to shredded material for RDF and making plastic granules and bars. Construction and Demolition waste to Interlocking Tiles and Bricks. Apart from this left of residual and other waste dump into landfill site which is non-combustible waste, non-recyclable waste, non-biodegradable waste and non-reactive. Baswar landfill site is the largest landfill site, where lakhs of tonne of legacy waste (old waste) dump in open area over long period of time, is being recycling by Bio-mining method/reclaimed and residual part dump into sanitary landfills.

Animals Incineration or cremation: The construction work of electric crematorium at Baswar has been complete for animal cremation. This crematorium would be used to dispose the dead animals found in the city. Per day 10-15 animals have been incinerate but some of the few months' incinerator has non-functional.

Discussion

In the new system, an individual has to wait for the sanitary workers to collect daily garbage, and some people are not ready to do so and garbage has thrown in the street after a sanitary workers and street or road sweeper leaves. This shows a lack of public awareness regarding effective handling of MSW. On the contrary, few people have their dustbins when sanitary workers come to their doorstep. Some of community bin, waste collection frequency is irregular. Apart from this, despite sufficient storage capacity, waste remains littered here and there on the road and lanes and has hardly been removed by PMC. Some of the narrow street in the city where sanitary workers or waste collection

vehicles will not reach to collect waste, they throw their waste on street or road side. Majority of household not segregate their waste into wet waste, dry waste and hazardous waste, due to which generate mixed waste that only processed as a compost from their mixed waste not other recyclable materials. It has been seen that most of the restaurant, Dhaba and fast-food shop not aware or interested to keep their, wet and dry waste dustbins, so mixed waste also generated from the commercial shops. Waste segregation practice yet not done by household and many commercial shops, so generate mixed waste, in which precious or recyclable materials goes to RDF and dumping site. Road and street sweeping waste mostly mixed up with C & D waste like small stone, bricks & sand and wooden, plastic etc. materials, so that the waste cannot useful for recyclable and RDF as resource. Most of the household generate is mixed waste but some of the household or community apartment segregate wet waste and market waste (vegetable & fish) generate wet waste goes to Arail Biogas plant to generate Bio-CNG from wet waste. Some of the mixed waste goes to Material Recovery Facility (MRF) centre for plastic waste segregation which is segregated by manual worker, that material used for making plastic granules and bars which are being used to produce packing covers, carry bags, buckets and mugs etc. and plastic to RDF as a fuel to cement industries. Mixed waste has processed through trommel screen for composting and leftover waste goes to dumping landfill site. In the processing and disposal site workers not wear apron, mask, safety gloves and shoes which affects on worker health in long term. Water logging and flood during rainy season has been blocking waste collection in those areas where flooded. Animals' cremation by electricity emit carbon is compress/collect in water and dump into an open area which contaminate soils.

Observations and Recommendations

- There is need to spread awareness in the society like (school, hospital, apartment, crossroads and street) about waste segregation at source through the Information, Education and communication (IEC) program for behavioural change. and enforcement regulations is strictly needed.
- Use large scale AI power cameras to identify illegal dumping garbage in the street and on the road site.
- Use real time monitoring system for waste collection and transportation in daily routing basis.
- Strictly implement regulations of waste dustbin and segregation at source in the hotels, restaurant, dhaba and fast-food shops.
- It has to be insured for collection of waste in narrow street where collection vehicle is not reached.
- There is need to be segregate at source of streets, roads and market place sweeping waste.
- It should be used mechanize tools instead of manual segregation waste segregation in MRF center.
- It should be implementing proper safety standard and equipment for sanitation workers involved in the waste collection and processing company.
- There should be deploying community dustbin in the street and crossroads for better waste management.
- Compress carbon in water emitted by cremation of animals should be treated as a leachate water treatment to curb contamination of soils.

6. Conclusion

Solid waste management is a critical environmental issue that affects human health, economic development, and environmental sustainability. The rapid urbanization and industrialization have led to an increase in solid waste generation, changing lifestyle and food habits posing significant challenges to waste management systems in Prayagraj city. A comprehensive approach to waste management is necessary to address these issues such as solid waste generation, collection, transportation and processing methods.

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