

A STUDY OF SOLID WASTE MANAGEMENT IN INDORE (M.P.)

Chetanya Mandeche^{*1}, Jay Vyas^{*2}, Mahesh Badole^{*3}, Savan Awashya^{*4},

Urvashi Mahajan^{*5}

^{*1,2,3,4}Student, Department Of Civil Engineering, Chameli Devi Group Of Institution, Indore, M.P., India.

^{*5}Assistant Professor, Department Of Civil Engineering, Chameli Devi Group Of Institution,
Indore, M.P., India.

ABSTRACT

The management of municipal solid waste has grown in importance in metropolitan areas as a result of the population's fast expansion. Reducing solid waste and processing it effectively is one of the Municipal Corporation's and urban local bodies' mandatory responsibilities. Two of Municipal Corporation's biggest concerns are the high rate of municipal solid waste generation and the complexity of trash generation. The state of Madhya Pradesh is thought to have its business capital at Indore. There are currently more than 19 lacking people living in Indore. In addition to infrastructure development, municipal solid waste management should be prioritized equally. Municipal solid waste management requires adherence to a carefully thought-out strategy. The goal of the current study is to examine how the city of Indore currently handles trash generation, collection, transportation, and disposal. The study also covers the several government initiatives put in place to efficiently manage waste. This study will give readers a good understanding of the current state of the Indore city's municipal waste management system.

Keywords: Municipal Solid Waste, Incineration, Transportation, Landfills, Recycle.

I. INTRODUCTION

It is a firm belief that every citizen has a fundamental right to a clean environment under Article 21, and that both local and state authorities have a duty to take all reasonable steps to maintain public health. Subsequently, a 2019 National Green Tribunal (NGT) judgment was observed to address the financial shortfall. According to a July 18, 2019 answer in the Lok Sabha, cities with a population of 100,000 or more create 67,000 tons of rubbish every day, or 44% of all waste generated in the nation. The NGT requested that state and federal governments create recommendations for implementing the 2016 Solid Waste Management Rules. In order to expedite the proceedings, NGT declared that any state or union territory that fails to adhere to these mandatory duties may be subject to legal action under the 1986 Environment (Protection) Act. A fine would also be assessed against the state, and the top state or local official might face personal liability [1]. The harsh truth is that nobody wishes to foot the bill for this. Even though India has long adhered to the idea that the polluter pays, no one feels accountable for the waste they produce, according to Shah of Swaha, a firm that manufactures mobile composting vans. However, "Indore's success demonstrates that this is feasible." This project is a beacon of hope for MP and other like communities around the nation. Estimates indicate that in ten years, the daily garbage production in Indore will increase from 1,200 metric tons to 2,000 metric tons. Reducing plastic waste and useable food waste in particular can help to lower this waste and maintain it at 1,500 metric tons. The verification of cleanliness on the ground, feedback from locals, trash management, creative approaches, financial viability, recovering expenses associated with solid waste management, isolation at the source, and the style of administration and execution all play a role in India's overall cleanliness. 2019 saw Indore rank top out of 100 urban towns with a population of 100,000 or more. The capital of Madhya Pradesh, Bhopal, came in second, followed by New Delhi and Chandigarh. After rising from 25 in 2016 to 1 in 2017, Indore has maintained its ranking for more than a year. Experts and locals stated that although the initiative was first promoted by the then-city official Manish Singh, the program has continued to be carried out and enhanced by the current judge, Asheesh Singh, demonstrating that the program is not reliant on a single individual. Furthermore, residents were shocked when this columnist questioned them about trash isolation and assortment because it has become a habit for them to isolate rubbish. Furthermore, according to Sambyal of CSE, the city's approach is incredibly cost-concentrated. During FY 2017–2018, Indore invested rupees 180 crore in the program as capital and spent rupees 155 crore on its operations. That kind of funding is not

available to many urban areas for effective waste management and sanitation. It is a win-win situation, though, because Indore also has "strong collection of user fees, high punishment charges, and makes revenue from the sale of fertilizer and dry waste." Property taxes provided the remaining money for the initiative, which collected ₹27 crore from users. Depending on the amount of waste they generate, household units pay between ₹60 and 150 per month, while corporate offices pay ₹3 for each kg of waste. For instance, in the roadside vegetable and food market, Indore plans to decentralize trash processing. This would assist in lowering user fees, benefit the client in the end from the handling of garbage, and assist the IMC in reducing preparation and transportation expenses. The IMC intends to use these kinds of initiatives to continuously reduce costs by 10%. There are several metropolitan communities that use decentralized waste processing, like Mysuru, Karnataka, and Panaji, Goa.

II. SWATCH BHARAT MISSION (CLEAN INDIA MISSION): THE STORY OF INDORE

The Government of India launched the "Swatch Bharat Mission" (SBM) on October 2, 2014, the day of the nation's father, Mahatma Gandhi. There were two aspects to the mission: urban and rural. In metropolitan areas, the focus was on creating network, private, and public restrooms as well as solid waste management in order to establish Open Defecation Free (ODF) cities. Currently, the city of Indore generates about 1,115 MT of waste every day, all of which is collected directly from the source, be it a family or a business establishment. In January 2016, a door-to-door collection pilot program was launched in two of the city's 84 wards. Almost a full year was needed to complete a door-to-door campaign, has successfully completed waste segregation at the source in all 100 percent of its business and household units. Indore's citizens took on a vital role in keeping the city tidy and polished. The better lifestyles of its citizens have enhanced Indore's state of tidiness. The Municipal Corporation successfully punished locals for segregating at locations and refraining from disposing of trash in open areas in less than a year. Through network investment, the Swachhata tale of Indore is genuinely transformed.

III. THE COLLECTION PLAN

The management of solid waste was done in the following steps [1-4]. principal gathering In some locations, municipal personnel collected household rubbish, while private agreements made by lodging settlements handled it in other locations. "Jagirdars" were the titles given to private garbage collectors. Their service quality was subpar, and they often disposed of trash in vacant areas or public land, posing a risk to nearby homes. Typically, the collected rubbish was deposited into dustbins situated along main thoroughfares. Thirteen hundred and eighty dustbins across the city, some the size of violins. These trash cans would frequently overflow, giving the city an unsightly appearance. This rubbish would be useful to stray animals, such as dogs, pigs, and dairy cows. The Jagirdars looked after some of these animals (cows and pigs), and they might earn additional income by milking the cows or selling them for meat. They had a personal interest in keeping the areas unclean so the animals could use them and their support costs would be reduced. Secondary collection: A2Z Infrastructure Limited, a private contracting authority worker, removed rubbish from the focus dustbins and transported it to an open dumping area in Devguradia. A2Z was facing a dire financial crisis, which had a significant impact on the secondary trash transportation system. Their financial struggles were evident in the subpar maintenance of the cars they managed and the erratic help that led to the gathering and overflow of trash cans. The city appears gloomy due to the inadequate distribution and handling of waste from residential units. Furthermore, because there weren't enough open restrooms for these people to use, open defecation was frequent in slum areas. In fact, even in the city zones, other inhabitants were also seen to be openly defecating due to the untidy state of the open restrooms. The deal ended in August 2015 after the Mayor expressed to the official her concerns about neatness and her uncertainty about extending her relationship with A2Z.

IV. DOOR TO DOOR COLLECTION

There are 19 zones and 85 wards in Indore. Normally, there are 600 company foundations (part of 88 specified business territories) and 6,000 family units in each ward. Waste is generated in Indore from a variety of sources, such as families, business zones, and various establishments like RWAs, hospitals, and commercial areas. The bulk assortment framework secures the semi-mass and mass generators, whereas the door-to-door

collecting framework secures the households or private buildings. Indore's door-to-door architecture ensures that all wards are covered 100% of the time [1].

Implementation of D2D collection system: To ensure that the door-to-door collection system is implemented in an efficient manner, a recognized study investigation that takes into account the number of residents in each ward and the amount of waste produced at each location must be finished. A thorough course schedule covering all wards was established based on that assumption. A specific plan in order to satisfy each ward's collection requirements. Partitioned vans are used in the door-to-door collection system. Each tipper has three distinct assortment bins for household hazardous waste, moist waste, and dry waste. These tippers transport home rubbish to the exchange station, where it is transported by hook loaders to the excavation site. A GPS-enabled system monitors every car used in the transportation and assortment framework. The monitoring cell keeps a close eye on the GPS system. Any off-route deviance from the route committed by a particular driver is penalized, and repeated violations are also grounds for termination. The Door to Door Collection System is used to collect the moist garbage from the homes. IMC has delivered the door-to-door assortment structure to collect waste from Indore's business districts and residential generators. The rubbish is transported to the garbage transfer stations for auxiliary assortment using divided vehicles known as "tippers." Through the Bulk Collection System, wet waste from semi-bulk producers that produce 25 to 100 kg of garbage is collected. The bulk collection vehicles are made up of a compactor (Figure 1) for collecting dry garbage and a dumper (Figure 1) for collecting wet waste. These vehicles follow a prearranged schedule of movement in pairs. When these cars reach the end of their route, they carry the waste. Bulk garbage generators are defined as those that produce more than 50 kg of waste annually. As per the guidelines set forth by the Government of India, it is mandatory for these generators to process their wet waste on-site. As a result, the moist waste from these generators is not collected. The tippers transport the wet waste collected by the door-to-door system trucks to one of the eight exchange stations. The tippers at the GTS discharge the wet garbage into devoted compactors, which then pack and load the waste into specialized hook loaders. Every approaching waste collection vehicle's information is recorded in the GTS logbooks. The bulk assortment cars go straight to the GTS instead of stopping at the GTS.



Figure 1: Wet waste collector (Dumper)

Distinct routes for collection: The core processing plant is home to the Weighment Bridge office. This is the main reason that all the cars approaching the plant communicate. Before the wet garbage can be moved to the handling facility, it must first be weighed at this automated office using both the bulk collection framework and door-to-door collecting methods. There are two distinct methods for processing wet waste: central processing plants and decentralized waste processing units. The mass generators prepare all of their wet waste (50 kg or more) on-site, therefore the central plant does not manage this garbage. The semi-mass assortment and GTS (D2D Collection) wet waste Lead acid batteries and sanitary pads are among the materials that make up domestic hazardous waste. This waste is gathered in a different container that is fastened to the waste collection vehicle's rear.

V. HOUSEHOLD HAZARDOUS WASTE

Lead acid batteries and sanitary pads are among the materials that make up domestic hazardous waste. This waste is gathered in a different container that is fastened to the waste collection

vehicle's rear. Table 1 and Figure 2 classify the waste composition of Indore. It is described as follows:

Like wet waste, dry waste is collected via mass assortment and door-to-door systems. Residents use tippers to collect their dry garbage, while the bulk collection system collects the dry waste generated by all bulk generators. A separate "Third Bin" is used to collect household hazardous garbage, and it is connected to the door tipper at the back of the door.

- Waste is collected secondary through the GTS. To go to the central processing plant, the dry garbage is loaded into specialized hook loaders, packaged, and discharged into specialist compactors.
- The DHW is transferred into drums, which are immediately fixed and weighed. The personnel of the organization in charge of the Central Biomedical Waste Treatment Facility completes this. The office staff gets the GTS employees ready for weighing by providing slips on which the date, time, and weight of the collected waste are noted. The garbage is subsequently transported in designated vans to the facility.
- The Weighbridge Facility receives the garbage after that. This facility, which is the main point of stop for all incoming vehicles at the plant, is located at the central waste handling plant. The electronic office logs various information such as vehicle in-out time, enrollment number, source move station, etc. together with the weight of all the dry trash collected by the bulk collection framework and door-to-door collection services.
- At Deveguradiya, India has centralized facilities for handling and processing dry waste. In this case, the dry trash is divided into different categories, such as rubber, paper, plastic, and metal. The 343 rag pickers working at the plant's two Material Recovery Facilities complete this isolation.

Straight from the GTS, the domestic hazardous waste is transported to the Central DHW Treatment Facility for incineration. An outside, contracted organization is in charge of this. Hazardous household and biological waste are treated at this facility. The trash is burned at this office. At both MRFs, inert is recovered throughout the dry waste treatment process. Next, the material is sent to the nearby sanitary landfill. The item is weighed at the weighbridge and entered into the system before being moved. After the garbage is burned, the residual portions of DHW are also sent to be landfilled. This is known as a hazardous landfill because it is a separate landfill system designed specifically for hazardous trash.

Table 1: Types of waste and their sources.

Type	Sources
Organic	Food scraps, yard (leaves, grass, and brush) waste, wood, process residues.
Paper	Paper scraps, cardboard, newspaper, magazine, bags, boxes, wrapping paper, telephone books, shredded paper, paper beverage cup. Strictly speaking papering Organic but unless it is contained by food residue, paper is not classified as organic.
Plastic	Bottles, packing, containers, bags, lids, cups.
Glass	Bottles, broken glassware, light bulbs, colored glass.
Metal	Cans, foil, tins, non-hazardous aerosol cans, appliances (white goods), railing.
Other	Textiles, leather, rubber, multi-laminates, e-waste, appliances, ash, other inert materials

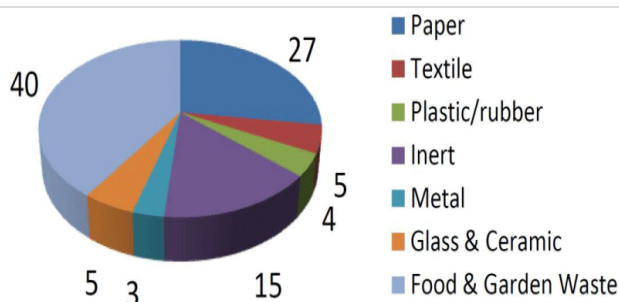


Figure 2: Composition of municipal solid waste.

Waste management process step-by-step: from gene-rating locations to processing units :-

Waste creation and segregation: Indore produces waste in a building that is divided. The garbage generators are referred to as semi-bulk, bulk, and home generators. Generators that produce less than 25 kg of waste per day are considered local generators. Semi-bulk generators are made up of generators that generate between 25 and 100 kg of waste each day. Bulk generators are those who produce more than 50 kilogram of garbage annually. The trash is produced by domestic generators in separate structures as dry waste, wet waste, and home hazardous waste. Wet and dry waste are separated by the mass/bulk generators. Transportation and collection of waste: Partitioned tippers collect the garbage for home generators in a separate building. The distribution of these tippers is either 50:50, 60:40, or 85:15. These vehicles collect the dry and wet garbage in different chambers. The home hazardous garbage is collected in an additional container that is attached to the tipper's back. As seen in Figure 3, the tippers' predetermined collection paths are described in their arrangement plan and are managed by the command center. After completing their routes, the tippers proceed to the designated GTS and deposit their waste into the designated compactor. The waste is bundled by the compactor and loaded onto a hook loader for transportation to the central processing facility.

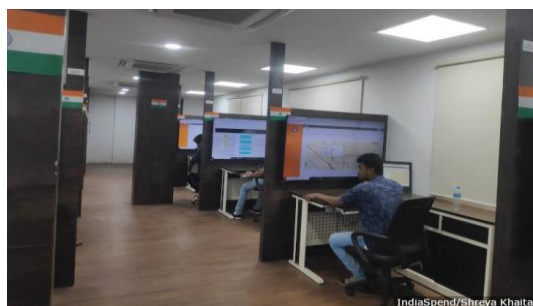


Figure 3: Indore Municipal Corporation command center to track garbage vans around the city.

The bulk framework collects the garbage from the bulk generators by sending out two vehicles, one for the collection of wet waste and the other for the collection of dry waste. In addition, the bulk generators are divided into two groups based on the quantity of garbage they produce. Generators producing 25–100 kg of trash fall into the first category. These are tiny bulk-mass foundations, such as coffee shops and tiny restaurants. Dumpers and compactors operate in pairs to gather rubbish along their route, collecting both wet and dry waste from these sources in a segregated manner. The generators producing more than 100 kg of waste have been placed in the next class. RWAs, communal gardens, hotels, etc. are some of these generators. While these generators process the wet waste they produce on-site, only dry garbage is collected from them. Weighbridge: The automated processing plant of the weighbridge facility serves as the main gathering place for all vehicles that approach it in order to discharge their waste. After entering the plant and unloading their rubbish, all incoming vehicles are wasted in an attempt to identify the waste they brought with them. A receipt is then generated and filed at the office. This receipt details the type and quantity of garbage moved, the vehicle's enlistment number, the source transfer station, and the vehicle's in-out time. trash processing: At the MRF locations, dry trash from the exchange stations and the bulk collection trucks is offloaded after further preparation and segregation. The exchange stations' and the bulk collection framework's wet waste is offloaded to the central composting plant for processing. The individual generators handle the bulk generators' moist waste on-site. The household hazardous trash is transported straight from the exchange site in biomedical vans to another facility for treatment. The Central Biomedical Waste Treatment Facility burns the hazardous waste [5]. Road cleaning: Every day, machines clean 800 km of streets, and water mist cleans sidewalks and road barriers. Every night, this uses 400 liters of water, the most of which is recycled water from the three sewage treatment plants the IMC built up. The remaining 2,200 km of interior streets are swept, and the debris is collected in gunny sacks, loaded onto trucks, and transported to the waste processing plant. The first six months of street cleaning removed between 20,000 and 30,000 metric tons of residue.

VI. TRANSFER STATION FOR TRASH (GTS)

As the state's budgetary capital, Indore is one of Madhya Pradesh's more economically developed cities. There are almost 25 lakh people living in Indore, making it the tenth largest city in India. The city is split up into 19

operational zones for solid waste management (SWM) and 85 wards. garbage is collected in an isolated manner in Indore; for instance, the generators separate the garbage at the source. 1115 MTPD is the total amount of rubbish generated in Indore. 58.25% of garbage is classified as wet or natural waste, 41.75% as dry waste, and 0.5% as hazardous and sanitary waste from homes. About 650 MTPD of wet garbage and 465 MTPD of dry waste are generated in total. The tri-partitioned trash tippers deliver all of the waste they gather to the designated GTS after collecting it from each of the 85 wards. The centralized plant, which is located 20–23 km from the city, was where the trash was being transported before to this. Eight ultra-modern transfer stations with three basic models—such as ramp-based static GTS, portable compactor-based GTS, and semi-portable compactor-based GTS—have been built by IMC to strengthen and lower the cost of the Secondary Collection and Transportation System. Hyva and TPS have installed these stations at various locations throughout the city. Star Square, Kabitkhedi, The Sanwer Road F-sector, Sangam Nagar, Dhar Road, Sirpur, Labagh, IT Park Crystal DakkanwalaKua, Rajshahi.

All of the aforementioned types feature a system for collecting and transporting separated garbage to the removal site using hook loaders. Two containers are present:

Blue shading: used for collecting dry garbage and Green shading: applied to the gathering of moist waste. There are two phases to the collection of MSW from door-to-door trash tippers. Step one: the blue hopper is used to unload the dry garbage. The second stage involves offloading the wet waste into the green hopper.

These receptacles are connected to separate blue and green holders (Figure 4). Each container is filled with the separated MSW. When the containers are fully loaded, a hook loader lifts them and sends them in a separated manner to the disposal site. Wet garbage is loaded directly into the Centralized Composting Unit by the Hook loader, and dry-stacked waste is led to the Material Recovery Facility 1 and Material Recovery Facility 2 at the removal site. In accordance with the guidelines established by the Biomedical Waste Regulations of 2016, the container for sanitary waste and home hazardous waste is off-stacked into designated drums and sent to the Common Biomedical Waste Facility (CBWTF).

The open-defecation city

When someone chooses to relieve themselves outside of a toilet and instead uses a field, bushes, woodland, open body of water, or other open location, this is known as open defecation. People's ignorance and a lack of access to restrooms are the causes of open defecation. In addition, bathroom awareness was important for the ODF objective. The IMC signed NGOs in October 2016 under stringent guidelines including turnover and prior experience with urban planning. NGOs' primary duty was to locate important ODF locations within and surrounding the city. The city's 72 fundamental ODF locations were identified by the cleaning crew. NGOs were crucial in identifying ODF locations and bringing them to the attention of experts. The important success for ODF was made possible by these NGOs, who did a commendable job of identifying key ODF locations and encouraging social change among the broader public. 72 OD sites have been identified subsequent to the November 2016 summary. Thus, the Indore Municipal Corporation created a comprehensive plan to dispose of these 72 OD sites. A few initiatives to create Indore ODF that were tried were:

- Creating an action plan and strategy for the 72 crucial OD locations that have been identified.
- Relocating 5,000 impoverished households within a year to vacant Basic Services for Urban Poor (BSUP) apartments.
- Strict action and oversight against defaulters by IMC authorities, with over 500 defaulters receiving spot fines.
- 400 IMC personnel and six NGOs actively initiated and monitored ODF operations.
- A total of 12343 IHHL have been identified as being constructed, of which 12343 have been built.
- 189 Public toilets have been identified to be constructed and till date, 189 have been constructed.

In areas where slums have been established on private property, in transit, and in contested settlements, modular restrooms have been constructed. This assisted in addressing the sanitation issues brought on by people residing on unlicensed property, laborers working building sites, nomadic communities, people using truck parking lots, etc., for whom permanent restrooms are impractical. The new restrooms may be

disassembled and used as needed after these slums are relocated. IMC mandated that all construction sites provide workers with sanitary facilities by means of a notification.

- IMC has designed 17 mobile restrooms (Figure 5) that are intended for use at public events and spaces, such as weddings, political gatherings, marathons, etc. Residents of Indore can use this kind of restroom by paying for it. The Mayor affirms these accusations in Council. It is guaranteed that these multipurpose toilets will be appropriately clean while using water.

Waste classification: Table 2.

Classification of waste: Table 2.



Figure 4: The transfer stations

VII. RECYCLING GARBAGE INTO FUEL

Organic waste from the vegetable, fruit, and flower market is converted to methane in a bio-methanation facility for the decentralized processing of trash. Mahindra Waste to Energy Solutions Ltd. stated that about 20 tons of waste are collected daily and converted into 750–800 kg of bio-compressed natural gas (bio-CNG). The organization and IMC have a long-term agreement for the operation of the plant.

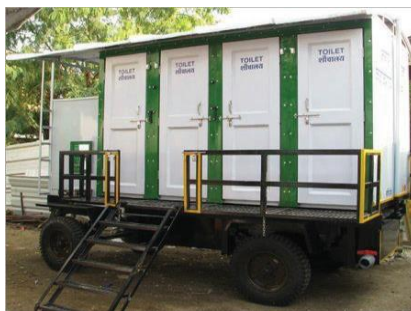


Figure 5: Mobile toilets at Indore GTS.

Table 2: Sources of solid waste contents and typical waste generation.

Source	Typical waste generators	Solid waste contents
Residential	Single and multifamily dwelling	Food waste, paper, cardboard, plastics, textiles, yard waste, wood, glass, metals, ashes, special wastes (e.g., Bulky items, consumer electronics, batteries, oils, tires), and Household hazardous wastes.
Commercial	Stores, hotels, restaurants, markets, office building etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous waste.
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Housekeeping wastes, packing, food waste, construction and demolition materials, hazardous waste, ashes, special waste
Institutional	Schools, hospitals, prisons, government centres.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous

		waste
Construction and Demolition	New construction sites, Road repair, renovation Sites, demolition of Buildings	Wood, steel, concrete, dirt, etc.
Municipal services	Street cleaning, Landscaping, parks, Beaches, other recreational Areas, water and Wastewater treatment Plants	Street sweepings; landscape and tree Trimmings; general wastes from parks, Beaches, and other recreational areas; Sludge
Process (Manufacturing etc.)	Heavy and light Manufacturing, refineries, Chemical plants, power Plants, mineral extraction And processing.	Industrial process wastes, scrap Materials, off-specification products, Slay tailings
Agriculture	Crops, orchards, vineyards, Dairies, feedlots, farms.	Spoiled food wastes, agricultural Wastes, hazardous wastes (e.g., Pesticides).

The produced gas is supplied to hotels and the Indian Institute of Management at a financed cost and used to power municipal transportation. Compost is made by blending 1-2 tons of flower business waste every day into slurry and keeping it apart. In Figure 6, one of the plants is displayed.

Methods that Indore employed in MSW:

Gasification is the process by which organic material containing carbonaceous chemicals is heated above 700 oC to produce carbon monoxide (CO). Syngas is the end result of this process and is a different kind of renewable energy. There is additional solid trash (ash) in the by-product. The several types of gasifiers that are available include plasma, fixed beds in counter current, parallel, and fluidized beds. Burning organic material found in MSW produces combustion and ashes as byproducts. This process is known as incineration. For diseases, poisons, and other dangerous wastes, it is advantageous. The incinerator is used to carry out the procedure. The waste primarily comprises of high inert content (30–50%), high organic matter (40–60%), high moisture content, low heat content (~1000 kcal/kg), and greater installation and maintenance expenses, making it an unfavorable waste treatment alternative. Composting is the process of converting organic waste into fertilizers and soil additives by breaking them down. Compost is employed in soil rehabilitation because it is high in nutrients.

Landfill: This is one of the oldest methods; waste is dumped in a uniform layer on a dump and covered with dirt.

Recycling: This method creates new goods from waste. Glass, paper, electronics, textiles, plastic, metal, etc. are typical materials. It is regarded as the essential component of contemporary waste minimization.



Figure 6: The bio-methanation facility opposite the vegetable and fruit market. Organic waste is converted to fuel used by city buses and as cooking fuel.

Dumpsters: Landfills' primary goal is to dispose of solid waste with the least amount of negative environmental impact and lowest operating costs (Figure 7).

In order to place the most rubbish possible, the site needs to be effectively maintained. Among the four phases of operation are: Site choice: Before using the site for sanitary landfills, factors such as terrain, geology, land use, transport routes connecting the site, distance from the center of waste creation, etc., need to be taken into account.

Site preparation: The two primary considerations for sanitary landfill sites are operational effectiveness and water pollution. By adding a semi-permeable membrane, polluted water is kept out of the water on Earth. This membrane is made of either an artificial sheet made of bentonite-mixed soil, imported clay, or natural clay. So that only pure water is released into the environment, the contaminated liquid is captured and cleaned. The efficiency criteria are governed by additional factors like as construction and runoff.



Figure 7:

Image credit: Asheesh Singh

Operations: To make the maximum use of the site's vacant space, continuous compaction is implemented. Rats and insects are managed, and bad odors are avoided, by compacting and covering garbage on a daily basis. The gas released by the decomposing garbage is captured and used as fuel or burned on the spot.

Post-closure management: The site needs to be made back to seem natural after it is closed to additional rubbish. However, leachate and gas emissions need to be regularly monitored. Enhancement of the trenching area:

1. Two 6.25-acre designed landfills have been built and are utilized as needed.
2. A 200,000 MT garbage dump on five acres of land has successfully undergone bioremediation.
3. There are now two built weigh bridges.
4. A vehicle service facility with capacity for six vehicles at once has been created.
5. A garbage collecting center for plastic has been set up.
6. A system of fire hydrants has been installed to combat fires.
7. A work shop has been constructed for minor car repairs.
8. For the easier operation of waste vehicles, a cement concrete road with drains and lighting has been electrified.
9. Both inside and outside the dumping site, a green belt has been established.
10. The waste disposal site has a boundary wall built around it [5].

VIII. RECYCLING

Three elements make up this step of municipal treatment: reduce, reuse, and recycle. Policy interventions are the primary means of introducing reduction. For example, the government's ban on plastic bags. On the other hand, reuse is a well accepted practice that is simple to comprehend. Nevertheless, recycling incorporates components of municipal solid waste, such as:- Paper and cardboard are made from pulp, which is made from wood and plant fibers. They contribute significantly to garbage because of their limited lifespan. There are three different kinds of waste paper: corrugated board, post-consumer paper, and high-grade paper.

The paper is initially arranged in colour groups. The grinding process, which is carried out either physically or chemically occasionally, comes next. Compared to chemical re-pulping, mechanical re-pulping produces paper that is of inferior quality. Once the paper has been agitated, water is added to create a slurry. This slurry is compressed after being made thicker. After it has dry, the sheets can be cut out. Nonetheless, bleaching or whitening is not required. Paper that has been recycled loses strength, which is likely why it doesn't have 100% strength. Glass: In the waste system, glass is typically the leftover material from food and drink containers. There are three kinds of glasses:

- Glassware containing soda lime: goblets, bottles, jars, etc.
- Glass made of crystal: artwork, fine drinking glasses, and vases.
- Pyrex or borosilicate glass: used in laboratories.
- To make cullet, glass is broken down and then melted to make new bottles. One of the properties of cullet is that it melts at lower temperatures.

Plastic: A significant portion of garbage is made up of plastics. Usually, distillation of fossil fuels produces it. The polymers are used to create the powder or granulated form. Cardinal traits are decreased after recycling when various polymers are mixed together. Two categories exist for plastic recovery: energy recovery (heat and electricity).

Material recovery: recycling by chemical and mechanical means.

Plastics are broken down chemically into monomers, which are then utilized in refineries to create new goods. Plastic undergoes mechanical treatment, which entails sorting, washing to get rid of extraneous objects, drying, and chipping. After being extruded, these chips become black plastic.

Metal: The two most common metals in solid waste are Fe and Al. They are made from mineral ore and found in containers, foils, and cans. They recycle in a manner akin to that of glass, which entails smelting in a furnace and then producing new goods from it.

Transforming garbage into items that are helpful:

Fertilizers and compost: Microorganisms and oxygen work together to break down raw organic material into compost. Raw organic materials can include a wide range of materials, including yard trash, manure, food waste, and agricultural waste. Sorting is used to transform the raw material into a pile of tiny particles. Either naturally occurring nematodes, earthworms, and soil insects attack the pile, or it is created artificially by grinding, shredding, and chopping. After the pile is created, the decomposition process is processed by the actinomycetes, fungus, bacteria, and protozoa in the soil. The two stages of pile decomposition are the active phase and the cure phase. Temperature rises quickly during the active period because of the metabolism of microorganisms. The temperature can increase to 55 to 70 °C in a day or two. This temperature breaks down phytotoxic chemicals, helps get rid of weed seeds, and improves the material's sanitation by killing microorganisms. The breakdown of organic molecules into stable, humid compounds proceeds during the curing period. Curing takes a variety of lengths of time, ranging from one month to a year, depending on the feedstocks, composting technique, and maintenance. Refuse-derived fuel: The first stage in producing RDF is separating combustible waste from non-combustible waste, such as metal and glass. The fragments have to be tiny. The assembly of unsegregated garbage, such as plastic, organic waste, textile, etc., happens next. to supply the calorific value that is needed in order to burn. Moreover, the following sequence of actions is taken: Manual Distinguishing

- Air separation: air is forced upward, lifting low-density materials.
- Reduction in size

Rotating screening is another name for trommels.

The purpose of drying is to lower the moisture content of MSW.

Metal separation:

Using magnetic separation, ferrous metal separation

Using eddy current separation for non-ferrous separation

- Manufacturing the finished product: the leftover waste is combined with binders, such as agricultural husk, and sent through a pelletizing machine to create pellets.

- **Plastics:** A sizable portion of garbage is made up of plastics. Usually, it is produced by the refinement of fossil fuels. The polymers provide the powdered or granular form. Reusing results in a mixing of different plastics that reduces the cardinal highlights. Two distinct approaches can be used to divide the plastic recuperation:
- **Energy recovery:** Power and warmth.
- **Material recuperation:** recycling by chemical and mechanical means. Compound reuse involves breaking down polymers into monomers, which are then used to create new products in treatment centers. Plastic is mechanically treated by arranging it, washing it to remove foreign experts, drying it, and then cutting it into chips. After then, these chips are released, leaving behind dark plastic.

A bio-methanation facility for the wholesale market of fruits and vegetables:

The largest mandi in Central India is called Choithram Mandi. Fruit and vegetable waste is produced regularly at a rate of 20–25 MTPD. Previously, the waste was collected and moved to IMC's centralized waste processing and disposal site, which resulted in exorbitant labor and transportation costs. Therefore, IMC establishes a 20 MTPD bio-methanation plant (also known as a bio-CNG plant) as part of its aim to advance the decentralized treatment of natural waste. IMC chose Mahindra & Mahindra Ltd. Mumbai to construct the plant through the offering procedure, and the company was chosen in December 2017. Of the total undertaking cost of ₹15.00 Cr, ₹7.2 Cr was incurred. IMC gave the VGF. The venture's concession period is 15 years. At Choithram Mandi (Figure 8), all of the fruit and vegetable waste is currently collected and processed at the Bio CNG plant. Every day, about 800 kg of compressed, purified biocNG with 95% pure methane gas are produced. About fifteen city support buses are powered by the compressed Bio-CNG gas. The slurry is dried and turned into organic fertilizer. The processed slurry is sent through a powerful liquid separation equipment, and the filtered fluid is used to create new slurry.



Figure 8: Choithram Mandi, Indore

Evaluation of gaps (Table 3)

The following steps are necessary to address every shortcoming of the current system and implement the solid waste management system in Indore City in accordance with the Solid Waste Management Rules of 2016:

- Complete waste collection and storage from door to door.
- Eliminating city trash cans to prevent waste from being stored next to roadways.
- Litter bins should be fixed in all commercial locations.
- Building a waste-to-energy facility; • Setting up contemporary transfer stations in key places.

Table 3: Comparison with SLB provided by MoUD Indicator [1].		
Indicator	Benchmark levels	Indore
Household level coverage of SWM service	100	88.9
Efficiency of collection	100	90
Extent of scientific disposal of MSW	100	8.34
Extend of MSW recovered/recycled	80	40
Extent of segregation of MSW	100	45
Efficiency of redressal of Customer complaints	80a	NA

Efficiency in collection of user charges	90	NA
Extent of cost recovery in SWM service	100	NA

IX. CONCLUSION

The collection, disposal, and management strategy for municipal solid waste in the Indian city of Indore is presented in this document. The plan is created by keeping a careful eye on factors including road connection, population density, the capacity for producing and disposing of trash, and the movement of waste from collecting sites to disposal sites. For more effective management, the strength of the transfer stations might be increased. Additionally, the model shows the minimum cost to distance ratio for moving waste to a landfill. This concept is used by the Indore Municipal Corporation to facilitate effective solid waste management and employee schedules.

X. REFERENCES

- [1] Indore Municipal Corporation.
- [2] Public Health Department, Indore Municipal Corporation.
- [3] Municipal Solid Waste (Management and Handling) Rule 2000. Government of India, New Delhi.
- [4] India Infrastructure Report 2018.
- [5] Indore City Development Plan and City- Level Agenda.