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Legacy Waste Management - A Case Study of Pune City.

Mr. Vishal Madhukar Bhandare[1], Mr. Shrikant M Bhosale[2], Dr. Y M Patil[3]

[1] PG. Student Department of Technology, Shivaji University Kolhapur-416004, Maharashtra India.
[2] Assistant Prof. Departments of Technology, Shivaji University Kolhapur-416004, Maharashtra India.
[3] Assistant Prof. Rajarambapu Institutes of Technology, Shivaji University Kolhapur-415414, Maharashtra India.

Abstract – *Since 1985 there was no any existence of dumpsite in Pune. But at the time of industrialization population increases day by day and Pune covert into the metropolitan city, and city comes under the unexpected load of Municipal Waste, and place of empty ground, farms taken by dumps of Solid Waste. Before the years of industrialization farmers were collected urban waste, and farmers converts this discarded waste into the compost and utilized it for the farming activities. After the introduction of plastic in recent years, most of the city's waste contains plastic, and farmer refused for the collection of cities waste and ultimately cities Solid Waste took place on empty ground and farms. In year 1989 District Collector of Pune allocated the land at Uruli/Fursungi for the disposal of cities solid waste. An efficient and environmentally friendly process known as "bio-mining" or "landfill mining" includes stabilizing old legacy waste in landfills by recovering valuable resources. In order to provide protection through the removal of waste, which will also help the community become more independent and pollution-free it entails reusing, recycling, and recovering with the goal of creating a viable resource. Near about 80% of plastic waste found in landfill & 75% of metal and glass remained and 5 % conversion of inert material turned into soil by weathering action. By referring the guidelines of Central Pollution Control Board (CPCB) or as per the direction of NGT, court directed that every city/corporation should follow the clause J of SWM Rules, 2016.*

Key Words: *Legacy waste, bio-mining, landfill mining, Central Pollution Control Board (CPCB), National Green Tribunal (NGT), Municipal Solid Waste (MSW, Solid Waste Management (SWM).*

1. INTRODUCTION

The term "legacy waste" refers to a mixture of biodegradable wastes, plastic waste, textiles, metals, glass, and other materials that have partially or totally decomposed. Landfill mining was initially documented in a year 1953 an article on the procedures employed at a disposal site run by the Tel Aviv City in Israel. A number of landfill mining projects were conducted in the late 1990s to reduce groundwater contamination, promote the recovery and reuse of mined materials, and expand waste capacity in Florida and Connecticut. As per the research of the Florida, as mining waste was 60% as a substance resembling dirt. The Deonar dumping ground in Mumbai was mined in 1989 as prototype case research for utilizing compostable. At the Kodungaiyur and Perungudi dump in Chennai, Kurian Joseph and his research crew from Anna University created the study of old city refuse in 2003. At depth of 3 meters samples were taken. It was found that 65% of the waste was composed of tiny particles, and after determining their geotechnical appropriateness, they were suggested for usage as compost material or material used for the landfilling. Although far above USEPA guidelines, in the recovered material heavy material were found, in which violate Indian composting regulations. Chronic neglect for scientific and sustainable treatment has produced to an ever-increasing quantity of MSW finding as a way to Indian dumpsites. Several of the aged dump sites are even so ruminating whenever their poisonous legacy. Unlined dumping ground is polluting the air & water, causing long duration menace to the human health & environment. In accord with Swachh Bharat Mission (SBM) 2.0 operating standards, with a population of cities under one million must remove old municipal waste sites by 31 March 2023, while one million population cities or more must clean up their dumping ground site by 31 March, 2024. 1,250 hectares of valuable land are lost to the disposal of MSW each year in India. As per the National Green Tribunal (NGT) study, over 10,000 hectares, or around 14,500 football stadiums, of urban land are thought to remain trapped in India's legacy waste dumpsites. For city officials all throughout India, reclaiming running dumping ground in an affordable & environmentally responsible manner is one of the high importances.

India recently saw a major shift in waste management strategy that made it possible to clean up old waste dumps and rotted out the reasons and excuses for not doing so. A huge financing of Rupees 1,41,600 Cr has set aside for Swachh Bharat Mission 2.0, with a concentrated on source segregation, MRF facility, phase-out of single-use plastic, processing of C & D waste, as well as cleaning up all remaining landfills around the country. Since the Vedic era, houses have discharged primarily food waste, which has been recycled into the soil together with stable wastes using compost pits. Farmers were collected the discarded unwanted material and that collected unwanted material (waste) by farmer and they convert it into the compost and

utilize it for farming. Years were passes & cities tends toward urbanization, Urbanization increase day by day, with the changing the life style. Generation of Municipal Solid Waste (MSW) is rising together with global population growth, & landfills are continuing to fill up with recyclables that can be utilized as materials, or to recover energy. By stabilizing aged legacy waste in landfills and recovering precious materials, a technique known as "bio-mining" & "landfill mining" is effectual & environmentally sustainable. Main objective is to handling with the realistic categorization & recovery of mining legacy waste as well as potential recycling and processing options through an average compositional analysis of data collected over the past 25 years. According to estimates, there are 80% of plastics in landfills, 75% of metal and glass, and 5% of inert that has weathered into soil-like material. The flowchart demonstrates that the waste ratio, according to compositional analysis, is 40:60 to the cement industry and power plants, around 7.3% of the combustible material utilized in co-processing will be supplied as RDF. Recycling facility received recyclable materials Non-combustible materials, C&D waste, and inert garbage should be disposed of in a low-lying region. Such as for the embankment filling of road, river filling, and basement of newly constructed building. With respect to changing life style, in everyday life uses of plastic also get increases. The end point of this appears into the compositional characteristic of cities waste; people started discarded plastic with kitchen wastes. Plastic falls under the non-degradable category, and end point of this blanketed plastic is supposed to that soil become infertile. Result of these activities is that farmers could not able to fertile as much crop compare to hardly any year ago, because rain could not able go in for into the plastic and seeds become infertile. So farmers stopped the gathering the mixed waste and cities comes under the unexpected load of waste. So people continuously dumped the waste outside the metropolis along road sides. Heaps of Old Municipal wastes (legacy waste) were produced by the unchecked and ongoing dumping of municipal solid waste. Succeeding the decades of neglecting, that particular waste deposited at wide open ground and this open dumps have grown larger and higher, being the pollution's primary source. This deposited waste carry the dry waste & wet waste it can also call it heterogeneous waste i.e. Bio-degradable & non degradable. This deposited waste rotting in breathless heaps produces the foul dark liquid known as leachate that destroy the vegetation all over about the dumps and pollutes the groundwater reason for polluting is leachate generation. Degradation of solid waste is a factor in the generation of greenhouse gases like methane and carbon dioxide that contribute to global warming. On Other side greenhouse gases methane is an inflammable in nature, so it become reason of the fire, which contaminating an air quality. These open disposal grounds are becoming a massive mountain due to the gradual increase in municipal solid waste. Such as open dumping ground in Delhi Gazipur (69 meters), 55 meters height of Okhla dumps, 56 meters height of Bhalswa, all that dumping ground exceeding the allowable height. The city should abide by clause J of schedule-I of the SWM Rules, 2016, in relation to this Honorable NGT communication to all municipal corporations. If a municipal corporation violated the SWM Rules, 2016, the municipal corporation is accountable for covering up for any environmental damages. India's cities are battling the control of their waste since these dumpsites are full and cannot absorb any more waste. They have also been unable to locate land for the construction of facilities for waste processing. Up to 1,250 hectares of India's valuable land are lost each year to the disposal of MSW, according to Swachh Bharat study (2020). Over 10,000 hectares of valuable urban land are covered by 3,159 legacy waste dumpsites in India, according to the National Green Tribunal.

2. About Legacy Waste

Waste that has been accumulated and kept for a long time on a land or another area of undeveloped land is referred to as legacy waste. Legacy Waste is a term used to describe the method of science of removing, handling, sorting, and using for business the old municipal solid waste that has been dumped in landfills. The term "legacy waste" often refers to old municipal solid wastes that are put in landfills, even though it has not been formally specified in any Indian government documents. Legacy waste is a mixture of biodegradable waste, plastic waste, textile waste, metal waste, glass waste, and other materials that have partially or completely decomposed. There is no pertinent information available regarding the minimum age of wastes to be classed as legacy waste. The aim is to clean up former dumps unscientifically planned & maintained this could be damaging the public health and environment in the long term.

It generally include the

- Bio-soil
- RDF
- Inerts/ Rejects
- Construction & Demolition
- Glass & ceramics/ Metals
- Plastics/ Rubber
- Bio-compost

The form of legacy waste is regulated by the landfill's age. Component of legacy waste based on the percentage of waste still in the landfill, composition grounded on the following fractions, like as

¬ Scrap and polymeric material: This comprises the textile and cardboard, plastic, paper etc.

¬ Stones: More than 20 mm in size

¬ Fine Soil: Fraction of fine soil is found more in percentage in the landfill. Fine soil materials are mineralized and decomposed organic waste with sand and silt, fine fragment of the C & D waste.

¬ Miscellaneous: These include the broken glass, sanitary napkin, metallic fraction such as razor, needles.

Figure 1 Picture of Legacy Waste

2. Methodology

Geographical conditions:

The research work was performed in the jurisdiction of Pune Municipal Corporation and legacy waste plant situated in Uruli Fursungi Pune. Pune is the second-largest metropolis in Maharashtra and the sixth-largest city in all of India. The current population of the city is approximately 39.33 lakhs with nearby one million households. The area of the Pune city is 250 sq.km. Pune also known as bicycle city, according to current population bicycle city has been changes to automobile city. Disposal site situated between 73.51° east and 18.32° north. Pune metropolis is located in the Deccan Plateau. Found different seasonal temperature and weather.

Figure 2 Pune Municipal Corporation boundary map

Figure 3 Legacy waste disposal site.

Methodology for the Legacy Waste

- ✓ To study characteristics or quantity of Legacy Waste generated from Pune City.
- ✓ Comparative study of different methods used for Legacy Waste Management for Pune City
- ✓ To prepare action plan for Legacy Waste Management for Pune City.
- ✓ To suggest solution for Legacy Waste Management for Pune City.
- ✓ To check the economic viability of suggested option for Pune city.

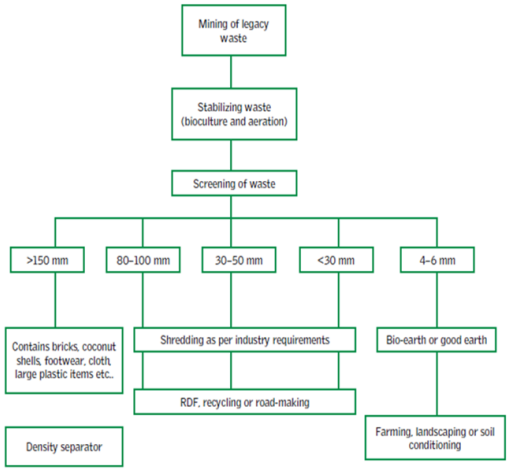

Figure 4 Process flow diagrams for the processing of legacy waste.

Legacy Waste Process:

Municipal solid waste is a category of garbage that mostly consists of household waste (domestic waste), occasionally with some business waste, Construction and Demolition waste, sanitation waste, and rubbish from streets also

included in a certain location. This MSW consists mostly of wet, biodegradable organic waste (at least 65%, and frequently more). Paper and plastic waste are the next two biggest waste sources. The bulk of waste for all socioeconomic classes was made of biodegradable materials as opposed to recyclable or unwanted items.

Mostly of the waste generated form household, hotels, vegetable market, fish market, so that majority of the cities inorganic organic and waste is produced at various levels; the specifics are described here. 40% to 45% of the trash is organic, 30% to 35% is inorganic, and 15% to 20% is inert waste or refuse. Waste generation depends on the commodity uses. Different activity arises different waste.

The sample of legacy waste was gathered from solid waste dumping ground of Pune city. The details physical and chemical analysis was done in Environmental Engineering laboratory. From PMC dumpling yard site 20 kg of legacy waste sample was collected for component separation of legacy waste.

Figure 5 Sample collected from Legacy Waste site

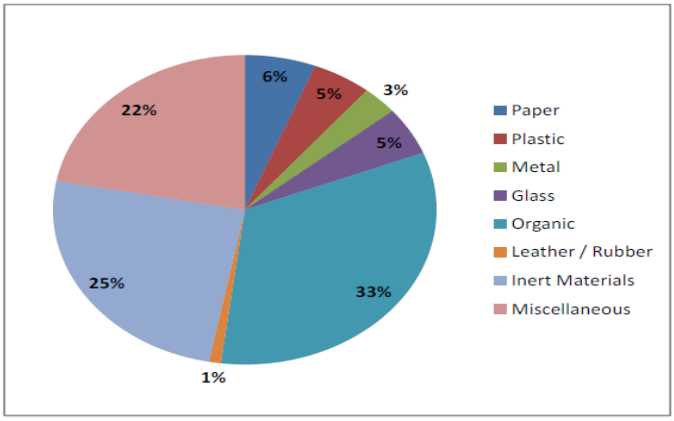

Figure 6 % wise components of Legacy Waste

After studying the various documents and literature, most of the municipal corporation uses the CPCB guidelines for the bioremediation or the treatment of Old Municipal Waste. As per CPCP guidelines and characteristics of legacy waste following method must be used by Pune Municipal Corporation for effective waste management. The details of suggested plan for management of legacy waste for Pune city is as given below

Excavation and heaping of legacy waste	Equipment and machinery required i) JCB for excavation Ii) Tractor/dumper iii) Land for stacking
Preprocessing of legacy waste	Spraying of bio-culture for odour removal
Transportation up to processing Plant	Equipment &machinery required I) JCB for loading II) Tractor/dumper
Screening/Component Separation	Equipment and machinery required I) Separator II) Screen
Separated Legacy waste I) Compost II) Inert material III) Plastic and other material	Application of separated legacy waste I) Compost-Agriculture use II) Inert material- Land filling III) Plastic and other material- for manufacturing of Paving blocks

Suggested plan for effective Legacy Waste management

3. Observation:

The details for various processes suggested for Municipal Corporation of Pune is given in below section of the thesis
The process of bio-mining involves excavating previously dumped waste and creating windrows of legacy waste. The waste is then stabilized through bio-remediation, which involves exposing all of the waste to the air and using composting bio-culture to recover valuable resources (such as organic fines, bricks, stones, plastics, metals, clothes, and rags), and it is then managed sustainably through recycling co-processing. Following process is initiated to accomplish the bio mining-

Excavation/ Pre-processing treatment:

For reducing toxic gases, odour, and the dust, in the demarcated area. The excavation be started from low height heap of waste to the high height heap of waste. Dumped waste excavated and turning with the use of excavator in heaps/cells formation. During the excavation as old waste dump contains various toxic gases and odour causing substance was treated by scientific manner with spraying of Bio-culture. Turning process will neutralize the toxic gases and also control the odour and dust.

MSW Heaping-Stacking:

After excavation completion of the above pre-treatment process, separate heaps is created and stacked in proper size of Lenght (m)X Width (m) X Hight (m) with the use of excavator. During the process each heap is turned upside down in every 5 days and same utilised after 45 days for further process. During each turning of heaps, to improve the de-composing process and to get the require results, bio-culture is added for maintaining quality of legacy waste.

Transportation-up to processing plant tipping floor:

The pre- processed MSW is shifted through trucks at the tipping floor of final processing shed, after weighment at Weigh Bridge. The proper record of each vehicle is maintained. While shifting of legacy waste necessary precaution is taken, so that no effect on nearby premises and surrounding areas. After this, legacy waste is ensured/ checked the quality of material for moisture.

Screening of Waste:

The process of legacy waste in Bio mining processing plant comprises of glass removal, density separation, mass separation, shredding, dust removal, inert removal, moisture removal, and the final products, RDF, Bio-compost, Inert, Bio-soil, and other recyclables material. The waste feeded to the hopper under goes 8 trommels of different sizes of 120mm, 100mm, 80mm, 22mm.

Mining of Legacy Waste

Basically for the mining of legacy waste or excavation of legacy waste excavator or loader are used. Dumpsite contains pool of leachate in an unlike layer and different odorous gases, this puddles excavate by using excavator, so unnecessary trapped gases or leachate drained out, excavated material transported for the further process.

During the process of legacy waste excavation and material handling this point must be taken under consideration, Leachate should be collected and transported for further treatment in leachate treatment plant.

As per characteristic and quantity of legacy waste land requirement, plant and machinery is prepared. The details of capital investment and recurring expenditure is given in Table 1

Particulars	Requirement	Cost (lakh)
Land	20 Ar	
Plant and machinery		
JCB	02	80
Dumper	04	100
Tractor with Loader	02	40
Component separator processing plant with industrial shed	01	130
Man-power	12X Rs.25000	36
Electricity for processing plant	21000 units/month	302.40
Total investment		688.40

Table 1: Machinery required for the processing Legacy Waste

The proposed capacity of processing plant is 1000 MT/day. From this processing plant revenue generation model is prepared for legacy waste management. The details of revenue generation model are given in Table 2

Sr. No.	Particulars	Quantity MT	Rate Rs/MT	Amount (Rs)
1	Compost/Bio-soil	450	3600	16,20,000
2	Refused Derived Fuel (RDF)	280	1200	3,36,000
3	Plastic/metal/ glass etc.	68.00	1200	81,600
4	Construction/ demolition waste	34.00	200	6,800

Total Revenue generation from legacy waste processing plant (Per day)	20,44,400
Assuming 300 days working of processing plant per year Therefore revenue generation (Rs./year)	6132 lakhs

Table 2: Details revenue generation for legacy waste management

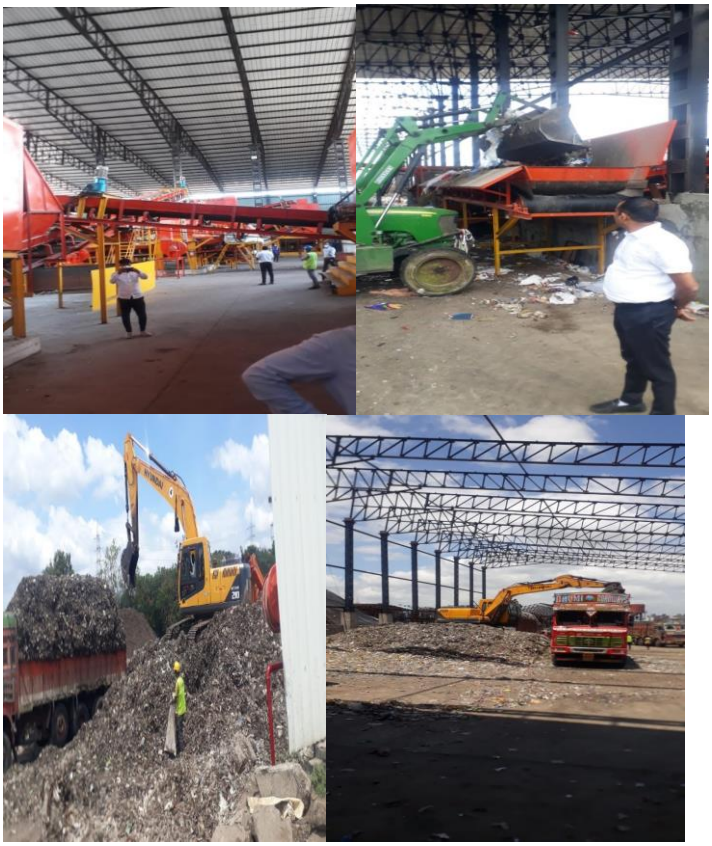

Figure 6 Processing of Legacy waste

4. Results and Discussion:

The 20 kg legacy waste sample is collected from solid waste dumping site of Pune City which is located at Urali Devachi village. This sample is collected at 3 different locations which represent true sample of legacy waste from dumping site. For sample collection and deciding location for sample collection guidelines of CPCB were used. The legacy waste sample is analyzed in private Environmental Engineering laboratory at Pune. The detail report of analysis is given in table 3

Parameter	Sample I	Sample II	Sample III
Bulk density	185	102	165
Moisture content	39.50	33.14	48.00
Volatile matter	54.02	41.69	42.81
Calorific value	4195	4450	4544

Table 3: Sample analysis report.

From analysis the bulk density of sample 1 is 185 kg/m^3, sample 2 is 102 kg/m^3 & sample 3 is 165 kg/m3. The average bulk density of old municipal waste (legacy waste) is 150 kg/m^3. By using this information plant layout for legacy waste management is developed.

The moisture content of sample 1 is 39.5%, sample 2 is 33.14 % & sample 3 is 48.00 %. The average moisture content of old municipal waste is 38.21 %. By using this information air requirement for separation of old municipal waste is developed.

The volatile matter of sample 1 is 54.02 %, sample 2 is 41.69 % & sample 3 is 42.81 %. The average volatile matter of legacy waste is 46.17 %. The results show that approximate 46.17 % material may be used as compost for agriculture purpose. The compost/bio-soil good soil conditioning material.

The Calorific value of legacy waste sample is determined by using proximate analyzer. The calorific value of sample 1 is 4195 Cal/gm, sample 2 is 4450 Cal/gm & sample 3 is 4544 Cal/gm. The average Calorific value of legacy waste is 4396.

To check the economic viability of suggested option:

The economic analysis of suggested options was also studied. The details of calculation are as given below:
Capital Investment = 3.50 Cr
Recurring expenditure = 3.38 Cr
From this processing plant three important material is recovered I) Compost/bio-soil ii) Plastic/glass/metal and other material and iii) Refused derived fuel as per market rate of all these three material and calculation shown in Table 2 revenue generation is Rs 61.32 crore. But in India awareness about recycle and reuse of waste is not satisfactory. Therefore, the payback period of legacy waste processing plant is 5 years. This calculation shows this project is good potential value and it is need for sustainable development. This project will be useful for proper utilization of land for solid waste management.

5. Conclusion:

- The study concluded that legacy waste content 46 % organic matter and good calorific value. This result showed that 46 % material is helpful for agriculture propose. The 10 % material from legacy waste is good

calorific value which is useful as a refused derived fuel for cement industry and remaining 9 % material is inert which is useful for filling low laying area from Pune city.

- Under Swaccha Bharat scheme and other various funding available for management of legacy waste would be utilized for management of legacy waste. The process suggested is excavation, stacking, application of bio-culture and separation/screening and storage of segregated legacy waste. By using funds from Swaccha Bharat this processing plant is being implemented. Implementation of this processing plant would reduce fine imposed by NGT to Pune Municipal Corporation.

- After study was carried out for various technologies used for management of legacy waste of solid waste generated in various wards of Pune city that was discovered that solid waste with high organic content and moisture content has the potential for composting. Which could be efficiently improved by minimizing the load on landfill sites. Contribute directly towards the sustainable development goal. Cost optimization of legacy waste management in urban areas still needs further probe and research as that given to urban areas. A Tentative Budget shows Income more than Expenditure for a year indication is possible then and then only when community participation. Overall, such approach not only directly advantage for Municipal Corporation but also create more potential employment outcome from this facility. From this calculation. The yearly expenditure for operation and maintenance is 3.38 Cr and income from resource recovery is 6.11 Cr if formers and industries ready to purchase compost and RDF material separated from legacy waste.

- The economic analysis of processing plant showed five years is payback period for processing plant for legacy waste management. This shows good potential for business in legacy waste management.

- There is need to conduct awareness about segregation, recycle and reuse of solid waste. There is also need to conduct awareness workshop about composting and benefits of composting which will be useful for sustainable development.

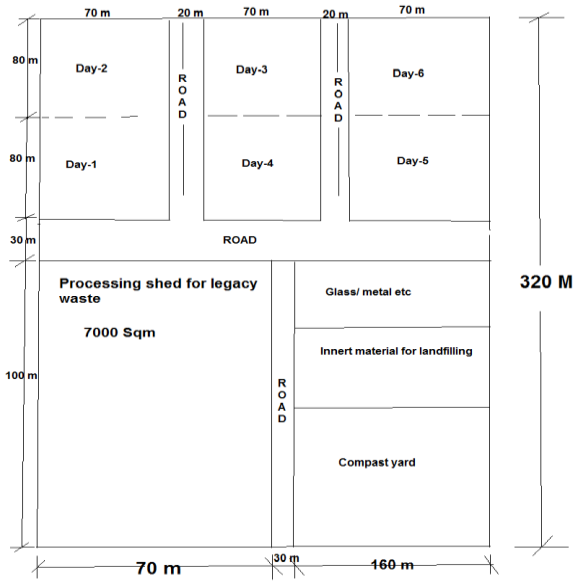

Fig 7 Proposed layout of 20 Acre land for Legacy waste management for Pune city

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