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# Recovery of Materials from Residential Solid Waste

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**ABSTRACT-** Waste management is the biggest problem for the present as well as the future world. We are creating a miserable future for the generation forced to live in this polluted world. The global metal waste alone is 1.3 billion tonnes and it is expected to grow to 27 billion tones by 2050. According to the latest report, India generates 1.57 lakh tonnes of solid waste per day. Out of which only 20% of waste is taken to the recycling path and the remaining 80% is landfills through the improper way. This 80% of waste creates a massive impact and spoils our environment. The objective of the paper is to study the household participation in municipal solid waste management in Nagpur, India. The study mainly focuses on identifying the level of waste sorting and the practice of the 3Rs (Reduce, Reuse and Recycle) principle in households, as well as the perceived factors and difficulties that influence household participation and public behaviour in local municipal solid waste management. In this study, a range of theories on inorganic material production municipal waste management, sustainable waste management, circular economy and household participation are explored and reviewed. The objectives of this study are to identify the current situation of municipal solid waste management in Nagpur, India, and the level of household participation in local municipal solid waste management; therefore to explore approaches for improving household participation to develop the sustainability of local municipal solid waste management.

**KEYWORDS:** Municipal Solid Waste, Reduce, Reuse, Recycle, Waste Management

## I. INTRODUCTION

### 1.1 OVERVIEW

The world is moving towards urbanization and industrialization. This growth and development have created a major impact on the environment by causing land, water, air, and noise pollution through heaps of waste reduced air quality, polluted water, global warming, greenhouse gas, acid rain, etc. Dumping of huge plastic waste causes drought, as it reduces the chance of rainfall. (Liu, et. al., 2018; Ramachandra et. al., 2018). This improper disposal of waste causes infectious and chronic diseases to humans and animals (Banerjee, et. al., 2019).

Every year we are generating a huge waste of 1.3 billion tonnes that can cover the entire world. With the current rapid urbanization and population growth, it is further expected to increase up to 2.2 billion by 2025. The world waste production is expected to grow to 27 billion tonnes per year by 2050, one-third of which will come from Asia, majorly contributed by China and India. The per capita of waste generation rate in the world is going to increase from 1.2 to 1.42 kg for the next decade. Asian countries contribute up to 1 million tonnes of waste per day. Already, the dumping yards of most of the countries like US, Japan, UK, Netherlands, etc. are full (Nitin Joshi).

### 1.2 MUNICIPAL SOLID WASTE

Municipal solid waste management has always been a concern, especially in all developing countries across the globe. In contrast to traditional solid waste management focused on waste treatment, proposed the hierarchy of waste management that emphasizes the maximum use of materials and the minimum generation of pollutants throughout the waste management process. In 1987, a commission known as Brundage published the 'Our Common Future' report, which created the concept of sustainable development for the environmental and green house concerns. Sustainable



waste management involves the Reduce, Reuse and Recycle of waste materials, which is also known as the “3Rs principle”. In today's era, with the growth of population and urbanization process, the amount of wastes generated is exponentially increasing, putting a significant burden on the waste disposal and treating process. The available land for landfills is decreasing as quantity of waste and city area increasing and large amounts of greenhouse gases are emitting through incineration process, which also cause serious environmental problem such as leachate leakage, harmful emissions and water contamination. As the situation becomes more and more critical, we are looking for sustainable waste management which has been treated as an expected solution to these problems. For many developed countries, such as Germany and Japan, practiced sustainable waste management that have significantly mitigated the burden of waste disposal, such as the availability of land for landfills and subsequent environmental problems. And the practice of the actual 3Rs principle can also contribute to the transition from the existing linear economy to a circular economy in a country. In order to develop sustainable waste management in a country, households can make a great contribution through their participation, such as sorting out waste, reducing the inorganic material, practicing the 3Rs principle in daily life, and participating in clean-up campaigns and educational programs, etc. The scale of public participation in municipal solid waste management varies significantly between developing and developed countries. Households in developing countries view municipal solid waste management as a public service without extra charges, and ignore their responsibility for environmental protection and contribution to local municipal waste management. In addition, for many developing countries, local governments lack the financial and human resources to develop municipal waste management. Households' participation can provide this needful human resource, thereby mitigating the financial burden on local municipalities, and their involvement in local municipal solid waste management can enhance their sense of responsibility for maintaining such public services.

### 1.3 Overview of Nagpur Scenario

Nagpur is one of the major cities of central India located in Vidarbha region of Maharashtra state. Nagpur city has a population of 24,05,421 as per the 2011 Census of India. Nagpur is known for being one of the top five green cities in India. Rapid economic growth, increasing population and change in living standards of city causes a high generation rate of different forms of wastes. Waste management and treatment is a major problem faced by municipal bodies all over the world especially in India. There are no specific centres for the disposal of e-waste and medical waste. Waste management techniques are not up to the mark as far as the increasing population of the city is concerned. In this paper we are presenting an overview about the scientific techniques that can help to earn Nagpur the status of ‘ecocity’. We have suggested for the betterment of existing waste management techniques. We can keep river and lakes in the city clean and beautiful for that permanent wall fencing around the lakes and river may lower the quantity of solid wastes deposition and using the treated waste water for other purposes such as irrigation or agriculture etc. Public awareness campaign can also help people to know about the adverse effects of improper waste disposal. Some private organizations and NGO's can also be a helping hand in making the city clean and green. Conservation of water, power, fuel, etc. which play a vital role in conservation of environment and development of eco-friendly city is to be done. Reduction in useless consumption of water, power and fuel will help in sustainable development of eco-friendly city. City may develop in very systematic manner without compromising on greenery if certain steps are properly followed.

With 2.5 million population (Census 2011), Nagpur is the third largest city in the state of Maharashtra. The city is an educational hub and also emerging health hub in central India. With growing population coupled with urbanization and increasing floating population, the city is under pressure to meet the growing demands of its citizens. It is estimated that the city will grow to population of 4.3 million by 2041. Presently, the city generates 900-1000 TPD of waste, out of which only 150-200 TPD of waste is being processed. Evidently, the waste management system in Nagpur is presently inadequate. Irregular collection service along with limited processing and disposal facilities have led to open dumping of huge quantity of waste, which can have significant environmental and health impacts in future. The city is also poised to develop as a ‘Smart City’, with support from the Smart Cities Mission of the Government of India. The vision of the smart city proposal by NMC aims to create an inclusive ecosystem. Realizing the urgent need of a systematic municipal solid waste management system for the city, it was decided during the discussion with Regional GIZ Urban Nexus and Nagpur Municipal Corporation to undertake a detailed solid waste management study for the city. The advisory services will conduct an overall study of municipal solid waste being generated in the City and provide recommendations to choose the best suited technology for processing the waste.

In India the amount of waste generated per capita is estimated to increase at a rate of 1%- 1.33% annually. It is estimated that the total waste quantity generated in by the year 2047 would be approximately about 260 million tonnes per year. The enormous increase in waste generation will have impacts in terms of the land required for waste disposal. It is estimated that if the waste is not disposed off in a more systematic manner, more than 1400 sq. km of land would be required in the country by the year 2047 for its disposal.

At present the standard of solid waste management is far from being satisfactory. The environmental and health hazards caused by the unsanitary conditions in the cities were epitomized by the episode of Plague in Surat in 1994. That triggered public interest litigation in the Supreme Court of India. Based on the recommendations of the committee set up by the apex court in that Public Interest Litigation (PIL), the Government of India, has framed Municipal Solid Waste (Management and Handling) Rules 2000, under the Environmental Protection Act, 1986.

One of the major requisite of these rules is to establish door-to-door garbage collection system in the cities. Nagpur which is located in centre of India has taken initiative in implementing MSW Rules 2000 by introducing 100% door-to-door garbage collection. It has enabled:

- Livelihood creation for 1600 people from most deprived segment of the society.
- Clean environment as 75% of the total waste generated is being collected from doorstep.
- Successful Public Private Peoples Partnership
- Use of ergonomic tools for managing waste
- Use of appropriate technology for waste management, also creating entrepreneurship opportunities.
- Effective recycling of waste for useful purposes.
- Partnership of Waste Producers
- Partnership is going on successfully for last 3 years.

## II. PROPOSED METHODOLOGY

For our study we had taken example of Nagpur city to discuss the effects of Household participation impact on municipal solid waste and hence it can apply to other cities of India.

The objective of this study is investigating the household participation in municipal solid waste management in cities of India like Nagpur which includes two main parts:

- 1) Investigating the current situations of household participation and local municipal solid waste management, and
- 2) Identifying the potential approaches to improve the sustainability of local municipal solid waste management through household participation and by applying more economical method for solid waste treatment.

The research perspective is basically a conceptual model to determine the practice and the analysis of household participation in municipal household waste management. To propose the recommendation, a range of information sources are integrated, desk research and questioning are both included in this research to ensure the validation of information.

### 2.1 PROFILE OF NAGPUR CITY

#### 2.1.1 PROJECT AREA DESCRIPTION

Nagpur is the third largest city in the state of Maharashtra after Mumbai and Pune and is the largest city in central India. Nagpur is also being developed as a Smart City under the Government of India Smart City programme. Nagpur is the geographical center of the country and is the major trade centre in the region and is well connected. Nagpur Municipal Corporation (NMC) spreads over an area of 227.38 sq. km with a total population of 24.06 lakh (2.4 million) according to the census of 2011. Nagpur city makes up 4.73% of the total urban population of the state. The city is now among the fastest growing cities in India and is rapidly emerging as commercial, retailing and logistic hub.

#### 2.1.2 Geographical Location and Regional Linkages

Nagpur is situated in the eastern part of Maharashtra. The coordinates of the city lie between 78°30" to 79°30"E and 20°30" to 21°45"N. The average altitude is 310.5 m above mean sea level. Nagpur is located in the exact center of the Indian peninsula. The city has the Zero Mile Stone locating the geographical center of India, which was used by the British to measure all distances within the Indian subcontinent. Nagpur is well connected with the major urban centers across India.

### 2.1.3 Road Connectivity

All major highways and railways pass through Nagpur. Due to the good connectivity, the city has become a major trade and transportation centre in the region. The following national highways (NH) and state highways (SH) pass through the city.

- └ NH 7: Connecting Varanasi-Jabalpur-Nagpur-Hyderabad-Bangalore-Kanyakumari
- └ NH 6: Connecting Hajira, Gujarat-Surat-Dhule-Amravati-Nagpur-Raipur-Sambalpur-Kolkata
- └ NH 69: Connecting Nagpur-Betul-Obedullaganj near Bhopal
- └ SH 9: Nagpur-Umred-Nagbhid-Chandrapur
- └ SH 248, SH 255, and SH 260

### 2.1.4 Rail Connectivity

In Nagpur, the railway service was established in the year 1867. Nagpur is an important railway junction and a transit for all the trains that connect the four major metropolises of Mumbai, Delhi, Chennai, and Kolkata. Within the city, there are small railway stations located at Ajni, Itwari, Kalamna, Kamptee, and Khapri. Other destinations connected include Kolhapur, Pune, Ahmedabad, Hyderabad, Jammu, Amritsar, Lucknow, Varanasi, Bhubaneswar, Thiruvananthapuram, Cochin, Gorakhpur, Visakhapatnam, Bangalore, Mangalore, Patna and Indore.

### 2.1.5 Air Connectivity

The Sonagaon airport is 7.5 kilometers south of Nagpur city, located in the Multi Modal International Hub Airport of Nagpur (MIHAN) area, and the domestic airlines connect with major cities such as Mumbai, Delhi, Ahmedabad, Pune, Bengaluru, Hyderabad, Indore, and Kolkata. Nagpur is also connected to international destinations such as Bangkok, Singapore, Doha, Dubai, and Sharjah.

## 2.2 Demography

Demography analysis includes details on the size, structure and distribution of populations, and spatial and or temporal changes in them in response to birth, migration, aging and death.

The analysis helps in understanding the previous and present conditions of population, growth, development and uses of natural resources. The existing data used for demographic analysis would be utilized for the population projection till the year 2047.

### 2.2.1 Current Population

According to the provisional census data for the year 2011, Nagpur City's total population is 24.06 lakh (2.4 million). There has been an almost threefold growth in the population in the last four decades, from 8.66 lakh (0.87 million) in the year 1971 to 24 lakh (2.4 million) in the year 2011. However, the decadal growth rate has been continuously decreasing for the city. The decadal growth rate for Nagpur city's during the last decade was 17.24%, which was less than the country urban population growth rate (31.80%) and state urban population growth rate (22.57%). The population details of Nagpur since 1971 and decadal growth in the population are shown in.

**Table 2.1: Decadal Population Growth**

Year	Population NMC	Total	-	Decadal Change	Decadal Rate	Growth
1971	866,000					
1981	1,217,000			351,000	40.53%	
1991	1,622,000			405,000	33.28%	
2001	2,052,000			430,000	26.51%	
2011	2,405,665			353,665	17.24%	

Source: Census of India and City Development Plan for Nagpur

### 2.2.2 Slum Population

The growth of slum population in Nagpur in the past few decades has been huge. During 1971, the number of slum pockets in Nagpur was around 47, which increased by seven times in 1992 and, in 2008, another 50% slums were added.

In the year 2008, a slum survey was conducted in Nagpur and published in the form of Slum Atlas for Nagpur. According to the report, the total slum population in the city is 8.58 lakh (0.86 million) which is 36% of the total population. A total of 446 slums – both notified and non-notified – are scattered throughout the city area, particularly in zones 4, 7, 8 and 9.

### 2.2.3 Population Projection

Population growth in any place depends not only on natural increase but also on in-migration. In addition to Nagpur's rapid socio-economic development that had a significant impact on the urbanization in the city, future growth is governed to a large extent by the development patterns in the city. The extent of in-migration in Nagpur city is mainly the impact of the key projects that are influencing socio-economic development in the city and peri-urban areas.

The population of NMC has been projected up to the horizon year 2047, taking into consideration the decadal population trend of the Census of India from 1971 to 2011. The population is projected using three statistical methods, viz. Arithmetic Progression Method, Incremental Increase Method and Geometric Progression Method.

The average decadal population growth rate of Nagpur city has been 29%.

**Table 2.2 : Population Pojection**

Year	Census Population	Arithmetic Progression	Incremental Increase	Geometric Progression	Average	Population Growth Rate
1971	866,000					
1981	1,217,000					40.53%
1991	1,622,000					33.28%
2001	2,052,000					26.51%
2011	2,405,665					17.24%
2017		2,636,615	2,675,582	2,789,967	2,700,721	12.27%
2022		2,829,073	2,868,639	3,156,716	2,951,476	9.28%
2027		3,021,531	3,061,919	3,571,676	3,218,376	9.04%
2032		3,213,989	3,255,421	4,041,184	3,503,531	8.86%
2037		3,406,447	3,449,145	4,572,410	3,809,334	8.73%
2042		3,598,905	3,643,091	5,173,467	4,138,488	8.64%
2047		3,791,364	3,837,259	5,853,536	4,494,053	8.59%

Source: Population projection by Arcadis

Table 2.3: Projected Population for Nagpur

Year	2017	2027	2037	2047
Projected Population	2,700,721	3,218,376	3,809,334	4,494,053

## 2.3 WASTE QUANTIFICATION & CHARACTERISATION

### 2.3.1 Waste Quantification

Municipal Solid Waste (MSW) quantification for Nagpur has been estimated based on the past records of waste transported to the dumpsite by NMC. A truck scale of 30 tonne capacity is installed at the existing dumpsite at Bhandewadi to scale all incoming waste coming to the dumpsite prior to processing or disposal.

A detailed analysis of the weighbridge data for the last two years from April 2015 to March 2017 has been carried out to estimate waste generation for Nagpur. Based on the available weighbridge record, approximately 14,000 tonnes of waste reached the dumpsite in 2016 –17 (April-March), and 13,300 tonnes in 2015-16 (April-March). The average daily collection of waste based on the weighbridge record for last two years is 1,119 tonnes per day. **Figure 2-2** shows the details on the average monthly waste received at the Bhandewadi weighbridge and provides details on the average waste generated per day in the different months of 2016-17.

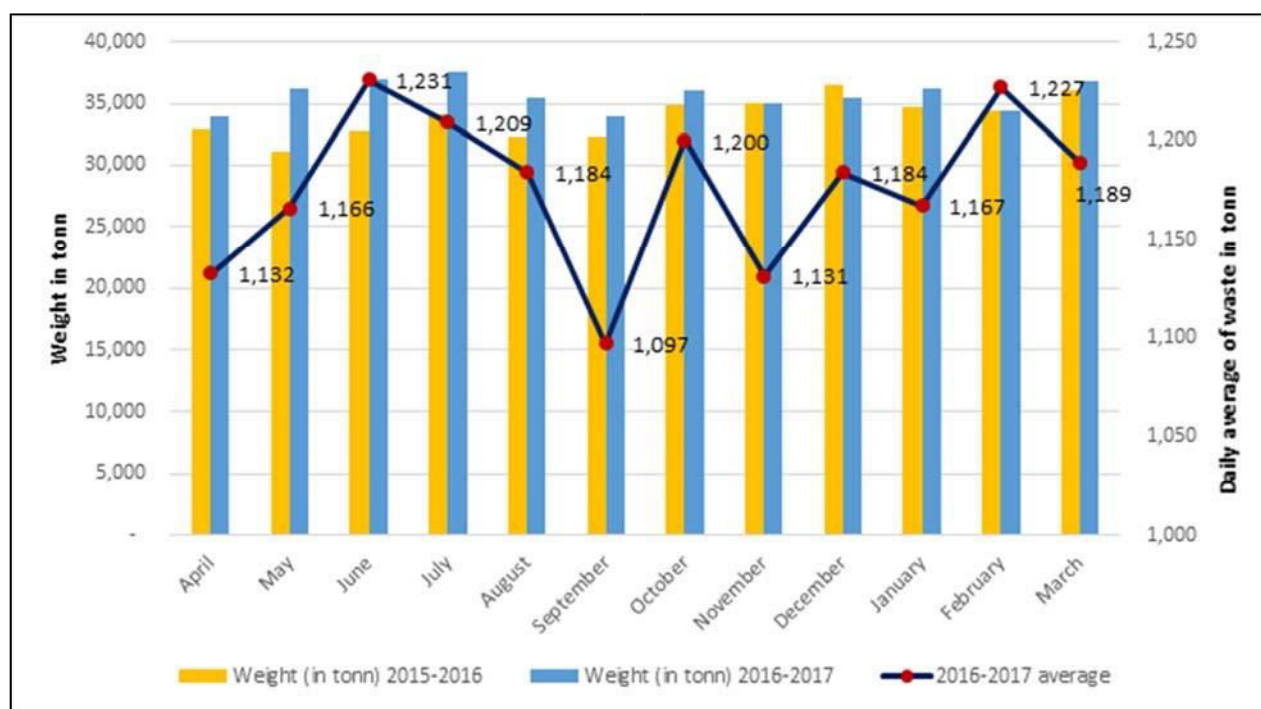


Figure 2.2: Incoming Waste to Weighbridge at Bhandewadi Dumping Site

Source: Based on the data collected from Bhandewadi Weighbridge Nagpur from April 2015 – March 2017

### 2.3.2 Results of Physical Characterisation of Waste

Zone-wise waste composition (primarily residential waste)

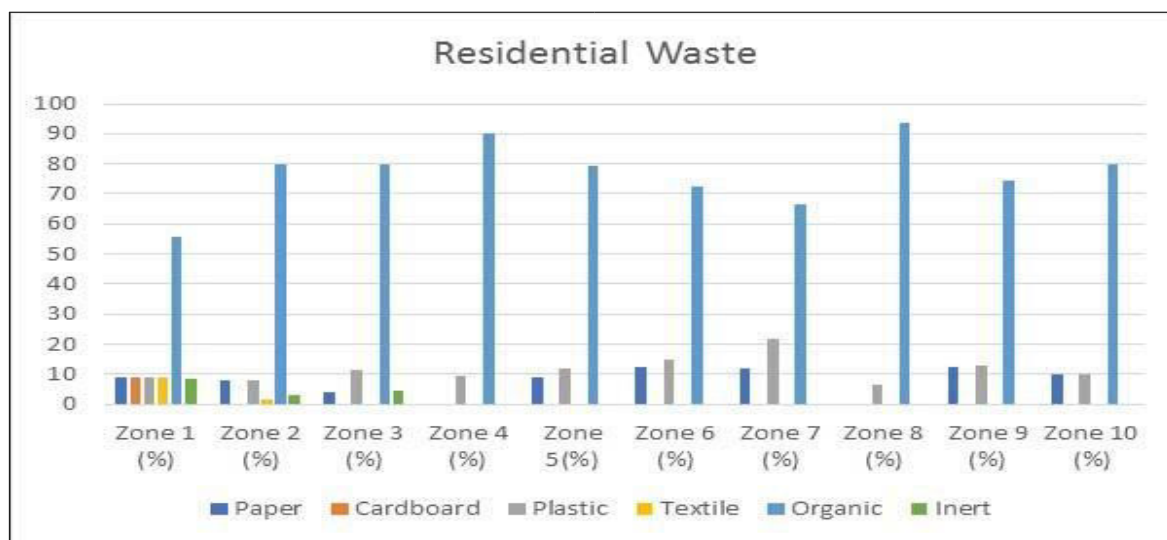
The results for the zone-wise waste characterisation (primarily residential waste from households) are presented and Error! Reference source not found.. The results indicate a very high percentage of organic fraction in the waste (77%), followed by plastics (11.60%), and paper (7.66%). The balance (3.74 %) constitutes inserts, textile and cardboard.

Table 2.4: Average Physical Characteristics of Solid Waste of all 10 zones in Nagpur

Sl. No.	Item	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Average
1	Paper	8.93	7.99	4.09	ND	8.91	12.50	11.67	ND	12.50	10.00	<b>7.66</b>
2	Cardboard	8.93	ND	ND	ND	ND	ND	ND	ND	ND	ND	<b>0.90</b>
3	Plastic	9.00	7.86	11.45	9.58	11.88	15.00	21.67	6.50	13.00	10.00	<b>11.60</b>
4	Textile	9.07	1.33	ND	ND	ND	ND	ND	ND	ND	ND	<b>1.04</b>
5	Organic	55.71	79.89	80.00	90.42	79.21	72.50	66.67	93.50	74.50	80.00	<b>77.24</b>
6	Inert	8.36	2.93	4.45	ND	ND	ND	ND	ND	ND	ND	<b>1.57</b>
7	Wood	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8	Thermocol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9	Metals	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10	Glass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND- Not Detectable

Source: Results of Waste Characterisation Analysis conducted by NEERI for different zones of Nagpur (samples collected from secondary collection points and residential areas), April/May 2017



(Figure 2.3: Residential Waste according to zones)

## 2.4 EXISTING SWM SYSTEM IN NAGPUR

### 2.5.1 Overview of existing system

Nagpur Municipal Corporation (NMC) is currently generating an average of 1100-1200 TPD of waste, with an average per capita generation of 444 grams per person per day. NMC has been a progressive urban local body and has taken some measures for improvement of waste management in the city; however, there is still a need for a lot of focus and considerable improvement.

According to the SwachhSarvekshan<sup>1</sup> survey, 2017, a survey to rank 500 cities in India on the basis of cleanliness and other aspects of urban sanitation initiated by the Ministry of Urban Development, Government of India, Nagpur ranked 137 out of a total of 434 cities surveyed, with an overall score of 1158 as against Navi Mumbai (1705), the top-ranked city in Maharashtra and Indore (1808) the top-ranked city in India.

For solid waste collection and transportation, Nagpur scored 293 as against Greater Mumbai (360), the top-ranked city in Maharashtra and Imphal (360), the top-ranked city in India in this category. Some of the initiatives by Nagpur city include privatisation of waste collection and transportation services, which involves the collection of waste from doorsteps and transportation to the dumpsite. In the year 2008, Nagpur city came up with the concept of a bin-free city and eliminated more than 80% of primary collection points/ community bins from the city. There is still scope for improvement in the collection and transportation system, including improvements in logistic management, optimal utilisation of vehicles, increasing coverage of outer city areas, and bringing efficiency to segregation practices.

For solid waste processing and disposal, Nagpur scored 82 as against Pimpri-Chinchwad (180), the top-ranked city both in Maharashtra and in India in this category. This indicates that there is surely a requirement to improve the overall processing and disposal system for waste in the city. There was previously some initiative for the processing of waste in the city, which includes setting up a waste to RDF facility with support from a private operator. However, the facility is not currently in operation.

SwachhSarvekshan is a survey was conducted by the Quality Council of India (QCI) under the Swachh Bharat Abhiyan to rank 500 cities across the country with a population of one lakh and above on cleanliness.

In addition, a waste bioremediation project primarily for the existing waste is being practiced by the city on the existing dumpsite. According to discussions with the city officials, the project has managed to considerably reduce the height of the existing waste dump. However, the project and technology is currently under question and facing challenges because of recent incidences of a huge fire (March 2017) and odour issues. Other initiatives by the city include the signing of a contract with a private operator for setting up a new waste-to-energy facility.

Despite the above efforts, the processing and disposal of waste in Nagpur requires much higher level of attention to make it compliant with the Solid Waste Management Rules, 2016 (SWM Rules 2016), Ministry of Environment, Forest and Climate Change, Government of India. The existing dumpsite at Bhandewadi is open and subject to various risks due to fire, leachate percolation, emission and is certainly a health and safety concern for the people working on-site as well as people residing along the edge of the dumpsite.

The existing waste management scenario is discussed in more detail further in this section.

## 2.4.2 Collection & Transportation

### 2.4.2.1 Primary Collection

For the effective management of waste, the city has been divided into 10 zones. Door-to-door waste collection is practiced in all wards, except outer city areas. NMC has privatised collection and transportation of the solid waste and awarded the contract to Kanak Resources Management Limited (KRML) in December 2007. KRML is responsible for the door-to-door collection of waste and transportation of waste to the dumpsite at Bhandewadi. The current contract for KRML expires in May 2018.

The vehicles deployed for door-to-door collection activities include handcarts, tricycle rickshaws, auto tippers, and small trucks (Tata 407). Under the “Bin-Free City” programme of NMC, a number of community bins have been reduced and eliminated and most of the garbage collected from various residential, commercial and institutional areas is directly transferred to the waste collection and transportation vehicles, which act as moving waste receptacles.

### 2.4.2.2 Segregation of Waste

SWM Rules 2016<sup>2</sup> prescribe source segregation of waste, i.e. segregation of waste by the generators but, as of now, segregation of waste at source is not practiced by the generators. Segregation of waste (limited to recovery of high value recyclables) is practiced by the workers engaged in door-to-door collection of waste. High value recyclables such as plastics, metals, papers, etc. are separated by the workers involved in door to-door collection which provides them

with additional income. Continuous efforts are required by NMC and KRML to implement source segregation and to raise awareness among the citizens for implementation of the same.

### 3.4.3 Waste Transportation System

As discussed earlier, waste transportation in Nagpur is privatised with KRML providing the infrastructure and service for transportation of waste to the Bhandewadi dumping site. The vehicles deployed for transportation include tipper trucks of various sizes, dumper placers and compactors. Waste from the smaller vehicles utilised in primary collection is transferred to the larger vehicles for further transfer to the dumpsite. Transfer stations developed in various zones are utilised for optimising vehicle utility and bringing more efficiency to operations. Approximately 300-325 trips per day are made to the Bhandewadi dumpsite, with each vehicle making 3-4 trips per day. Provides details of the vehicles deployed by KRML for collection and transportation of waste in Nagpur, including details on vehicles' capacity and trips undertaken. The vehicles and other infrastructure currently deployed by NMC do not have the facility to keep the dry / wet waste separate at the time of collection. With mandated segregation at source, the city requires separate vehicles for the collection of segregated waste from household/community level and other waste generation sources.

Analysis of the existing vehicle deployment plan shared by NMC for KRML indicates that the total carrying capacity for the mixed waste is approximately 2.4 times the waste generation. However, operational inefficiencies of KRML result in waste accumulation at the community bins and other secondary storage points (observed during field survey). In 2015, NMC started developing the Geographic Information System (GIS) based-route map for waste collection and monitoring. The system was developed to bring efficiency to collection and transportation, including proper utilization of manpower, saving of fuel, reduction of time and ensuring regular collection of waste. Currently, the GIS-based monitoring system has been adopted in only a few zones and is being utilised for tracking of the vehicles involved in collection & transportation of solid waste.

### 2.4.4 Treatment System

Currently, there is no working waste treatment facility in Nagpur. Waste collected from various parts of the city is dumped at Bhandewadi dumpsite, which is approx. 10 km from the city centre. In the year 2009, NMC awarded the work of treatment and processing of municipal solid waste to M/s. Hanjer Biotech Energies Pvt. Ltd., Mumbai. Approximately 11 acres of land was leased to M/s. Hanjer Biotech Energies Pvt. Ltd. for development of the composting and Refuse Derived Fuel (RDF) based processing facility. The contract was awarded on a Build, Operate and Transfer (BOT) basis for 12 years. The first two years were for construction and development, and the remaining 10 years for operation and maintenance. The total capital cost for the project was Rs. 26 crores (Euro 3.60 million) and the tipping fee paid by NMC was Rs275 (Euro 3.81) per tonne. After a major fire incident in the plant in 2012, which destroyed a major part of the segregation unit & machinery, the plant became non-functional.

### 2.4.5 Disposal System

The Bhandewadi dumpsite is an open dumpsite in Nagpur, spread over 22 hectares or 54 acres of land. The site is surrounded by habitation on three sides (east, north and west), a sewage treatment plant to the southeast, and a composting and RDF plant developed by Hanjer to the south. The approach road to the site is also from the south end of the site.

The Bhandewadi dumpsite has been in operation since the year 19668 and has been earmarked as a compost yard in all the development plans for the city since then. It is estimated that more than 18,00,000 MT of waste has been dumped on the dumpsite since its inception. However, no actual record of waste dumped at the dumpsite is available with NMC. In the year 2011, a part of the waste from the dumpsite was shifted and capping was provided over an area of 40,630 sqm (4 ha). The balance area is currently being used for the disposal of waste. NMC has earlier constructed a cell for the safe disposal of rejects from MSW processing on the existing dumpsite. However, during the site visit, the sanitary landfill cell was observed to be non-operational.

The waste is currently dumped indiscriminately with minimal compaction and no daily cover, having no system for collection or treatment of leachate leading to likely contamination of the soil and ground water resources. Many secondary studies<sup>9</sup> have indicated a higher level of ground water pollution in the area surrounding the Bhandewadi dumpsite. The dumpsite is subject to frequent fires during the summer season and has been causing air pollution, odour nuisance and have an adverse health impact on the nearby residents. Recently, there was a major fire outbreak on the dump site in March 2017, which has raised questions about the operations of the dumpsite.

## 2.5 Assessment of Prevalent Technologies and their Suitability for Nagpur

In order to assess the suitability of the technology for Nagpur, the following technology assessment criteria/ filters were used:

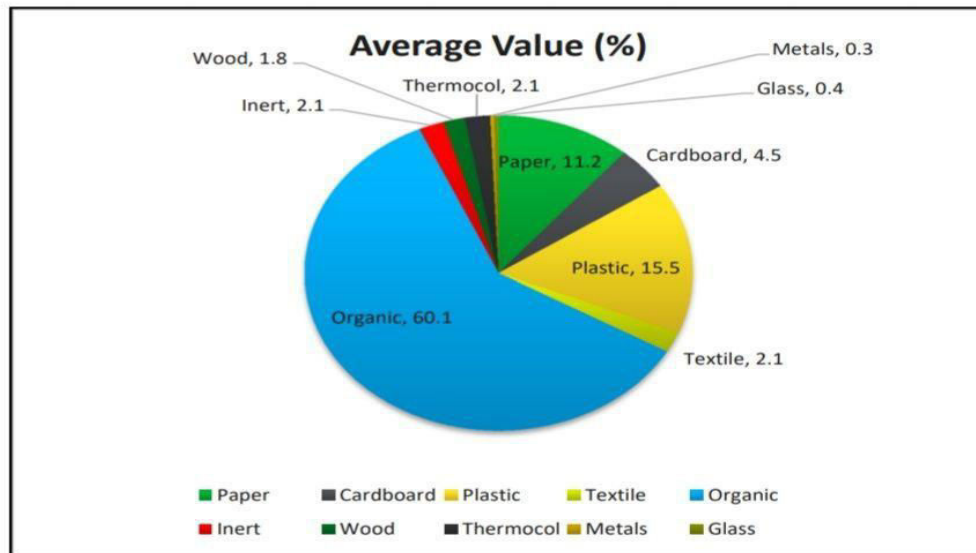
- Waste Suitability: Technologies that are suitable for MSW characteristics of Nagpur;
  - Technology should be capable of handling high organic waste & high moisture content - Studies conducted by NEERI in April/May 2017 show high organic (60%) and moisture content (56%).
- Suitability of technology for mixed waste and segregated waste – Though MSW 2016 mandates segregation of waste, putting segregation into practice requires a lot of efforts from ULB's side and is a time-consuming process to make resident adhere to waste segregation practices. In addition, it requires additional infrastructure for segregated collection and transportation and has high operation cost due increase in transportation cost and deployment of additional manpower.
- Technology Reliability: Technologies that are proven internationally for large-scale application for MSW and could be considered without reservations for Nagpur
- State of Art and Clean Technology: Technologies with low emission & low negative environmental impacts
- Waste technology value chain assessment: Technologies that requires value addition of the MSW chain for sustainability against following parameters
  - Technology that can process mixed waste
  - Technology that requires pre-processing of waste to make it compatible
  - Technology that requires source-segregated waste and a higher degree of pre-processing
- Compliance with the regulatory requirement: The technology is in compliance with the regulatory requirements (i.e., confirms to the MSW Rules, 2016 requirements);
- Rejects diversion to the landfill – technologies with low diversion of rejects to the landfill are more acceptable.
- Social acceptability: Technology should be socially acceptable
- Market for products and by products
- Low carbon footprint

## IV. RESULTS AND DISCUSSION

From the findings it is clear the residents are not aware of any outlined method and responsibility of waste management adopted by the authorities for keeping the Municipality clean. the. As such therefore there is no such a way of doing things and which has been sensitized to the residents, and therefore this leads to the reason why majority of the residents said that they are not aware of any standards or norms and therefore the failure of the municipality to sensitize their people on the importance of personal responsibility to keep Cities clean.

Here are the outcomes of our research study which provides an effective solution for the household residents to effectively take part in Municipal solid waste management are mentioned below –

1. Developing Capacity of the Municipal Personnel.
2. Raising Public Awareness for Attitude and Behaviour Change.
3. Building Community Empowerment .
4. Mobilizing the People .
5. Ward-Based Integrated Solid Waste Management Scheme.
6. Changes as the Outcomes of the Interventions.
7. Working and Benefits of Mechanical Biological Processing Technology.
8. The average percentage of material recovered from residential solid waste -



## V. CONCLUSION

For better management of solid waste, periodic review of each steps involved in waste management like generation, collection, disposal etc. should be conducted & accordingly implementation of “Best Practices” is necessary. Best practices for waste management can be achieved by well known ‘3R’s principle (Reduce, Reuse and Recycle). Wet garbage from hotel, resident can be recycled by establishing composting or vermicomposting plant in the vicinity. This will produce good manure that can be used for gardens and lawns. The least technically complex and most cost-effective solution should be chosen.

From the findings it is clear the residents are not aware of any outlined method and responsibility of waste management adopted by the authorities for keeping the Municipality clean. There is no specific way of waste disposal and management which can be called the norm or best practise for the Municipality’s Households . As such therefore there is no such a way of doing things and which has been sensitized to the residents, and therefore this leads to the reason why majority of the residents said that they are not aware of any standards or norms and therefore the failure of the municipality to sensitise their people on the importance of personal responsibility to keep Nagpur clean.

Due to the high moisture and organic content of the MSW and taking into consideration that the MSW collection takes place as mixed waste, mass incineration is not recommended for Nagpur. We recommend an enhanced process which operates without waste segregation at the source therefore providing easy transformation to energy. According to our assessment, the mechanical-biological treatment of the MSW is the most suitable technology under the existing scenario; and the MYT process based on the technology providing maximum utilisation of waste, minimum diversion of rejects to landfill and highly flexible process for heterogeneous waste is most suitable for Nagpur.

Local Bio-degradable waste processing units, wherever possible set up small scale processing units (composting or biomethanation) in public parks, playgrounds, recreation grounds, gardens, markets. Waste should be also seen as a ‘resource’ and not just a problem. This indeed should be carried out by government and every individual residing in the city to bring Nagpur to the first position as a green city. Preventing a good and clean environment today can lead to a better tomorrow.

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## REFERENCES

1. Gupta, S. & Kansal, A. 1998. Solid waste management in India: options and opportunities.
2. Resources, Conservation and Recycling, 24, 137-154 .
3. JNNURM. (2011) Municipal Solid Waste Management : Treatment Process and Prospects
4. Of Public Private Partnership.
5. Rajkumar Joshi and Sirajuddin Ahmed, "Status and Challenges of Municipal Solid Waste
6. Management in India: A Review," Cogent Environment Science (2016),
7. Singh, S.K., Singh, R.S., 1998. A study on municipal solid waste and its management practices in Dhanbad–Jharia coalfield. Indian Journal of Environmental
8. Quantitative and qualitative assessment of municipal solid waste for Nagpur city Journal of Engineering Research and Studies E-ISSN 0976-7916 Pankaj R.Modak\*, Prakash B.Nangare
9. Mahesh C. Vats and Santosh K. Singh, Status of E-Waste in India –A Review [www.ijirset.com](http://www.ijirset.com) Volume 3, Issue 10, October 2014 retrieved on December 10, 2017
10. Ramachandra, T. V., Bharath, H. A., Kulkarni, G., & Han, S. S. (2018). Municipal solid waste: Generation, composition and GHG emissions in Bangalore, India. Renewable and Sustainable Energy Reviews, 82, 1122-1136.
11. Pappu, A., Saxena, M., & Asolekar, S. R. (2007). Solid wastes generation in India and their recycling potential in building materials. Building and environment, 42(6), 2311-2320.
12. Pandey, R. U., Surjan, A., & Kapshe, M. (2018). Exploring linkages between sustainable consumption and prevailing green practices in the reuse and recycling of household waste: Case of Bhopal city in India. Journal of Cleaner Production, 173, 49- 59.
13. M. Banumathi & D. Arokiaaraj, (2011), "Eco-labeling–The Need for Sustainable Marketing", National Conference in the era of Global Recovery-2011 (SGEGR2011) ISBN:978-93-80530-39-0, pp.511-515.



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