

Sustainable Approach towards Solid Waste Management: A Case of TIER II Indian City- Gwalior

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Abstract—In the growing state of urbanization, Indian cities are victims of ineffective implementation of policies which in turn results in haphazard growth leading to mismanagement. Waste management is one such problem which evolves out of inefficient mechanism. Currently, policy makers at national as well as international levels acknowledge the issue through programs like Swachh Bharat Mission, Swachhta Sarvekshan, etc and the newly evolving Sustainable Development Goals (SDG's) at global level. This paper aims to elaborate the scenario of Municipal Solid Waste Management (MSWM) in a tier II Indian city, Gwalior. The present system, implementation and process of MSWM have been thoroughly discussed with an approach for its future sustainability.

Index Terms— Municipal Solid Waste Management (MSWM), Sustainable Development.

I. INTRODUCTION

Urban India faces an enormous challenge managing its gigantic load of solid waste. It is increasing continuously with increase in population and urbanization, not only in quantity but also in variety. It is estimated that about 62 million tonnes of waste is generated annually in the country, out of which 43 million TPA is collected, 11.9 million is treated and 31 million is dumped in landfill sites.¹

A. What is Waste?

Anything that is not useful or unwanted is considered as Waste or Garbage. But in Nature's dictionary the word Waste doesn't exist. Everything in nature has a purpose. The biggest mistake is to think that waste is useless and to throw waste in dumping yard. By doing this we are interfering with the natural process of recycling. Actually, the problem is due to the nomenclature. Waste is actually not a **trash**, it's a **Resource** that can be reused and recycled in various forms. Hence **Solid waste** can be defined as "Organic or inorganic waste materials produced out of household or commercial activities, that have lost their value in the eyes of the first owner but which may be of great value to somebody else." (Robinson, W.D.1986).

B. Waste Management and UN Sustainable Development Goals (SDG's)

Waste management is a global issue. In 2015 UN summit in New York, Agenda 2030, 17 sustainable

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¹[According to a report by Ministry of Environment, forest and climate change, GOI (5/April/2016)].

development goals are officially adopted by every country. Amongst them, goals directly or indirectly related to waste management are identified as follows-

- Goal No.12- Responsible consumption and production.(Waste minimization)
- Goal No.3- Good health and well being.(Reducing illness from pollution)
- Goal No.6- Clean water and sanitation (reducing water pollution).
- Goal No.13- Climate action (reduction of GHG).
- Goal No.7- Affordable and clean energy.(Waste to Energy)

Goal No.11-Sustainable Cities and Communities (Reduce the adverse per capita environmental impact of cities)

II. SOLID WASTE MANAGEMENT IN INDIA

A. Problems of unscientific MSW disposal in India

In India, only about 75- 80% of the municipal waste gets collected and out of this only 22-28 % is processed and treated and remaining is disposed off indiscriminately at dump yards. It is projected that by the year 2031 the MSW generation shall increase to 165 million tonnes and to 436 million tons by 2050. If cities continue to dump the waste at present rate without treatment, it will need 1240 hectares of land per year and with projected generation of 165 million tons of waste by 2031, the requirement of setting up of land fill for 20 years of 10 meters height will require 66,000 hectares of land.²

As per the Report of the Task Force of erstwhile Planning Commission, the untapped waste has a potential of generating 439 MW of power from 32,890 TPD of combustible wastes including Refused Derived Fuel (RDF), 1.3 million cubic metre of biogas per day, or 72 MW of electricity from biogas and 5.4 million metric tonnes of compost annually to support agriculture.

TABLE I. POLICIES REGARDING WASTE MANAGEMENT IN INDIA
(SOURCE: MANUAL II ON MSWM & SWACH BHARAT MISSION BY CPHEEO)

YEAR	RULES, POLICIES, SCHEMES, FINANCIAL PLANS
1989	The Hazardous Waste (M&H) Rules
1994–1995	MSWM strategy paper by NEERI J.S. Bajaj Committee (The High Powered Committee on Urban Solid Waste Management)
1998	Bio-medical Waste (M&H) Rules Supreme Court appointed Barman Committee
2000	MSW (M&H) Rules CPHEEO Manual on MSW
2005	Report of the Technology Advisory Group on SWM JNNURM (2005–2012)—40 MSW projects costing Rs. 2,186 Cr sanctioned from a total of 65 cities covered UIDSSMT (2005–2012)—51 MSW projects costing Rs. 327 Cr sanctioned from a total of 632 cities covered 12 th Finance Commission (2005–2010)—Rs. 2,500 Cr for 423 Class I cities
2006	Strategy and Action Plan-Use of compost in cities
2007	11 th Five-Year Plan (2007–2012)—Rs. 2,210 Cr for MSWM
2008	National Urban Sanitation Policy (NUSP) Service Level Benchmarks (SLBs) in MSWM Hazardous Waste (Management, Handling & Transboundary Movement) Rules National Mission on Sustainable Habitat (NAPCC)
2010	13 th Finance Commission (2010–2015)—Establishing standards for delivery of essential services
2011	Plastic Waste (M&H) Rules E-Waste (M&H) Rules Draft Bio-medical Waste (M&H) Rules
2014	Swachh Bharat Mission, October 2014
2016	Waste Management Rules, 2016 comprising of Solid Waste Management Rules, Plastic Waste Management Rules, Bio-Medical Waste Management Rules, E-Waste Management Rules, Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and Construction and Demolition Waste Management Rules, 2016.

²[According to a report by Ministry of Environment, forest and climate change, GOI (5/April/2016)].

B. Policy Interventions in India

In 1990s, After the Supreme Court judgement in *Almitra Patel vs Union of India* (writ (civil) no.888/1996), pertaining to municipal wastes, we have various Waste Management Schemes and Policies from Government of India. The Swachh Bharat Mission in October 2014 is flagged as a turning point for Waste management Awareness amongst the Urban Local Bodies (ULB's). The table below shows the timeline of various policies for waste management in India, with waste management rules 2016 being the latest addition. However, these policies are just the beginning of the process,. The more difficult challenge lies in the implementation stage. This paper describes the challenges within the city of Gwalior related to waste management.

III. MUNICIPAL SOLID WASTE MANAGEMENT IN GWALIOR CITY

A. Quantity of solid waste generated

Gwalior is a Class 1 city with an approximate population of 1400000 people (2017). The total waste generated in Gwalior is calculated by the municipal authority to be around 152,570 metric tonnes annually (418 metric tonnes per day)³. Hence, the per capita generation is approximately 0.355 grams per capita per day. There is no data on the quantity generated by different sources; however, informal discussions revealed that about two-thirds of the waste generated is from domestic sources and about one-third from non-domestic sources. (Refer Table II)

TABLE II. TOTAL QUANTITY OF WASTE GENERATED (ESTIMATED) (SOURCE: GWALIOR MUNICIPALITY AND FIELD DISCUSSIONS)

Category	Quantity of waste, tons/day
Waste Collected by vehicles	325
Uncollected waste	53 approx.
Waste collected by rag pickers	40 approx.(including paper)
Total waste generated	418

B. Solid waste collection and storage

Primary collection

The primary collection system in Gwalior constitutes sweeping, cleaning and collection from houses by the sanitary workers and placing the waste in the nearest collection point or open place. For this purpose, the corporation has installed collection bins at different places. The average spacing of dustbin is 3.5 km. There are total 317 vehicles used for transportation and collection of waste. In the core area of old Gwalior, a specific problem of primary collection of Municipal Solid Waste arises due to large number of narrow lanes. Therefore, the garbage is transported from the streets to the collection centres in hand carts. Gwalior Municipal Corporation has deployed nearly 2903 sweepers and sanitary workers for collection of waste from Waste Bin/ waste pile/ waste heaps and for street sweeping. Sweepers carry out street sweeping between 6 a.m. to 11 a.m, the labour is provided with 25 trolleys and 750 handcarts. The average road length per sweeper is 500 metres.

For analyzing the current situation of waste management, a **field survey** is conducted for 50 households belonging from different income groups. It was found that 80% peoples store waste in Metal or Plastic Containers. 70% peoples segregate newspapers and plastics which they sold to *Kabadiwala* (local waste recycling agents). Residents generally do not use separate containers for storing Dry and Wet waste separately. They throw mixed waste daily. The present door to door waste collection is not carried out effectively; in most localities, people throw waste either in curbside containers or at road before sweeping. Most of the people feel the lack of information and awareness about proper handling of waste. Almost 90% peoples pay waste management fees along with House Tax to the municipal authority. Through visits and observation it is found that nearly 15% of the bins are not in good condition. There is no platform below the bins because of which the nearby area remains unhygienic. Various problems identified by peoples are as follows:

³Swachh Bharat Mission Booklet 2017 by Gwalior Municipality

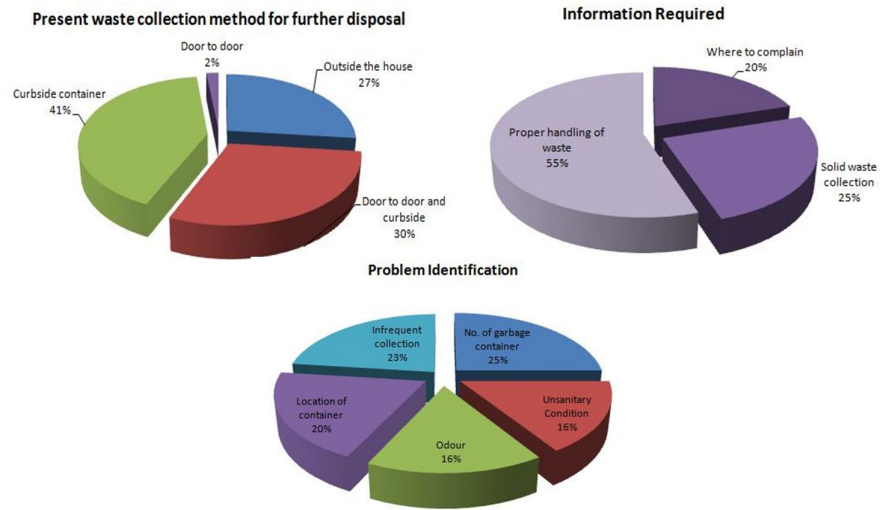


Figure 1: Data regarding Waste collection in Gwalior
(Source: Survey Questionnaire analysis by Author)

Secondary collection

Wards are allotted to the workers and they collect the waste from the dustbins/ containers and the other collection points and disposes it off directly at the disposal sites. Route charts have been made and they lift the container as per their Schedule.

10 Sanitary workers were interviewed for analysing present situation of waste management in Gwalior. The problems faced by these workers are as follows:

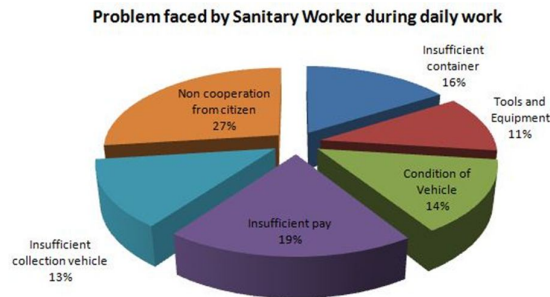


Figure 2: Problems faced by sanitary workers in case study area
(Source: Survey Questionnaires analysis by Author)

Waste Collected By Vehicles: Gwalior Municipal Corporation has total 317 vehicles for collecting and transporting municipal solid waste from collection points to disposal sites. Under Swachta Sarvekshan 2018, the present scenario of the vehicles working for sanitation works is shown in table below (Table 3).

By weighing the vehicles at weighbridge with and without solid waste, the actual carrying capacity of the vehicle was assessed. Similarly the number of trips performed by the vehicles was monitored for 15 days at the disposal site. Based on the monitoring of these vehicle movements, it is estimated that on an average a Dumper placer performs about 4 trips per day and the other vehicles perform about 3 trips per day. According to Gwalior Municipal Corporation, **325 tons of waste is collected by Municipal vehicles per day.**

Uncollected Waste: There are around 425 collection points and 525 dust bins in the City where the community and sanitary works deposit the waste, Municipal vehicles pick the waste from these places and transport the same to disposal site. On an average the number of collection points to be attended by a collection vehicle is 15. However the points actually attended by the vehicles based on discussions with the vehicle operators is estimated to be around 10 only. Thus around 75-100 points would be left unattended per

TABLE III: TYPES AND NUMBER OF VEHICLES IN SANITATION WORKS (SOURCE: SWACHTA SARVEKSHAN BOOKLET, GMC)

Vehicles Name	Numbers
Closed Tipper Vehicle	158
Mini jetting Machine	28
Tractor trolley	59
Dumper (Big/ Small)	30
Aysher placer	07
Dumper placer	02
JCB (2,3DX)	23
Poke lane	03
Loader	05
Road Sweeper Machine	02
Total	317

day. On an average solid waste accumulation at these points is estimated to be around 500 to 750 kg. Average quantity of **waste uncollected in a day is 53 tons per day.**

Waste Collected By Informal Sectors: Gwalior, like many Indian cities has a remarkable trend of rag picking, *Kabadiwala* and *Pheriwala*. Field survey reveals that almost 80% households sell their old Newspapers, Plastic wastes, Cardboards, Tins etc. to these *Kabadiwalas* at certain reasonable amount ranging between 10-25Rs./Kg. Also there are certain women who exchange Old Cloths with New Steel Utensils. Some self-help groups work for recycling old clothes for making Mats, Blankets, Mops etc. Thus people earn money from waste. They store their valuable inorganic wastes and sell them to informal waste collectors. The measurements for Waste collected by informal sectors are not available and it is estimated to be **40 Tons/day**, through on site discussions with Vendors (*pheriwala*), Street collectors, Rag pickers, Sub dealers and Main dealers in the city.

B. Processing and treatment of waste

Presently, there is no facility for processing and treatment of Municipal Solid Waste except that some material is recycled through private vendors at source or from dumping site. The Municipal Solid Waste as received is dumped at the dumping site without processing. No transfer station or transit stations are established for the waste collection, it is disposed off directly to the Barah Land fill site. Thus it takes more trips leading to higher consumption of both time and fuel. Often sufficient no. of trips are not undertaken, leaving waste uncontrolled at collection point.

C. Existing MSWM Organizational System in the local body

The Gwalior municipal authority employees around 2903 sanitary workers to carry out the sanitation work under the supervision of sanitary inspectors. Other than 2903 sanitary workers there are 100 standby temporary workers who will work in absence of any sanitary worker. The sanitary workers are supervised by Health Officers and Sanitary inspectors. The responsibility lies with the Zonal Officers headed by the Executive Engineer of the dept who reports directly to the Municipal Commissioner. Present status of the municipal staff and resources for Sanitation are tabulated below:

TABLE IV: DETAILS OF MUNICIPAL STAFF AND RESOURCES (SOURCE: SWACHTA SARVEKSHAN BOOKLET, GWALIOR MUNICIPAL CORPORATION)

VidhanSabha	Zone/Ward	Zonal Officer	A.H.O. / S.I.	Sanitary Guard	Door to door vehicle	Tractor / trolley	JCB	Dumper	Dumper placer	Container	Poclain
Gwalior	1-7 /21	7	1-1	991	43	9	5	5	3	42	1
Gwl.East	8-14 /19	7	1-1	925	44	10	5	10	3	68	1
Gwl.South	15-21 /20	7	1-1	748	40	8	5	7	2	14	1
Gwl.Gramin	22-25 /6	4	1-1	239	06	3	4	2	1	0	0
Total	25/66	25	4-4	2903	133	30	19	24	9	124	3

D. Bulk waste generators

All the Hotels, Restaurants, Dharamshala, Canteen, etc. are the places where more than 25 peoples can sit together and have food. These places are the bulk generators of the wet waste. Gwalior municipal cooperation have given orders to these organizations to develop composting facility in their premises. The numbers of such organizations which was marked by zonal officers, as registered in municipality office (1.10.2016) are listed below:

TABLE V: DETAILS OF BULK GENERATORS OF WET WASTE (SOURCE: GWALIOR MUNICIPAL CORPORATION)

Areas	Restaurants /Hotels	Canteen /Mess	Marriage Garden	Bhojnalaya	Hostels/School/College	Dharamshala	Others
Total	153	37	162	51	16	22	54

E. Public private partnership in Gwalior

A private agency selected recently oversees the Waste Management in Gwalior currently.

- Project estimated cost: 254.59 Crores
- 20% of the total project cost is given by M.P. Govt. and 20% is given by Central Govt.
- Rest of the project cost is managed by the selected agency.
- For Collection, Storage, Transportation and Processing, and finally Disposal of waste, the agency is provided an amount @1701 Rs./Tonne by the Municipal Corporation.

At present this agency has started working in four wards namely 20, 21, 22 and 23. They collect waste from door to door and send them to land fill site.

IV. PRESENT SCENARIO: DISCUSSION, ISSUES AND SUGGESTIONS

TABLE VI: EXISTING SOLID WASTE MANAGEMENT PROCESS IN GWALIOR

Steps involved in SWM	Processes or Technologies used
Collection	Door to door (in few localities), Community bin
Sorting	Rag picking, Selling recyclable materials i.e. newspapers and plastics
Transportation	Closed Vehicles
Segregation	No Segregation
Treatment	No Treatment
Disposal	Dumping without segregation at Barah Landfill site
Monitoring	Manual monitoring, Digital in some areas

In 2016, Gwalior ranked 400th position in Swacch Sarvekshan, but in 2017, the city showed a drastic improvement with the 27th rank all over India. But Gwalior is not following a sustainable waste management model. The centralized cluster-based approach of tackling the issue, means that the problem of overburdened landfills continues to persist. Additionally, this means that Gwalior does not meet the statutory requirements of the Municipal Solid Waste Management Rules (MSW Rules), 2016 that clearly state that all solid waste needs to be segregated into three categories at the household level – wet, dry and domestic hazardous waste. Also, Waste to energy plants should not burn mixed waste and also classifies landfill disposal as the “least preferred option”.

For Sustainable Solid Waste Management, we need to shift our focus towards Decentralized Waste Management Systems i.e. Waste Segregation and Treatment at Source. Such a process is adopted by the Zero Landfill City Of India, Alappuzha which is ranked as the Cleanest City of India by Centre for Science and Environment (CSE). Most of their organic waste is converted into compost or biogas. Inorganic wastes like plastic, glass, metals, papers etc. are sent for recycling. These cities make money from solid waste rather than spending crores in collecting and transporting wastes to landfills.

A. Strategies for making Gwalior a sustainable and clean city

100% Waste Segregation

The first and most important step towards efficient waste management is waste segregation at Source. But for achieving 100% segregation, Involvement of community leaders, community associations, self help groups and local residents, who represents the community at large is crucial. A strong awareness campaign needs to be planned for providing basic waste handling information to the Citizens and to the sanitary workers. Local Advertisements and Posters for waste segregation should be displayed at prominent locations. Coupon

rewards can be given for proper segregation. A 'Green Culture' needs to be developed in which each individual contributes to Waste Minimization by reducing, reusing and segregating waste. For immediate and proper action, the government officials need to be very strict regarding MSWM processes. Cleaning Squads should be given authority for instant fines on waste disposal on roads and streets. Different days should be assigned for collection of different types of inorganic waste and some value should be assigned for various types of recyclable waste, so that public will get a habit of waste segregation. Wet waste should be handled separately at community level. Door to door collection should be practiced effectively.

Decentralized Waste Management System

The management for Wet waste should be strictly done at Community or Ward level. So that full potential of "waste" can be utilized. Through recycling, generating a significant profit for the municipal body. Various existing and profitable waste management model's like Kerala's Thumburmuzhi Model can be an inspiration, an initial step towards this process.

Waste processing at Household Level

Waste, if segregated, can be processed easily at household level. The dry recyclable waste can be sold to the informal sectors. The wet waste disposal, for smaller housing units with no land (like in high density areas), can be done by municipal authority or through pipe composting. In Group Housings and Residential Colonies, fixed bio gas plant can be installed. For others, Community wet waste processing unit can be installed in public areas with regular collection facilities twice a day. Government should promote the installation of such units at household levels. This results in waste processing at source and provides valuable compost and bio gas.

Involvement of Informal Sectors

Informal sectors are the real heroes for efficient waste management. Their experience and knowledge could be capitalized by formalizing and organizing them. Efforts must be made to bring them together in some formal rag pickers organizations or associations and measures should be initiated to provide them social security, safety equipments and proper health.

No Tipping Fees

Various case studies shows that tipping fees will leads towards huge scams. The company or some authorities misuses this power and tries to increase the quantity of waste, in place of waste minimization, for earning more and more profit. Some evidences prove that sometimes they load stones and debris for increasing truck load. To avoid this, the provision for tipping fees should be avoided. In place of it, the company should be awarded for the amount of waste being Processed or Reused or Recycled.

Zero landfill

According to SWM Rules 2015, landfills should only be used for residual waste that is "non-usable, non-recyclable, non-biodegradable, non-combustible and non-reactive". It goes on to state that every effort will be made to recycle or reuse the rejects to achieve the desired objective of zero waste to landfill. Landfills results in emissions of various Green houseGases (GHG) and finally towards Environmental Pollution and Global Warming. It should be the least preferred option for waste management.

No Incinerators

According to Mr. Ravi Agarwal, the director of Toxic Link, incinerators are actually "landfills in the sky". They results in emission of various toxic gases like dioxins which harms public health severely and results in environmental degradation and GHG emissions. Their use should be limited for a sustainable waste management practice.

Scientific Utilization of Plastic Waste and Agro Waste

Plastic is durable, easy to produce, lightweight, unbreakable, odourless, and chemical resistant. But plastic does not decompose. This is its biggest drawback. Plastic garbage is commonly seen around the city and has started causing several problems. But there still exist many ways in the market to recycle plastics and reuse them in various forms in construction, and industrial fields, like reusing in road construction, energy generation etc. These methods need to be explored and setup with required expertise.

Agro waste, soyabean waste, cotton stalk, saw dust, baggase can be utilized for making Bio mass Brikades, which can be used for Cremation and also as a fuel in Industries. The calorific value of this product is higher than wood and moisture content is low. This is the best and eco-friendly use of waste as it also reduces the use of wood.

V. CONCLUSION

The problem of Waste management is getting severe each day. In the growing world of consciousness, it is necessary for us to understand the value of our existing resources and to utilize its whole potential. There exist many potentially fruitful policies and systems in place which are currently not giving results due to lack of implementation and monitoring. The city and country at large would progress greatly by ensuring the execution of tasks and processes designed and prescribed at various levels of the waste management field.

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