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# Decentralized Waste Management: Analysis for Residential Localities of Gwalior City

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**Abstract –** *The quantum of waste generated in Indian towns and cities is increasing day by day on account of its increasing population and increased GDP. Almost 95% Indian cities are following Centralized Waste Management Systems but the results are not satisfactory as most of the waste ends in the landfill sites. Decentralized Waste Management deals with the waste right from the point of its generation. This paper is an effort to find out strategies which will help to evolve an efficient, environmentally viable Solid Waste Management system that could be functional in the existing fabric of the city of Gwalior.*

***Key Words***: **Door to Door Waste Collection, Waste Minimization, Zero Landfill, Segregation of Waste, Recycling of Waste**

## 1. INTRODUCTION

Urban India generates about 42 million tonnes of municipal solid waste per annum. By 2050, 50 per cent of the country's population is projected to be urban, and the amount of waste will increase substantially. The 12th Schedule of the Constitution of India makes it obligatory for municipal authorities to keep cities and towns clean. Given their wide range of responsibilities, however, dealing with waste in both practical and environmentally sound ways is one of their most significant challenges, and innovative solutions are required for efficient management.

The city of Gwalior is facing the same problem of inefficient waste management. The population and urban sprawl of the city is increasing rapidly due to immigrations for educational and business purposes which in turn put a burden over existing services to tackle this increasing amount of waste effectively. At present, the city is generating 418 metric tonnes of waste every day which is collected in mixed form and dumped in the landfill site. If the same process continues, our city will also have huge mountains of garbage like other metro cities. Today the city is in need of a system where no waste will go out of the colonies in mixed form. All the waste will be segregated, processed and recycled efficiently within the residential colonies. This system will lead us towards sustainable waste management. Also our municipalities can earn money from waste rather than spending crores on its management.

## 2. STUDY AREA

Gwalior is a Tier II Indian City with population of 1069276 (Census 2011). The city is rich in the cultural heritage and has historical importance. It is located on the periphery of Madhya Pradesh state, 321 km (199.5 miles) from Delhi & 121 km (76 miles) from Agra. At present the population of the city is estimated to be 1400000.

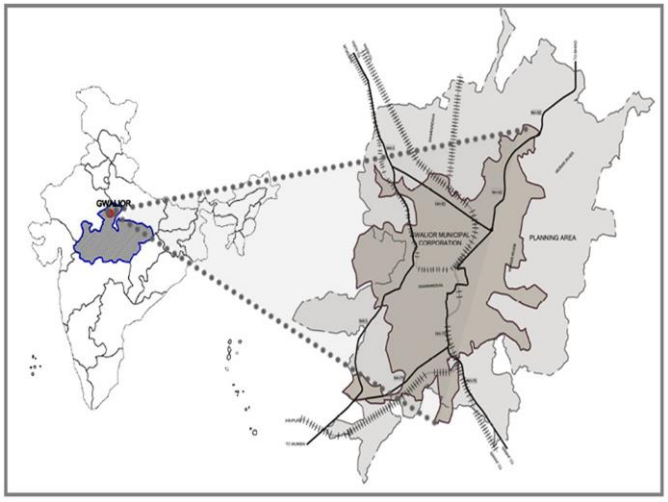


**Figure 1**: Location of Study Area (Gwalior)
(Source: GMC)

**Table -1**: Gwalior Municipal Corporation Highlights
(Source: Gwalior Development Plan)

| Gwalior Municipal Corperation Highlights | |
|---|---|
| Location | 26.22N 78.18E |
| Average Elevation | 197 Meters i.e. 646 Feets |
| Municipal Corporation Area (Census 2011) | 173.68 Sq. Km. |
| Municipality Area (Development Plan 2021) | 18985 Hectares |
| Planning Area(Development Plan) | 42652 Hectares |
| Planning Area and Special Area(Development Plan) | 73279 Hectares |
| Total Wards | 66 |
| Sanitary Zones | 25 |
| Number of Households | 202066 |
| Total Population(2011) | 1069276 |
| Present Population(2018) | 1400000 approx. |

## 3. WASTE MANAGEMENT OF STUDY AREA

### 3.1 Present Scenario

According to Municipal Corporation, the city is generating 418 MT of waste daily i.e. 1,52,570 MT annually. Hence, the per capita generation is calculated approximately 0.355 grams per capita per day. Out of this waste, 325 MT is collected daily by the sanitary workers and the remaining is either collected by the informal workers or left uncollected. At present, all the waste is collected in mixed form, transported and dumped in Barah landfill site. The present waste management scenario is tabulated below:

**Table 2:** Existing SWM Process in Gwalior
(Source: Field observation by author)

| 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 |

A **field survey** was conducted for 50 households belonging from different income groups in a residential locality of Gwalior (Tansen Nagar) for analyzing the current situation of waste management. On analysis of questionnaires it was found that 80% people store waste in Metal or Plastic Containers. 70% people segregate newspapers and plastics which they sold to *Kabadiwala* (local waste recycling agents). Residents throw mixed waste daily. They don't use separate containers for Wet and Dry Waste. The present door to door waste collection is not being 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% people pay waste management fees along with House Tax to the municipal authority. The peoples are willing to pay additional amount for proper and timely waste collection. Various problems identified by peoples are as follows:

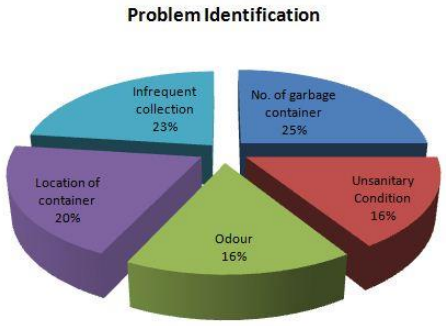


**Figure 2:** Data regarding Waste collection in Gwalior
(Source: Survey Questionnaire analysis by Author)

In Swacchta Sarvekshan 2017, Gwalior ranked 27th position all over India in Cleanliness, but the waste management approach adopted by the city is not sustainable. This centralized cluster-based approach of tackling the issue will result in overburdened landfills. Additionally, the city 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. These rules also specify that waste to energy plants should not burn mixed waste and also classifies landfill disposal as the "least preferred option".

### 3.2 Need of Decentralized Solid Waste Management Systems in Residential Localities

In the previous two decades, the population of the city increased at very fast rate (fig-3) which results in emergence of various new residential colonies in the outskirts. According to Gwalior Development Plan, At present, 2803 Hectares of Land is residential area, which is 48% of the total developed area. (Table 3) Directly proportional to population increase, the solid waste problem has become one of the prime concerns for the city administration.

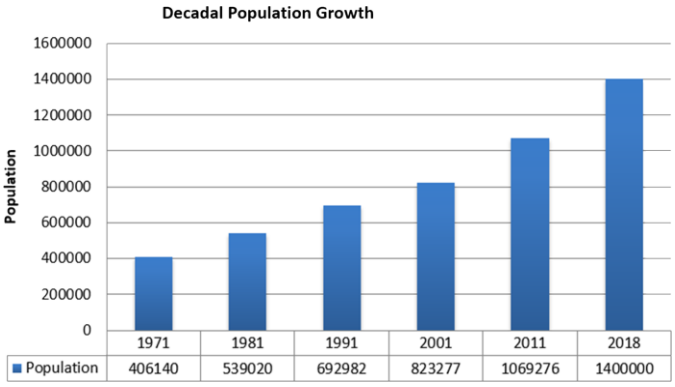


**Figure 3**: Decadal Population Growth
(Source: Gwalior development plan and Census)

**Table -3**: Present Land Use of the city
(Source: Gwalior Development Plan)

| S. No. | Land Use | Area (in hectare) | | Developed area (in hectare) | | Land use percentage |
|---|---|---|---|---|---|---|
| | | Total Area | Percentage | Total Area | Percentage | |
| 1 | Residential | 2803 | 6.6 | 2803 | 48.0 | 2.80 |
| 2 | Commercial | 319 | 0.7 | 319 | 5.4 | 0.32 |
| 3 | Industrial | 367 | 0.9 | 367 | 6.3 | 0.37 |
| 4 | Public and Semi Public | 922 | 2.2 | 922 | 15.8 | 0.92 |
| 5 | Public Amenities | 222 | 0.5 | 222 | 3.8 | 0.22 |
| 6 | Recreation | 212 | 0.5 | 212 | 3.6 | 0.21 |
| 7 | Transportation | 997 | 2.3 | 997 | 17.1 | 1.00 |
| 8 | Agricultural land/Forest land | 36320 | 85.1 | - | - | - |
| 9 | Other land | 260 | 0.6 | - | - | - |
| 10 | Water sources | 230 | 0.5 | - | - | - |
| | TOTAL | 42652 | 100.0 | 5842 | 100.0 | 5.84 |

Current systems of packaging also means an increase in the volume of per capita waste generation which tends to increase with increase in per capital income.

The efficient solution to the problem of waste is to reduce, segregate, process, recycle and reuse the waste within the local area so that no waste will go out of the community. It only comes out in the form of a wonderful resource. And finally the problem of waste will not exist and we will lead towards Zero Landfill. This can be done effectively by Decentralized Waste Management Systems.

## 4. CENTRALIZED V/S DECENTRALIZED WASTE MANAGEMENT

The Gwalior Municipal Corporation is practicing Centralized Solid Waste Management currently. All the waste, in mixed form, is dumping at the Land fill site of Barah without processing. The disadvantage of centralized control of solid waste management is that the wastes are not collected in an efficient manner which results in overflowing garbage bins in various residential colonies. Also, the location of Landfill site adds huge transportation costs to the municipality budget. Dumping of waste in the Landfill sites is the least preferred option of the waste management hierarchy as it leads towards emission of Green House Gases and Global Warming. Also, the seepage of Leachate from the heaps of garbage will contaminate the soil and ground water and eventually came back and ends in our plate or glass. That's why we need to move away from dumping waste to Landfill to managing it as close to source as possible.

The Decentralized Solid Waste Management (DSWM) is a system to provide a clean environment and hygienic living condition by reducing the quantity of waste at source. It involves the management of municipal solid waste by various small waste management centres within the locality. Such centres are called Integrated Resource Recovery Centres (IRRC) which can be either profit making or not for-profit organizations engaged in collecting, transporting and processing around 2 to 20 metric tons of waste from the locality (Karthykeyan et al., 2012). The collected organic waste is converted into compost and the inorganic waste is further sorted into different categories, compacted and sold to the recyclers.

The advantages of a decentralized system are enormous. It improves aesthetic and hygiene conditions of the locality as no waste remain uncollected and the process can be easily monitored. Also it will not require a secondary garbage collection service by the municipality. Decentralized schemes provide better income and employment options to the informal waste collectors and underprivileged sections of the society. Our municipalities can save huge transportation costs and further expansion of Landfill sites can be avoided. They can earn money from waste by converting it into resource. By Composting, we can improve the quantity, quality and nutritional value of agricultural food products and can improve public health. In this way apart from providing a sustainable solution to waste management, this system has many direct as well as indirect economic, social, health and environmental benefits.

The legal framework of the country, headed by the Hon'ble Supreme Court of India has given support to community based waste management schemes. The community can thus avail legal support for decentralized initiative of municipal waste management.

## 5. PROMINENT EXAMPLE OF DECENTRALIZED WASTE MANAGEMENT IN INDIA

Decentralized Waste Management System has various success stories in India. One such example is Kerala's Zero Waste Alappuzha, which has been recognized by the United Nations Environment Programme (UNEP) in 2017 , among **top five cities in UN list** to successfully manage solid waste, alongside cities like Osaka in Japan, Ljubljana in Slovenia, Penang in Malaysia and Cajica in Colombia. The city has no landfill site and all the waste is managed within the city by following decentralized methods. 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 those who are unable to install fixed biogas plant at home, Community wet waste processing unit can be installed in public areas with regular collection facilities twice a day. Details of waste management at community and household level in Alappuzha are given below:

### 5.1 At Community Level

The organic kitchen waste is collected twice a day and processed at community level by using Kerela's **Thumburmuzhi Model**. The model consists of a tank of 4x4x4 feet (1 feet equals 0.3 m) made of ferro cement or bricks. It is designed in such a way that air enters into the tank through the gaps on the sides. It should be kept under a roof to avoid rainwater falling into the tank. This model adopts layering technique and a single layer may hold as much as 500 kg of wet organic waste. Hence our four layered compost bin has the capacity of two tons of organic house hold waste. When one bin is full with all different layers, the bin is left intact for 90 days and all the waste will be aerobically converted into quality compost.

A layer of fresh cow dung or slurry from the biogas plants is put at the bottom of the tank to generate microbes for composting. Above this, a 15 cm layer of dry leaves or dry grass or small pieces of paper is placed. Over this, layers of bio-waste and cow dung are placed. Dry leaves and dry grass absorb water oozing from the garbage. The construction cost of each tank is around Rs 10,000. A unit with two tanks, roof, side walls and water facilities costs Rs 1–1.5 lakh. In Alappuzha, The municipality has set up 12 waste collection centres, with 165 Thumburmuzhi bins at public places and the old waste dumping spots.

**Figure 4** : Thumburmuzhi Model
(Source: Suchitwa mission kerela)[1]

**Clean Model[2]:** Being an aerobic recycling model (in the presence of oxygen) temperature rises rapidly, as much as 70-80 degree (pasteurization temperature). This heat build-up curtails spreading of bacteria/ virus pathogens. Aerobic degradation prevents putrefaction and hence no foul smell or environmental pollution occurs. The method uses a consortium of natural microbes, verified and purified by scientists; hence there is no foul smell. The entire matter completely disintegrates and hence Thumburmuzhi model is ecologically a clean model. UNDP climate control group has lauded this technology as the most ideal and safe method for India. The green house gas emissions are meager, thus valuing on carbon credits and there is no much leach ate in the process.

**Calculations:**
Let us assume the same model for Gwalior
For a locality with 100 households with an average of 5 members in each family
Total population= 500
Total waste generated=500 x 0.355kg/capita/day
=177.5 kg/day
Assuming 60% wet waste
Total wet compostable waste=177.5x60/100= 106.5 kg/day
Total waste in 90 Days= 106.5x 90= 9585 kg
Capacity of one Thumburmuzhi bin of size 4x4x4 feet is 2000 Kg. (In four layers) which is converted into compost in 90 days. Thus total number of bins required for a locality of 100 households= 9585/2000= Approx. 5 bins.

### 5.2 At Household Level

At Household level, wet waste management is done as follows:

***Fixed Bio Gas Plant:*** The fixed biogas plant costs Rs 17,500 and can treat 8-10 kg of waste per day. The plant provides biogas for two–three hours daily. The portable biogas plant has a capacity of 1,000 litres and costs Rs 13,500. In this plant, 5–7.5 kg waste can be converted into compost and the biogas is available for 80-90 minutes. In Allapuzha, Kerela, Suchitwa Mission, the state's nodal agency in-charge of the total sanitation programme, gives 75 per cent subsidy to biogas plants and the cost to the user is around Rs 5,000.[3]

***Pipe Composting:*** The pipe composting system is ideal for a small family. It consists of two PVC pipes of 1.25 m length and 20 cm diameter with two caps. The pipes are fixed in a vertical position on the ground with one-fourth of the pipe under the ground. A 30 cm thick layer of gravel is first put into the pipe to absorb leachate. Waste can be put into one pipe for 30-35 days till it is full. Once full, the first pipe is closed with the lid. Then for the next 30-35 days waste is put in the second pipe. By the time the second pipe is full, waste in the first one would be converted into compost. The cost of this system is just Rs 890, and Kerala state government provides 90 percent subsidy for this. The user can get it installed for just Rs 100.

Decentralized waste management system had helped the municipality to save a substantial sum. Money saved on diesel used for operating 40-50 trucks to transport the waste to the dumping yard alone comes to about Rs 50 lakhs. The

[1] http://sanitation.kerala.gov.in/wp-content/uploads/2017/12/Clean-Homes-Clean-City-Alappuzha.pdf
[2] http://waste2wealthalliance.com/about/our-model/
[3] CSE survey report on Clean city of India, available at http://www.downtoearth.org.in/coverage/waste-smart-cities-54119

cost of the biogas produced through the plants works out to Rs 60 lakhs. The fertiliser can fetch up to Rs 30 lakhs. The savings are bound to go up when more and more wards join the project.

## 6. PROPOSAL FOR SWM IN RESIDENTIAL LOCALITIES OF GWALIOR CITY

For efficient decentralized waste management, the involvement of Community i.e. the waste generators is crucial. Source segregation is the key of success for which huge awareness programs and advertisements need to be planned. Creation of local citizen committee to monitor the waste management at the local level would help towards effective implementation.

The following step wise process can be adopted within the residential localities of Gwalior city:

1. Source Segregation and Collection

- Segregation of waste at source into three categories i.e. Biodegradable Waste (Wet Kitchen waste), Non-biodegradable Waste (Paper, Cartons, Plastics, Polythenes, Packaging Materials, Metals, Glass etc.) and Domestic hazardous Waste (Sanitary waste, Batteries, Medical waste etc.).
- Door to door waste collection of segregated waste.
- Non collection of mixed waste or collection of fine against its disposal on containers and road.

2. Transportation

Segregated waste should be transported to the nearest Resource management centre by Handcarts or through small vehicles.

3. Processing

- The biodegradable waste to be treated by bacterial culture for composting.
- Segregation of non-bio- degradable waste into recyclable waste and inert waste.
- Recyclable and Inert waste is further compacted and sold to certified recyclers.

4. Disposal

The residual waste which is non-usable, non-recyclable, non-biodegradable, non-combustible and non-reactive will be sent to the Landfill site ( In accordance to SWM Rules 2015).

## 7. LONG TERM IMPACT OF DECENTRALIZED SWM SYSTEM

The long-term impact of this system can be described as follows :

- Clean roads, lanes and locality.
- Pollution free environment
- No traffic jams due to heavy transportation vehicles
- Efficient sewerage and drainage system which results in a city free from menace of water logging
- Portable drinking water
- Healthy and nutritious food due to use of natural compost instead of chemical fertilizers.
- City free from epidemics such as cholera, hepatitis, diarrhea and dysentery
- Earning opportunities and Recognition to waste collectors, rag pickers and other informal sectors
- No need for further expansion of existing landfill site as this approach towards Zero Landfill through composting and increased recycling of inorganic waste

## 8. CONCLUSION

The improvement in the solid waste management is the greatest challenge being faced by the municipal authorities. The decentralized approach could be one of the effective methods to solve the problems of waste management in India as it has potential to reduce the quantity of waste by changing the mindset of the people. Decentralized approach is not only sustainable and financially viable but also helps to improve the quality of life and working condition of the waste pickers. It could bring about citizen participation, and contribute to environmental sustainability and economic efficiency. We need to turn the system of garbage management on its head. Only then we will really clean our cities—not just sweep the dirt under the carpet.

## REFERENCES

[1] A report on Decentralized Solid Waste Management Through Community Participtaion, A Pilot Programme In Purdilpur Ward Of Gorakhpur City (2010)

[2] Satpal Singh , (2014) "Decentralized Solid Waste Management In India: A Perspective On Technological Options", Cities - The 21st Century India, Pg.No. 289-303

[3] Karthykeyan D, Aziz A, Chatri A.K., & Shah S.K (2012), 'Public Private Partnership in Urban Water Supply and Municipal Solid Waste Management: Potential and Strategies, Ganesh & Co., Chennai.

[4] Gwalior Municipality Booklet on Swacchta Sarvekshan and Swacch Bharat Mission (2017).

[5] Government of Madhya Pradesh, Gwalior Development Plan 2021 (2008),

[6] Census of India

[7] http://www.cseindia.org/cse-clean-city-award-why-alappuzha-is-one-of-the-cleanest-cities-in-india-8120

[8] http://www.downtoearth.org.in/coverage/waste-smart-cities-54119

[9] http://pib.nic.in/newsite/PrintRelease.aspx?relid=138591