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Implementing Integrated Solid Waste Management: A Case Study of Domestic Waste in Ward No. 3, Gwalior City

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Abstract - *Municipal Solid Waste Management has been a significant concern worldwide. Mishandling of generated waste has caused severe health concerns for residents and disturbs the urban environment. Most Indian cities lack proper management of solid waste and rapid urbanization has pressurized the existing infrastructure. Gwalior City of Madhya Pradesh state has been taken as a case study for this research. The city was selected under the smart city project of the MOHUA, Government of India in 2016 and the waste management of the city is being done under the aegis of the Swachh Bharat Mission. Still, numerous parameters have led to the inadequacy of infrastructure and waste management. The study has looked at the obstacles and prospects of waste management by conducting a detailed study on a selected ward of Gwalior city where maximum challenges have been identified. The study involves a literature review of the waste management cycle and best practices. The government intervention done so far in this domain has been discussed. The site visits have been conducted and interaction with various stakeholders has been taken into consideration. Both primary and secondary data have been collected. A sample size of 120 households have been collected from the residents of the selected ward for having in-depth understanding. The analysis of primary data highlights the demand and supply gap along with the public perception and awareness of the city's waste management system. Public involvement at different stages of waste management for better infrastructure efficiency has been proposed with some recommendations.*

***Key Words*: Integrated solid waste Management (ISWM), Private Public Partnerships (PPP), Municipal Solid Waste Management (SWM), Sustainable Development Goals (SDG's)**

1.INTRODUCTION

As cited by the National Green Tribunal (in the matter of Compliance of Municipal Solid Waste Management Rules, 2016) the Municipal Solid Waste (MSW) remains one of the most serious challenges for environment protection. Deficiencies in proper management of solid waste have resulted in outbreak of serious diseases in the past and have such potential in future.

1.1 National Scenario

Over the past few years, our nation's stable waste manufacturing from domestic and commercial spaces has expanded appreciably because of the country's speedy populace increase and the ongoing pursuit of economic development. Per capita waste generation varies between 0.2 Kg to 0.6 Kg per day in cities with population ranging from 1.0 lakh to 50 lakh. With a speedy population increase and urbanization, annual waste generation is expected to increase by 73% from 2020 levels to 3.88 billion tonnes in 2050.[4]

1.2 Concerns

Compared to those in developed nations, residents in developing countries, especially the urban poor are more severely impacted by unsustainably managed waste in low-income countries. Over 90% of this waste is often disposed of in unregulated dumps or openly burned. These practices create serious health, safety, and environmental consequences. Poorly managed waste serves as a breeding ground for disease vectors contributing to international climate change through methane generation and can even promote urban violence.

2. METHODOLOGY:

To establish the method of data collection we looked for an area facing waste segregation and disposal problems created due to haphazard and unplanned urbanisation. For the collection data a set of questionnaires was created for the residents, commercial enterprises, community members and all the other various stakeholders involved as they are the one primarily facing the problem of waste and its harmful effects.

Simultaneously to lend a practical dimension to our methodological exploration, we drew insights from noteworthy case studies in India, specifically those of Agra & Bhopal . These empirical illustrations not only enriched our understanding but also engendered a nuanced comprehension of the manifold solutions employed to address the complex issue of solid waste management.

Following that, the purpose of Aims, objectives, scope, and constraints were articulated, carefully defining the

parameters within which the study took place. An in-depth analysis of case studies led to the orchestration of comprehensive solutions for the reduction of solid waste concerns.

3. LITERATURE REVIEW

Every element of nature serves a purpose. The worst error is to believe that Throwing waste into a landfill is pointless. Hence Solid waste is defined as "Organic or inorganic waste materials produced out of domestic or commercial activities, that have lost their value in the eyes of the first possessor but which may be of great importance to future users".[1]

3.1 Sustainable Development Goals of waste management

Managing waste is a global problem. The United Nations Goal 2030, which includes 17 sustainable development objectives, was officially endorsed by all member states in 2015 in the United Nations. The following objectives are included among them as being directly or indirectly connected to waste management are:

- Goal No 03: Improved health and wellbeing (lowering pollution-related disease)
- Goal No 11: Sustainable Cities and Communities (Cleanliness of the cities)
- Goal No. 12: Responsible Consumption and Production (Reduce|Reuse|Recycle)
- Goal No 15: Life on Land (Promoting healthy lifestyle of residents) [7]

3.2 – National Acts and Rules regarding (SWM) –

National Acts and Rules related to Solid Waste Management.

1. "The Environment (Protection) Act, 1986.
2. Municipal Solid Waste (Management and Handling) Rules, 2000.
3. EPA – "Rule and Implementation Information for Standards of Performance for Municipal Waste Landfills".
4. EPA - Municipal Solid Waste Landfill Regulations.
5. The National Green Tribunal, 2010" (Moud.gov.in, n.d.)

Policies Regarding Solid Waste Management in India –

1. **1994** – "MSWM strategy paper by NEERI
2. **1995-** JS. Bajaj Committee I The High-Powered Committee on Urban Solid Waste Management) [1]
3. **2000** -MSW (M&H) Rules CPHEEO Manual on MSW.
4. **2006** - Strategy and Action Plan-Use of compost in cities.
5. **2007** -11 Five-Year Plan (2007-2012) --Rs. 2.210 Cr for MSWM
6. **2014 -** Swachh Bharat Mission, "a country-wide campaign initiated by the Government of India in 2014 to eliminate open defecation and improve solid waste management".[6]
7. **2016** Waste Management Rules, 2016 comprising of Solid Waste Management" (Moud.gov.in, n.d.)

These acts and policies provided the guideline framework for the implementation of ISWM in the nation for effective waste management and fulfill the aspirations of SDG's leading to a healthy life-style of residents.

3.3 Policy Interventions in India –

The **Supreme Court's** decision in Almitra Patel v. Union of India (writ (civil) no. 888/1996), which dealt with municipal garbage, resulted in the 1990s in the development of several waste management programmes and policies from the Government of India. The **Swachh Bharat Mission** in October 2014 is remembered as a turning point in urban local bodies (ULB's) awareness of waste management. Also, the orders of **National Green Tribunal** and **MOHUA, GOI** guidelines and regulations are only the start of the process, though the implementation stage presents a more challenging challenge. This research discusses the difficulties faced with waste management in the city of Gwalior.

4. PRESENT SCENARIO OF SOLID WASTE MANAGEMENT IN GWALIOR CITY

4.1 – Introduction to Gwalior –

Gwalior is a historic city in north-central India at 26.2183° N, 78.1828° E with a municipal area of 375 sq. kilometres and a population of 20,32,036 as per census 2011[6]. It is a Tier I city located in Madhya Pradesh's far north-western corner. The urban population is 1.05 million people, including 0.14 million people living in notified and un-notified slums. The Gwalior municipal corporation is organised into 25 zones, each of which is further subdivided into 66 wards. The city has a density of 6157 people per square kilometre.[2]

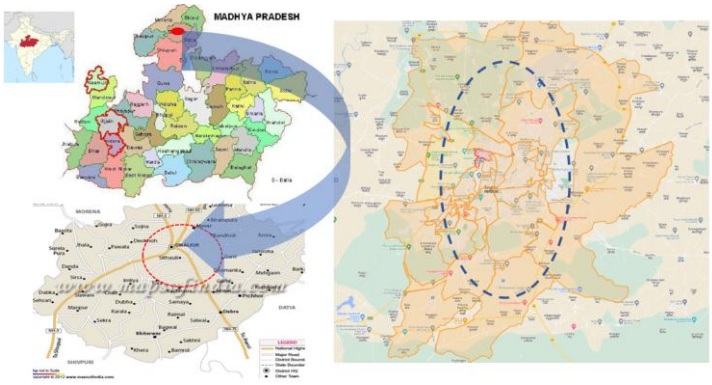

Fig -1: Municipal corporation city Base Map, Gwalior

Table -1: Present status of SWM in Gwalior city

Source Segregation	No source of segregation practice at present in GMC.
Door to door collection of waste	Currently, a street-to-street collection approach is followed in the 66 wards on alternate days basis.
Storage of waste	There are many garbage collection points & open points to store waste and subsequently transport them. On other hand garbage collection points there are 1.1 cubic meter bins for secondary storage of waste. The current practice is to store the waste in open plots.
Secondary transportation	Waste that is stored at garbage collection points is lifted and transported to the dump site by tractor trolleys and dumpers and tippers waste that is stored in open points is lifted by open points is lifted by open tractor trolleys and transported to the dumping site.
Waste Processing	At present there is no 100% processing facility at Gwalior and currently all mixed waste is being dumped at Kedarpur landfill site.

4.2 Waste Generation in the city -

Most of the solid waste is generated by households, markets and commercial areas. The total number of households in Gwalior Municipal Corporation is around 2,95,000. The city generates around 450 - 600 TPD of solid waste of which around 80% is dry waste and the rest 20% is wet waste. All kinds of waste including cow dung, biomedical, e-waste and construction & demolition waste are being mixed in the municipal stream of waste. Almost all the unsegregated waste is being dumped rampantly across the only present Kedarpur Landfill Site and at various open plots in the city even though recycling is limited.

Dry waste processing capacity of Landfill Site - 250 TPD

Wet waste processing capacity of Landfill Site - 390 TPD

Dry waste received per day (avg) - 400 TPD

Wet waste received per day (avg) - 150 TPD

The landfill site with a maximum processing capacity of dry waste around 250 TPD receives around 400 TPD of waste of which around 60% gets recycled and processed and rest over is dumped leading to its overburdening. Wet waste received is well within the processing limit and gets recycled completely into organic compost.[2]

Lack of recycling process and overburdening of waste leads to the accumulation of waste and creating hazardous issues for the populace as legacy waste.

Fig -2: Satellite image of unplanned dumping of waste at Kedarpur Landfill Site, Gwalior

5. INTRODUCTION TO THE STUDY AREA –

The ward no 03 Vinay Nagar Falls in the North Periphery of the Gwalior district. The area of the Vinay Nagar Ward is 2.18 km^2 approximately. The distance is 5.4 km from the railway station and 14.7 km from Gwalior Airport. It is 4.9km from the Bus Stand of Gwalior and 4.3 km from the Primary Business District, Maharaj Bada. Thirty thousand people live in a 2.18 m^2 total ward area.

With a population density of 14000 people/km^2, 12 colonies, it is the ward with the highest population in Gwalior.

Fig -3 : Base Map of Ward Number 3

Table -2: Demographic data of ward 03

Total population	30000
Total household	7200
Waste generation per day	10.5 TPD
Total literacy	79.29

5.1 Present status of ward's SWM-

The majority of the land in the ward is used for residential, institutional, and commercial purposes. Most of the waste, which is organic and may be recycled, is produced by residential individuals. Construction material stores in this ward produce hazardous waste that can be recycled and not recycled, and industrial garbage is also produced as a result of the presence of an industrial area.

The ward generates 10.5 tons of waste daily. out of which **dry waste is 70%** & **wet waste is 30%.** The vehicle collection is irregular; the majority of the waste is picked up by rag pickers, and people dump it in the nearby open plots or drains. Only **50%** of the material is being collected and disposed of by GMC because of insufficient facilities.

Only **50%** of the material is being collected and disposed of by GMC because of insufficient facilities. Municipal waste was typically discovered in a mixed form, which included bio-medical waste, construction waste, and other waste that had been placed in an open area. It was quite typical for waste to be burned at disposal sites. (Gwalior Nagar Nigam norm states that 350 gm. of waste is produced per person every day). The total number of waste collection vehicles operating in the city is 300 for all over Gwalior.

5.2 Current issues in the ward –

With a waste generation of 10.5 TPD in the ward , around 6 tonnes is collected by the ULB and the rest is dumped in the locality.

No. of waste generating units –

- Residential – 7200
- Commercial- 450

No slum area in ward no.3

The indiscriminate scattering of unsorted waste in and around the local landscape generates foul odours and poses health concerns for the community's inhabitants. This unmanaged waste accumulation fosters the proliferation of contagious ailments, while also attracting stray animals that fall sick after consuming these discarded materials. Furthermore, the obstruction of drainage systems results in heightened sediment buildup within the channels, leading to flood-like scenarios during the rainy season. This, in turn, results in the dispersal of harmful decomposing waste onto the streets and private properties of the residents. Moreover, this situation acts as an impediment to the realization of Sustainable Development Goals (SDGs) 03, 11, and 15.

5.3 Analysis of household survey -

The survey was conducted through google form and personal interactions with the people. A sample size of 120 households. the analysis of various questions are –

a) **Segregation of waste** – In the Vinay Nagar Ward, 68% of residents are aware of waste segregation, while 32% are not. Those who are aware still do not segregate the waste and discard it in the mixed form which creates issues in recycling. Literate people were more aware and opted for waste segregation at their homes.

b) **Method of disposal of waste** – 9% of people dump their waste in open spaces, while 69% of people dump their waste in municipal vehicles. 12% dumped in handcarts, 10% dumped in containers. It was observed that people who were not literate mostly discarded the waste in open land and did not use sustainable methods and a lack of awareness was observed among them.

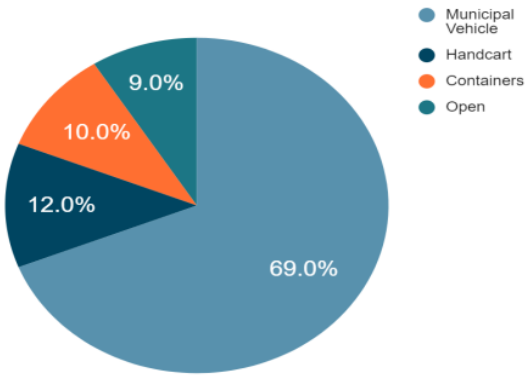

Fig - 4: Waste disposal methods opted

c) **Regularity of collection** –76% of residents claim that collection is regular, however, 24% claim that collection is not regular. It just collects thrice a week. Which is the basis for open disposal. The ULB needs to speed up their collection process and ensure that every household is covered at least once a day.

d) **Disposal service available–** Every amount of waste is either collected by the municipal corporation, a private individual, or both. 58.3% of households dispose of their vehicles through collection, 16.7% do so through hired private collectors, and 25% use both services. ULB should increase its collection vehicles and their frequency.

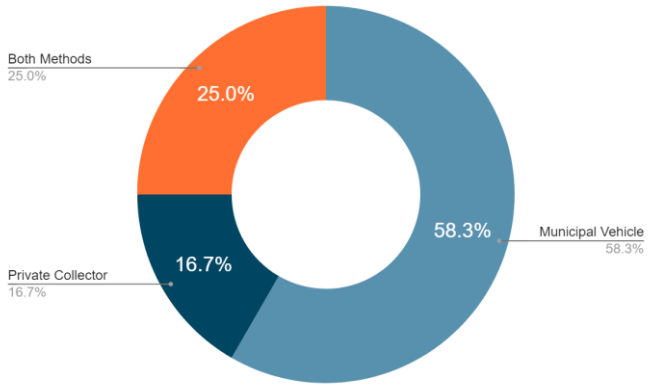

Fig - 5: Mode of waste collection

e) **Cleaning of area - 71%** coverage of the area for cleaning of the ward shows adequate manpower employed by the ULB. Proper training is necessary to manage the related functional components, such as garbage collection and segregation and safety equipment should also be made available to the safai-mitras to ensure their health-being and daily availability.

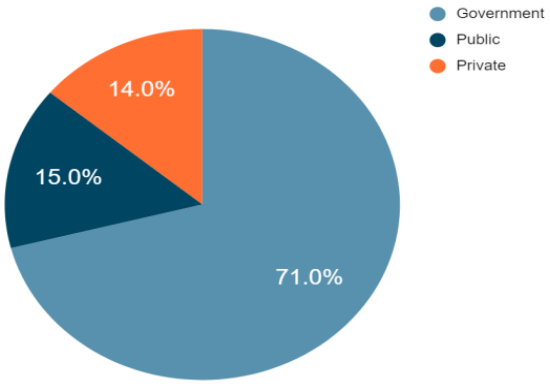

Fig – 6: Cleaning Methods

f) **Need of large bins** – Areas requiring color coded large community bins should be addressed on a priority basis to make sure the waste is not discarded in open on non- availability of waste collection vehicles. It also makes the task easier for both the public and the Government. The waste segregation by the residents into dry, wet and other waste can be ensured by discarding the waste in proper color-coded bins.

Fig – 7: Color coded bins

g) **Participant's opinion on opting Composting-** 69.2% of the respondents were aware about and ready to opt for composting. More awareness among the people is required to improve it further to 80% as it will reduce the daily incoming waste at the landfill site significantly and reduce its overburdening. Apart from Home Composting some pit composting plant should also be set up by creating awareness among the residents by the ULB.

6. PROPOSED ISWM SCHEME FOR VINAY NAGAR WARD IN GWALIOR CITY –

The ISWM strategy designed for the Gwalior municipal region aims to decrease the initial waste generation, followed by recycling and reuse, thereby achieving a reduction (in line with the 3R's of SDG 6) in the amount of waste being sent to landfills for ultimate disposal. To overcome limitations, an integrated strategic approach for ISWM incorporates existing data, standards, and framework.

The primary goal in this context is to guarantee appropriate storage, efficient collection, seamless transfer, processing, and responsible disposal of waste, taking into account the components within the waste stream. This is to be achieved sustainably and with active community engagement. Lastly, for maintaining a healthy environment, the ULB shall adopt this approach and shall pursue reducing the amount of solid waste cost-effectively.

6.1 Proposals -

1. Segregating waste at its origin, particularly household waste, involves the active engagement of the community. This is done by using separate containers and employing fuel-efficient vehicles for the routine collection of waste based on its characteristics. The inclusion of a compactor enhances the efficiency and cost-effectiveness of the collection process.

2. To increase the number of installed community bins and storage containers for storing biodegradable and wet waste.

3. Construction of transfer stations at suitable locations for impeccable operation of the SWM system.

4. Creation of Pit Composting Centres and spreading awareness about composting among the residents through various campaigns.

5. Increasing the number of collection vehicles and their frequency.

6. The training necessary to manage the related functional components, such as garbage collection and segregation, should be provided to all staff at all levels involved in solid waste management. Safai Mitras and rag pickers should also be compelled to undergo regular medical exams.

7. Portable truck mounted refuse compactor shall be deployed in the commercial areas to improve the waste collection efficiency of commercial areas.

7. CONCLUSIONS

Un-planned urbanisation and rapid population growth are partly blamed for the dramatic rise in volume of municipal waste produced in numerous Indian cities and municipalities. Waste management issues have a negative impact on public health as well as the environment. As a result, more integrated solid waste management systems are replacing traditional solid waste management solutions. But the implementation of the ISWM strategy is being seriously hampered by a lack of planning, proper funding, and ineffective administrative practices.

The Gwalior waste management system is outdated in the domain of effective waste management and disposal. Its efficacy has been hindered by financial difficulties and a lack of coordination and cooperation between the public and the relevant authority.

Along with use of cutting-edge spatial analytical tools like GIS and GPS, the potential for community involvement in the waste management system shall be stressed more for efficient management. While, for the system to succeed, government initiative is always required. Consumer advertisements that entice people to participate in waste separation and buy recovered goods can be used to promote waste recycling. ULB should promote composting of garbage concurrently since it will minimise the amount of waste to be disposed of and also help to safeguard the environment.

REFERENCES

[1] MSWM & Swachh Bharat Mission, Manual II, CPHEEO, MOUD,2016

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

[3] SOLID WASTE MANAGEMENT MONITORABLE ACTION PLAN, Municipal Corporation Agra (2020)

[4] Sayantani Jafa, Municipal Solid Waste Management in India- A Compendium Report, International Centre for Environment Audit and Sustainable Development (iCED), Jaipur, India (2022)

[5] Census of India, 2011

[6] GUIDELINES, MOHUA,2016

[7] Sustainable Development Goals, United Nations Environment Programme, 2015

[8] Brijesh Kumar Pandey, Savita Vyas, Mukesh Pandey and Anurag Gaur**.** "Characterisation OF MUNICIPAL SOLID WASTE GENERATED FROM BHOPAL, India" Current Science Perspectives 2(3) (2016) 52-56