

Decision-making of sustainable municipal solid waste management based on the SWOT analysis: A case study of Gurugram City, Haryana (India)

Suman Chauhan* and Sandeep

Department of Geography, Kurukshetra University, Kurukshetra 136119, India

(Received August 29, 2022, Revised March 2, 2023, Accepted March 12, 2023)

Abstract. In developing countries, solid waste is typically disposed of inappropriately, which has a negative impact on the environment and healthcare. One of the most serious environmental issues is the management of municipal solid waste because of the huge increase in waste generation brought on by industrialization, economic development, urbanization, and the exponential growth of Gurugram City's population. Municipal Corporation Gurugram (MCG) handles solid waste collection, transportation, and disposal. The city generates over 1100 tons of solid waste per day. In consideration of this, the current study employed the strengths, weaknesses, opportunities, and threats framework called SWOT analysis to critically examine the city's current methods for the management of municipal solid waste to provide more effective policy solutions. For conducting the analysis, the questionnaires and other interviews were conducted to gather information from households and officials in the city, and the observation made during field visits were recorded. The analysis shows that the waste management issue is getting worse for a variety of causes, including a lack of regulatory enforcement, insufficient technical and financial resources, insufficient people's participation, inadequate execution of policies, a lack of political priorities, and poor coordination between authorities.

Keywords: solid waste; sustainable; SWOT; urbanization

1. Introduction

Municipal solid waste management primarily entails the generation, segregation, collection, transfer, and disposal of MSW. It is carried out with the help of the central government, city municipalities, and households (Chen 2010). Sorting MSW into recyclables and other categories at home is the responsibility of households. Additionally, households should separately and at a specific time throw recyclables and other waste into the containers. Local administrations oversee the waste bins, transferring waste generated on-site, processing bio-degradable waste, and disposing of other waste. The design and planning of suitable environmental policies and initiatives are under the purview of the central government. However, MSW management is

*Corresponding author, Associate Professor, E-mail: chauhansuman132@gmail.com

^aResearch Scholar, E-mail: geog2127sandeep@kuk.ac.in

becoming more problematic owing to several factors, including inadequate financial and technical capability, insufficient infrastructure, unsustainable land use, inadequate policy, and a lack of regulatory enforcement (Kumar *et al.* 2009).

Increased living standards, industrialization, and urbanization all contribute to an increase in the complexity and volume of municipal solid waste generation (Gupta *et al.* 2015). MSW typically consists of biodegradable waste (food crumbs, paper, textiles, cardboard, and yard waste), partially biodegradable waste (Disposable cutlery, sludge, and wood), and non-biodegradable waste (Electronic waste, plastics, dust, leather, ash, rubber, glass, and metals). As per government agency reports, about 420 lakh tons of municipal solid waste, or 1.15 lakh tons per day (TPD), are generated annually in urban India, with 423 Class-I cities contributing 83,378 TPD of that total. Many researchers have changed in recent years and now use decision support methods to develop MSW management systems. One of the tools created to be utilized in the first stages of decision-making and as a predecessor to strategic management planning on the other is a SWOT (Strength, Weakness, Opportunity, Threat) analysis. It is a technique for analysis designed to find opportunities and strategies for successfully implementing MSW management. To identify variables that contribute to poor management, the study's purpose is to assess the current MSW management methods in Gurugram City.

2. Study area

Gurugram is located in the Haryana state. It is most well-known for being India's millennium city. It is one of the major cities in the National Capital Region. It is situated at 77° 02' E longitude and 28°45' N latitude. The city is divided into 35 wards with a total size of 314 sq. km. From a population of 0.8 million in 2011 to more than 1.8 million in 2021, the city has seen phenomenal development (MCG Reports). Due to the city's enormous urban growth during the past 20 years, factors include population increase, immigration, and unplanned urbanization. Gurugram is administratively divided into four zones: Gurugram south, Gurugram north, Gurugram west, and Gurugram east (Fig. 1). 1936 sanitation employees, both permanent and contract, oversee managing the solid waste (Table 1).

3. Objective

The study's main objective is to make a SWOT analysis for sustainable municipal solid waste management in Gurugram city.

4. Database and methodology

To determine the desired strategies for managing MSW in Gurugram City, a SWOT analysis is conducted. It evaluated which internal and external components are crucial for reaching the goal. The factors are:

- Internal factors: The management is informed of the internal factors' strengths and weaknesses.
- External factors - The threats and opportunities posed by the external environment.

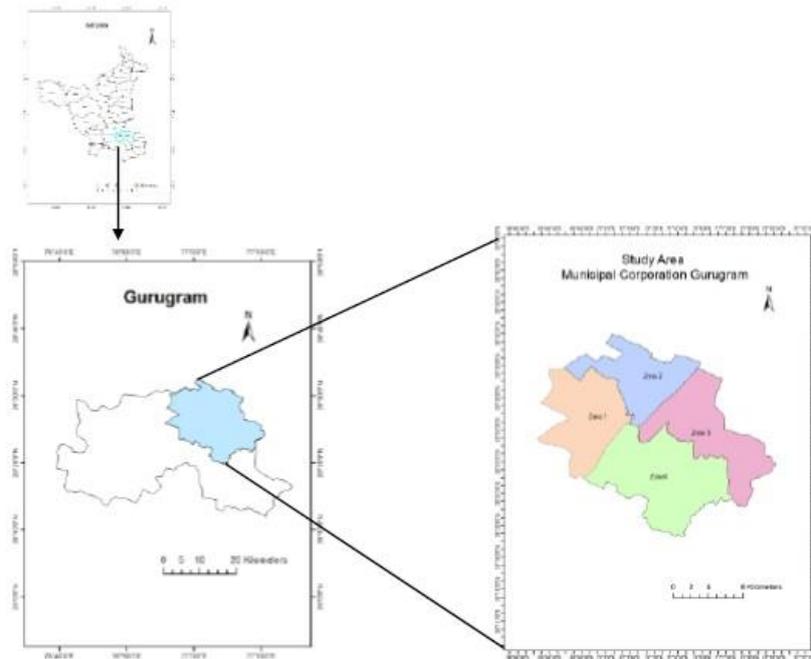


Fig. 1 Study area

- Proposing policy recommendations based on the SWOT analysis.

4.1 SWOT analysis

An important approach given by the United States Environmental protection Agency regarding waste management practices of an area is the SWOT model. This model helps to identify the positive and negative factors that could help to identify the effect on the management practice of an area (Srivastva *et al.* 2005). This method was used to assess the advantages and disadvantages of solid waste management techniques in Gurugram City. In the SWOT technique, various factors are used for identifying their impacts like strengths, weaknesses, opportunities, and threats of the program or other associated activity. For conducting a SWOT analysis, the questionnaires and other interviews were conducted to gather information from households and officials (Municipal Corporation Gurugram) on waste management practices in the study area, and the observation made during field visits were recorded.

5. Results and discussion

5.1 Status of MSWM in Gurugram City

The primary causes of waste generation in Gurugram are urban expansion, rapid population growth, and changes in consumer patterns. According to MCG, municipal solid waste generated in



Fig. 2 Unsegregated waste near landfill site



Fig. 3 Garbage Mountain and collection vehicles moving

Table 1 Current Worker's Availability of SWM in Gurugram City

Sr. No.	Activity	No. of Workers
1.	Door to Door Collection	1206
2.	Transportation	200
3.	Processing	460
4.	Disposal	70
Total		1936

Source: Report of Municipal Corporation Gurugram (2021)

Table 2 Zone-wise Waste Generation in Gurugram City

Sr. No.	Area	Waste quantity (tons/day)
1.	Zone I	370
2.	Zone II	230
3.	Zone III	310
4.	Zone IV	190
Total		1100

Source: Municipal Corporation Gurugram (2021)

the city was 525 tons/day (2011) and 1100 tons per day in 2021 (Table 2). In 2021, the daily average generation rate of solid waste was 0.58 kg/person.

Municipal solid waste (MSW) has different qualities that vary by place. MSW was collected from household's door to door and in containers at designated locations. MSW is transported to the disposal site after being collected. Sanitary landfilling is the predominant way of managing MSW in Gurugram.

5.2 SWOT analysis of municipal solid waste management practices

Table 4 SWOT Analysis of Municipal Solid Waste at Gurugram City

Strengths	Weaknesses
<ul style="list-style-type: none"> • Door to Door waste collection • Strong waste transportation services • Residents pay fixed user fees. • NGO, Resident Welfare Association also contribute to waste management. • Public-Private Partnership helped to relieve some of the landfill's congestion. 	<ul style="list-style-type: none"> • Lack of source segregation. • Not any specific arrangement for season-specific leaf waste. • Lack of a distinctive monsoon management strategy to stop the addition of moisture to waste at the Bandhwari dump. • Domestic hazardous waste (40 tons per day) received inadequate attention.
Opportunities	Threats
<ul style="list-style-type: none"> • Can use modern technologies to counter the circumstances. • Waste-to-energy capacity should be expanded. • Families should be encouraged to establish in-house composting facilities. • A key role might be played by social media to aware people about waste segregation. 	<ul style="list-style-type: none"> • Mix fraction of waste decreased the total energy content of solid waste. • Waste-related laws and policies are not being implemented effectively. • Waste handlers are unaware of the risk to their health at work. • Leachate, landfill gases, and odors from the open dumping site all cause environmental contamination.

5.3 Action plan according to the TOWS matrix

The Municipal Corporation of Gurugram (MCG) is the principal organization in charge of managing the area's municipal solid waste, which includes the storage, collection, and transfer of waste to the landfill site and processing facility. In Bandhwari village, Gurugram city has a 30.5 acre landfill that was built in 2018. Fig. 4 depicts the solid waste management system of the city as it now exists. The study used SWOT analysis to find flaws in the current municipal solid waste management procedures and suggest improvements.

6. Conclusions

- Economic development, unplanned urbanization patterns, and material consumption considerably enhance the MSW generation rate in any city. The poor waste management strategies and unscientific disposal system were responsible for the increased open dumping of MSW in Gurugram city. It could lead to the perpetual degradation of soil and overall environmental quality.

Table 5 TOWS Analysis of Municipal Solid Waste at Gurugram City

INTERNAL FACTORS			
		Strengths (S)	Weaknesses (W)
		<ul style="list-style-type: none"> • Door to Door waste collection • Revenue collection • People Groups contribution 	<ul style="list-style-type: none"> • No source segregation. • Absence of season-specific arrangement. • Inadequate monsoon management. • Less attention to E-waste.
EXTERNAL FACTORS	Opportunities (O)	(SO)	(WO)
	<ul style="list-style-type: none"> • Use of modern tech. • Expend Waste-to-energy capacity. • In-house composting. • Utilize social media. 	<ul style="list-style-type: none"> • Improving of waste collection by using modern machinery. • Alliance and cooperation with NGOs. • Incentive schemes should be applied for waste segregation. 	<ul style="list-style-type: none"> • Emphasize on waste related rules implementation. • Rescheduling people awareness programs. • Improvement of waste processing facilities.
	Threat (T)	(ST)	(WT)
	<ul style="list-style-type: none"> • Unsegregated waste. • Implementation of concern laws. • Unawareness of waste handlers. • Harmful gases from landfill site. 	<ul style="list-style-type: none"> • Focus on 100% collection of generated waste. • Arrange training camps for waste handlers. • Spray of herbal insecticide. • Plantation around the landfill site. 	<ul style="list-style-type: none"> • Promote waste segregation culture. • Make special arrangements for monsoon season. • Employees at landfill site should work in swapping shifts.

- The SWOT analysis is a useful tool for identifying the potential solutions and strategies for putting MSW management into practice. All activities that have an impact on the management of MSW are evaluated systematically as part of the SWOT analysis.
- The SWOT analysis in this study included both the positive and negative issues of MSW management. Some potential measures, such as those related to the environment, society, economy, and strategy, were determined after considering all the variables of weaknesses, opportunities, and threats, as well as strengths.



Fig. 4 Existing Municipal Solid Waste Practices in Gurugram

- Specific strategies, new management methods, and policies for public participation and awareness are some of the suggested courses of action.
- According to the study's findings, even if Gurugram's current solid waste management strategy is functional, it might not eventually prove to be effective from the perspective of a sustainable city. To reduce the load of solid waste generated in the city and, to a lesser extent, to lessen the mounting strain on natural resources, solid waste might be used in the production of compost and energy. As a result, the PPP mode should be more actively involved in strategic decisions about the successful execution of MSW management rules, 2016 and according to the Environment Protection Act 1986.
- Only if the community gets involved with the government can alternatives to the existing procedures be feasible.

References

- Asnani, P.U. and Chris, Z. (2007), *Improving municipal solid waste management in India: A sourcebook for policymakers and practitioners*. World Bank Publications.
- Chen C.C. (2010), “A performance evaluation of MSW management practice in Taiwan”, *Resour. Conserv. Recy.*, **54**(12), 1353-1361. <https://doi.org/10.1016/j.resconrec.2010.05.003>.
- Guarnieri, P., Silva, L.C. and Levino, N.A. (2016), “Analysis of electronic waste reverse logistics decisions using Strategic Options Development Analysis methodology: A Brazilian case”, *J. Cleaner Product.*, **133**, 1105-1117. <https://doi.org/10.1016/j.jclepro.2016.06.025>.
- Gupta, N., Yadav, K.K. and Kumar V. (2015), “A review on the current status of municipal solid waste management in India”, *J. Environ. Sci.*, **37**, 206-217. <https://doi.org/10.1016/j.jes.2015.01.034>.
- Gupta, S., Mohan, K., Prasad, R., Gupta, S. and Kansal, A. (1998), “Solid waste management in India: options and opportunities”, *Resour. Conserv. Recy.*, **24**(2), 137-154. [https://doi.org/10.1016/S0921-3449\(98\)00033-0](https://doi.org/10.1016/S0921-3449(98)00033-0).
- GURL, E. (2017), SWOT analysis: a theoretical review.
- Helms, M.M. and Nixon, J. (2010), “Exploring SWOT analysis—where are we now? A review of academic research from the last decade”, *J. Strategy Management*, **3**(3), 215-251. <https://doi.org/10.1108/17554251011064837>.
- Islam, A., Kalam, M.A., Sayeed, M.A., Shano, S., Rahman, M.K., Islam, S. and Hassan, M.M. (2021), “Escalating SARS-CoV-2 circulation in environment and tracking waste management in South Asia”, *Environ. Sci. Pollution Res.*, 1-18. <https://doi.org/10.1007/s11356-021-16396-8>.
- Jha, A.K., Singh, S.K., Singh, G.P. and Gupta, P.K. (2011), “Sustainable municipal solid waste management in a low-income group of cities: a review”, *Int. Soc. Tropical Ecology*, **52**(1), 123-131.
- Kumar, S., Bhatattacharyya, S.K., Vaidya, A.N., Chakrabarti, T., Devotta, S. and Akolkar, A.B. (2009), “Assessment of the status of municipal solid waste management in metro cities, state capitals, class I cities, and class II towns in India: An insight”, *Waste Management*, **29**(2), 883-895. <https://doi.org/10.1016/j.wasman.2008.04.011>.
- Ławińska, O., Korombel, A. and Zajemska, M. (2022), “Pyrolysis-based municipal solid waste management in Poland—SWOT analysis”, *Energies*, **15**(2), 510. <https://doi.org/10.3390/en15020510>.
- Mani, S. and Singh, S. (2016), “Sustainable municipal solid waste management in India: A policy agenda”, *Procedia Environ. Sci.*, **35**, 150-157. <https://doi.org/10.1016/j.proenv.2016.07.064>.
- Misra, A.K., Masoodi, M., Poyil, R.P. and Tewari, N.K. (2018), “Water demand and waste management with respect to projected urban growth of Gurugram city in Haryana”, *Beni-Suef University J. Basic Appl. Sci.*, **7**(3), 336-343. <https://doi.org/10.1016/j.bjbas.2018.03.003>.
- Narayana, T. (2009), “Municipal solid waste management in India: From waste disposal to recovery of resources?”, *Waste Management*, **29**(3), 1163-1166.
- Paes, L.A.B., Bezerra, B.S., Deus, R.M., Jugend, D. and Battistelle, R.A.G. (2019), “Organic solid waste management in a circular economy perspective—A systematic review and SWOT analysis”, *J. Cleaner Production*, **239**, 118086. <https://doi.org/10.1016/j.jclepro.2019.118086>.
- Pardo Martínez, C.I. and Piña, W.A. (2017), “Solid waste management in Bogotá: the role of recycling associations as investigated through SWOT analysis”, *Environ. Development and Sustain.*, **19**, 1067-1086.
- Rashmi Shah, U.S. (2012), “Sustainable solid waste management in rural areas”, *Int. J. Theor. Appl. Sci.*, **4**(2), 72-75. <https://doi.org/10.1007/s10668-016-9782-y>.
- Rathi, S. (2007), “An optimization model for integrated municipal solid waste management in Mumbai, India”, *Environ. Development Economics*, **12**, 105-121. <https://doi.org/10.1017/S1355770X0600341X>.
- Saxena, S., Ramakrishnan, S., Soni, D., Meena, K.K. and Arora, S. (2020), “Water quality monitoring of residential area affected by solid waste landfill site in Jaipur city”, *Test Eng. Management*, **82**, 14609-14622.

- Sharma, K.D. and Jain, S. (2019), “Overview of municipal solid waste generation, composition, and management in India”, *J. Environ. Eng.*, **145**(3), 04018143. [https://doi.org/10.1061/\(ASCE\)EE.1943-7870.0001490](https://doi.org/10.1061/(ASCE)EE.1943-7870.0001490).
- Singh, D. and Satija, A. (2018), “Prediction of municipal solid waste generation for optimum planning and management with artificial neural network—case study: Faridabad City in Haryana State (India)”, *Int. J. Syst. Assur. Eng. Management*, **9**, 91-97. <https://doi.org/10.1007/s13198-016-0484-5>.
- Srivastava, P.K., Kulshreshtha, K., Mohanth, C.S., Pushpangadan, P. and Singh, A. (2005), “Stakeholder-based SWOT analysis for successful municipal solid waste management in Lucknow, India”, *Waste Management*, **25**, 531-537.
- World Bank (2012), *What a Waste: A Global Review of Solid Waste Management, Urban Development and Local Government Unit*, The World Bank, Washington D.C., USA.