"Strategic Insights into Waste Collection and Transportation in Chitrakoot (UP & MP): A SWOT-Based Study"

Yoshita Ray, G. S. Gupta, Vandana Pathak

Yoshita Ray, Faculty of Science &Environment MGCGV Chitrakoot, Satna (M.P).

G.S. Gupta, Faculty of Science &Environment MGCGV Chitrakoot, Satna (M.P).

Vandana Pathak, Faculty of Science &Environment MGCGV Chitrakoot, Satna (M.P).

Abstract

This research provides a comparative analysis of municipal solid waste (MSW) management in Chitrakoot, covering Uttar Pradesh (UP) and Madhya Pradesh (MP). The changes in waste generation, composition and management practices between 2010 and 2024 are highlighted. Between 2010 and 2024, Chitrakoot has seen a significant increase in municipal solid waste (MSW) generation, mainly due to urbanization, population growth and changing consumer habits. In Nagar Palika Chitrakoot (Uttar Pradesh), annual MSW generation increased from 2,051.41 tons in 2010 to 5,000.12 tons in 2024, while daily waste increased from 5.62 tons to 13.88 tons. Similarly, in Nagar Parishad Chitrakoot (M.P.), annual waste increased from 959.73 tons to 1179.42 tons and daily waste from 2.62 tons to 3.23 tons. Waste composition studies reveal significant presence of biodegradable materials, highlighting the potential for composting and recycling initiatives. The purpose of this study was to present a practical model of strategic waste management via two Strength, Weakness, opportunity and Threats (SWOT)models and hierarchical analysis. A SWOT analysis identifies strengths such as strategically located waste management centers and public education programs, along with weaknesses such as insufficient infrastructure and limited recycling capacity. Opportunities exist to improve recycling and composting initiatives, while threats include rapid urbanization and poor regulatory enforcement. To address these issues, it is advisable to improve waste sorting practices, modernize existing infrastructure, implement public awareness campaigns, implement relevant policies, and adopt comprehensive waste management strategies.

Keywords: Municipal Solid Waste, Waste Management, SWOT analysis, Waste Composition, Sustainability

1   Introduction

Rapid urbanization in the 21st century has exacerbated the challenges of municipal solid waste (MSW) management, which is essential for urban sustainability and public health. Economic development, industrial growth, and improved living standards have led to an increase in waste generation, which is expected to reach

3.4 billion tons globally by 2050 (Kaza et al., 2018). Data analysis involved several techniques. SWOT analysis was used to identify and analyze the strengths, weaknesses, opportunities, and threats in household waste management in Penajam Paser Utara District. Through this analysis, the research is expected to reveal strengths such as available waste management infrastructure, supportive government policies, and high community participation; weaknesses such as lack of community awareness, limited funding, and inadequate technology; opportunities arising from central government support, potential for increased community participation, and partnerships with the private sector; and threats that include rapid population growth, policy changes, and negative impacts on the environment (Sari et al., 2021).Transport inefficiencies further complicate MSW management, resulting in increased fuel costs and environmental impacts. Several factors, such as vehicle type load weight and terrain affect fuel consumption (Heinold and Meisel, 2018). Waste collection and transportation account for 70 to 80% of the total costs associated with municipal solid waste (MSW) management (Erdem, 2022; Yadav et al., 2018); however, they often do not receive sufficient attention from municipal authorities (Bhide and Sundersan, 1983). Households generate various types of waste that require proper management to mitigate health and environmental risks (Yoada et al., 2014). Despite its ecological disadvantages landfilling remains the predominant method of waste disposal (Koda et al., 2015). This research uses SWOT analysis a strategic planning tool in business management to assess the strengths, weaknesses, opportunities and threats associated with current MSW management practices. Recognized by USEPA as a relevant model for understanding waste management systems SWOT analysis helps identify internal and external factors that affect waste management (Srivastava et al., 2005, Greene and Tonjes 2014). Although few studies have implemented SWOT analysis in the context of waste management, it is considered an effective approach to identify gaps and guide improvements (Allesch and Brunner, 2014).

1.1. Objectives of the study

The objective of this work is to identify the method of selection of right technology for processing and disposal of municipal solid waste, which may eventually promote a sustainable waste management system.

I.   To estimate the quantum of solid waste generation in the Chitrakoot UP and MP

II.   To determine the composition of MSW in the Chitrakoot UP and MP.

2. Methodology

The research uses data collected from field surveys, municipal records, and discussions with waste management officials to assess municipal solid waste (MSW) management in Chitrakoot (UP and MP) for the years 2010 and 2024. It adopts a comparative and analytical approach using secondary data sources. The main elements examined include waste generation, composition, collection, separation, transportation, and disposal to assess the current state of waste management. Furthermore, the research cites a SWOT-based strategic management analysis for solid waste recycling in Zahedan (Mor et al., 2016; Aich and Ghosh, 2016). It emphasizes the strategy formulation phase, identifying internal strengths and weaknesses, external opportunities and threats, and defining long-term objectives. Strategic planning includes decisions on business expansion, asset allocation, and potential mergers to improve recycling performance.

Figure 1: Overview of the MSW cycle from source generation to ultimate disposal.

2.1   Study Area:

Chitrakoot Dham, often known as Karwi is situated in the Chitrakoot district of Uttar Pradesh and functions as a Nagar Palika Parishad. As per the 2011 Census of India, the Chitrakoot Karwi block has a and encompasses an area of roughly 21.96 square kilometers. The urban area, referred to as Chitrakoot city within this block, has a population of 23,316. In terms of geography, Chitrakoot Dham is located between 24°48′ N to 25°12′ N latitude and 80°58′ E to 81°34′ E longitude, placing it in the Bundelkhand

region, which is noted for its semi-arid climate and environmental sensitivity. The town is famous for its religious importance, attracting pilgrims throughout the year, which exacerbates the challenges related to solid waste generation and management. Chitrakoot in Madhya Pradesh is found in the Satna district, adjacent to the Uttar Pradesh border. It is administered by a Nagar Parishad and is divided into 15 municipal wards, with local elections held every five years. Geographically, this part of Chitrakoot is located between 23°58′ N and 25°12′ N latitude and 80°21′ E and 81°23′ E longitude. Chitrakoot (MP) comprises 15 wards with a population of 23,316 according to the 2011 Census, and it spans an area of 1,584 square kilometres.

2.1   SWOT analysis of community municipal waste management

The SWOT analysis, which incorporated feedback from government officials, community leaders, and various local groups, highlighted important gaps and opportunities. This methodology, approved by the US EPA and supported by the literature (Gibis et al., 2001; Srivastava et al., 2005), demonstrates effectiveness in identifying strategic improvements aimed at achieving sustainable and potentially zero-waste practices. This research uses SWOT analysis as a strategic framework to assess and improve municipal solid waste (MSW) management in Chitrakoot (MP and UP). It identifies internal strengths and weaknesses, along with external opportunities and threats, to guide the development of more effective waste management strategies. In Chitrakoot (MP), the municipal corporation manages waste through a 4-acre landfill in Rajula, employing 112 Safai Karamchari and using only 25 containers, leading to waste and improper disposal problems. In contrast, in Chitrakoot (UP), Nagar Palika is responsible for waste collection at a 3-acre site in Marjadpur, employing 280 garbage collectors and 150 containers (50 large and 100 small). However, efficiency and coverage issues persist.

2.2.3 Findings From SWOT Analysis

SWOT analysis always seeks to interpret the better preparation of strategic planning proposal for three sanitation infrastructure, theses solid waste management, access to toilet, wastewater management.

Detail findings from SWOT analysis are as below:

Strengths	Weaknesses	Opportunities	Theart
S1: Established location of the solid waste management centre **S2**: Regular waste collection of door-to-door collection is done in residential areas. **S3**: Cost-effective and low-maintenance pit composting method. **S4**: Conducting strong awareness and training programmes about promoting waste management in the division. **S5**: Availability of finance. **S6**: Established Waste Collection Workforce	**W1**: Low management of waste dumping **W2**: Inefficient food waste sorting **W3**: Shortcomings in compost manufacturing process **W4**: Lack of recycling option for lunch sheet issue. **W5**: Limited technological advancements in waste processing. **W6**: Insufficient Waste Bin Infrastructure. **W7**: Inefficient Street Cleaning Practices. **W8**-Unscientific Waste Disposal: Open Dumping's Impact.	**O1**: Installation of a biogas unit within solid waste management centre **O2**: Obtaining external supports from Government and industrial associations. **O3**: Introducing five bins for waste separation. **O4**: Sustainable Waste Management via WTE in Chitrakoot. **O5**: Establishment of E-Waste Recycling Facilities. **O6**: Enhancing Chitrakoot Waste via Public-Private Collaboration. **O7**: Awareness Programs Driving Cleanliness in Chitrakoot.	**T1**: Open Dumping: Endangering Water, Air, and Communities. **T2**: Population growth and changing consumption patterns are leading to increased waste generation. **T3**: Uncontrolled waste disposal generates some health issues. **T4**: Dumping off waste in open drain is more than dumping in bins given by NagarPalika. **T5**: Numerous waste-related legislation and programs are poorly implemented.

Table 1: **SWOT Analysis**

2.　　　Municipal Solid Waste Management (MSWM) SWOT Questionnaire

SECTION A: General Information

1.　　Name (optional): _____

2.　　Designation/Role:

☐　　Municipal Officer ☐ Sanitation Worker ☐ Local Resident ☐ NGO/Private Contractor ☐

Other: _____

3.　　Ward/Area: _____

4.　　Date: _____

SECTION B: SWOT-Based Questions

1.　　Strengths

Please rate the presence or effectiveness of the following positive features (0 = Not at all, 10 = Very strong):

Statement	Score (0–10)
Door-to-door waste collection is consistent and reliable.	
Selective Collection Centers (SCCs) are functioning and accessible.	
The community participates actively in basic segregation.	
Awareness campaigns on waste management are active and visible.	

Average Strengths Score = (Sum of above ÷ 4) = _____

2.　　Weaknesses

Rate the severity of the following problems (0 = No issue, 10 = Very serious):

Statement	Score (0–10)
Lack of biogas plants or waste-to-energy initiatives.	

Statement	Score (0–10)
Absence or failure of the 5-bin segregation system.	
Poor collaboration between public agencies and private contractors.	
Inadequate training or resources for waste handlers.	

Average Weaknesses Score = (Sum ÷ 4) = _____

3. Opportunities

How much potential is there for improvement in these areas? (0 = No potential, 10 = High potential):

Statement	Score (0–10)
New waste treatment technologies could be introduced.	
Residents are willing to participate in waste segregation if guided.	
Policy support exists for improving SWM infrastructure.	
NGOs or SHGs can be involved in waste management activities.	

Average Opportunities Score = (Sum ÷ 4) = _____

Threats

How serious are these existing threats? (0 = Not serious, 10 = Extremely serious):

Statement	Score (0–10)
Open dumping causes air, water, or soil pollution.	
SWM-related diseases are present or increasing in your area.	
Lack of enforcement of waste management rules.	
Public apathy or lack of cooperation in waste reduction practices.	

Average Threats Score = (Sum ÷ 4) = _____

SECTION C: Final Rating (Optional)

Based on your experience, how would you rate the overall performance of the waste management system in your area?

☐　　Excellent

☐　　Good

☐　　Average

☐　　Poor

☐　　Very Poor

3.1　　SWOT Analysis – Chitrakoot Solid Waste Management

This document presents a concise SWOT analysis of municipal solid waste management (MSWM) in Nagar Palika Chitrakoot (Uttar Pradesh) and Nagar Parishad Chitrakoot (Madhya Pradesh). Using a structured questionnaire framework, it systematically evaluates current MSWM practices, identifying strengths that support effective waste collection and disposal, and weaknesses that hinder efficiency and sustainability. The analysis also highlights opportunities for improvement through technology, community involvement, and policy support,

while pinpointing threats like environmental degradation and institutional issues. These insights aim to guide policymakers and local authorities in designing targeted, context-specific strategies to enhance sustainable waste management in both regions.

Category	Proportion (%)	Interpretation
Strengths	23.1	Shows that approximately a quarter of the information is positive aspects of the waste management system, such as established selective waste collection centers (SCCs) and door-to-door collection.
Weaknesses	30.8	Highlights growth potential, such as biogas units, 5-bin systems, and public-private collaboration.
Opportunities	26.9	The Opportunities category emphasizes essential avenues for improving municipal solid waste management, promoting public health, and facilitating sustainable urban development. Achieving these benefits requires strategic planning, targeted investments, and proactive collaboration among stakeholders.
Threats	19.2	Suggests that relatively fewer threats have been identified, but they are still significant (e.g., health impacts, pollution from open dumping).

Table:2 Interpretive Analysis of SWOT Elements in Municipal Solid Waste Management
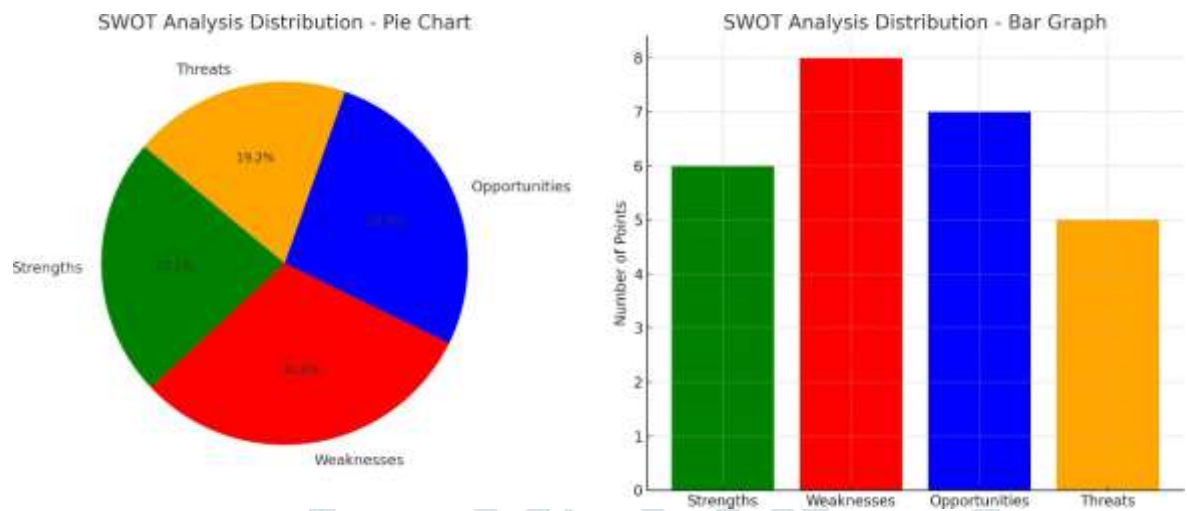
Figure 2: SWOT analysis distribution pie chart and bar graph

3.1.2 In Weighted Scoring Models

When evaluating options or planning interventions, weights help prioritize. Suppose you give each category a score based on its impact or urgency (on a scale of 1–10).

Table: 3 Score-Based Assessment of SWOT Factors in MSW Management

Category	Proportion (%)	Decimal	Score (out of 10)	Weighted Score
Strengths	23.1	0.231	6	$0.231 \times 6 = 1.386$
Weaknesses	30.8	0.308	3	$0.308 \times 3 = 0.924$
Opportunities	26.9	0.269	8	$0.269 \times 8 = 2.152$
Threats	19.2	0.192	2	$0.192 \times 2 = 0.384$

Total Weighted Score = 4.846/10 → This is a composite indicator of overall system performance.

Table:4 Category number of points

Category	Number of Points	Visual Meaning
Strengths	6 points	There are solid foundations, but fewer than the weaknesses.

Weaknesses	8 points	The highest score highlights the most significant problems.
Opportunities	7 points	Demonstrates strong areas for potential future development.
Threats	5 points	Highlights the fewest threats, although they still have a considerable impact.

4 Primary collection of MSW

Sweepers collect MSW from the streets and transport it to the nearest collection points (municipal dumpsters or containers). The MSW produced by each family is taken to the collection point or simply deposited on the side of the adjacent road, from where it is collected during street cleaning. This type of collection is called primary collection.

4.1 Secondary collection of MSW

Chitrakoot, municipal solid waste (MSW) disposal sites are generally located within 15 km of collection points, eliminating the need for transfer stations. Consequently, MSW is directly transported to disposal sites through secondary collection using systems such as hauled and stationary containers, as well as manually and mechanically loaded dumpers. The Hauled Container System (HCS) involves the transport of entire waste containers to disposal or processing sites, followed by their return. The Nagar Parishad Chitrakoot manages approximately 1179.42 tons of MSW annually, equivalent to 98.28 tons per month and 3.29 tons per day. Waste collection is conducted through 15 pickup vehicles (0.46-ton capacity) making two trips daily and four tractors (0.57-ton capacity) making six trips daily totalling 54 trips per day and handling 13.88 tons of waste. To enhance sustainability, the municipality should implement improved waste processing strategies such as composting, recycling and waste-to- energy technologies supported by public awareness initiatives and policy enforcement, to reduce landfill reliance and ensure effective long-term waste management.

Table:5 Characterization of MSW Chitrakoot UP Area

Per day generation (Ton)	Duration	Total quantity (Ton)	Metal (Ton)	Package (Ton)	Cardboard (Ton)	Glass (Ton)	Cloth (Ton)	Plastic (Ton)	Paper (Ton)	Rubber (Ton)	Total solid waste dry waste 33% (Ton)	Other waste (Ton)
14.35	January	444.87	0.29	12.15	10.25	6.59	23.42	53.12	29.28	11.71	146.81	298
			0.19	8.27	6.98	4.48	15.95	36.18	19.9	7.97	99.92	
15.22	February	426.24	0.28	11.66	9.64	6.32	22.84	50.74	28.1	11.24	140.66	285.58
			0.19	9.84	6.22	4.28	50.74	28.1	19.9	7.9	99.72	
14.13	March	438.21	0.29	11.95	10.08	6.48	23.04	52.05	28.8	11.92	144.61	293.6
			0.2	8.2	6.99	4.49	15.98	36.07	19.9	7.9	99.72	
13.6	April	408.15	-	11.73	9.89	4.48	22.61	50.88	28.27	11.31	134.69	273.46
				8.2	6.9	4.48	15.93	35.99	19.9	8.24	99.84	
15.16	May	455.06	0.35	25.12	8.87	25.57	7.39	66.69	11.82	4.36	150.17	304.89
			0.25	16.72	5.9	17.02	4.92	44.4	7.87	2.9	96.38	
14.12	June	423.84	0.07	24.51	8.65	18.75	7.21	64.89	11.54	4.25	139.87	283.97
			0.05	17.52	6.18	13.4	5.15	46.39	8.25	3.03	99.98	
11.9	July	369.1	0.26	10.803	0.111	5.857	21.475	46.855	26.03	10.412	121.803	247.29
			0.21	8.86	0.09	4.8	17.61	38.46	21.37	8.54	99.94	
12.02	August	372.62	0.245	10.148	8.559	5.502	20.174	47.639	24.453	9.781	122.967	249.65

			0.19	8.25	6.96	4.47	16.4	35.82	19.8	7.95	99.92	
13.43	September	403	0.264	10.983	9.263	5.955	21.834	48.471	26.466	10.586	132.99	270.01
			0.19	8.25	6.96	4.47	16.41	35.82	19.9	7.95	99.92	
13.22	October	410.03	0.264	11.176	9.425	6.059	22.215	45.88	26.928	10.77	135.313	274.72
			0.19	8.02	6.96	4.47	16.41	36.01	19.9	7.95	99.91	
12.84	November	385.4	0.255	10.578	8.021	5.736	21.029	45.88	25.49	10.196	127.185	258.21
			0.2	8.3	6.3	4.5	16.53	36.07	20.04	8.01	99.95	
14.95	December	463.6	0.21	24.02	9.8	6.3	22.04	51.53	22	11	152.99	310.61
			0.13	15.7	6.4	4.11	14.4	33.68	14.38	7.19	95.99	

Source: Municipal Office, Chitrakoot, U

Table :6 Characterization of MSW Chitrakoot MP Area

Per day generation ((Ton))	Duration	Total quantity ((Ton))	Metal (Ton)	Package (Ton)	Card board (Ton)	Glass (Ton)	Cloth (Ton)	Plastic (Ton)	Paper (Ton)	Rubber (Ton)	Total solid waste dry waste (Ton)	Other waste (Ton)
											33%	67%
3.56	Jan	110.6	2.92	2.92	6.57	2.92	2.92	9.855	6.57	1.825	Quantity	36.5
			8	8	18	8	8	26.98	18	5.02	Percentage	100
3.78	Feb	106.06	2.8	2.8	6.3	2.8	2.8	9.45	6.3	1.75	Quantity	35
			8	8	18	8	8	27	18	5	Percentage	95
3.22	Mar	100	2.64	2.64	5.94	2.64	2.64	8.91	5.94	1.65	Quantity	33
			8	8	18	8	8	27	18	5	Percentage	100
3.23	April	96.96	2.56	2.56	5.76	2.56	2.56	8.64	5.76	1.6	Quantity	32
			8	8	18	8	8	27	18	5	Percentage	100
3.43	May	103.03	2.72	2.72	6.12	2.72	2.72	9.18	6.12	1.7	Quantity	34
			8	8	18	8	8	27	18	5	Percentage	100
2.74	Jun	82.2	3.09	3.09	3.09	3.09	3.09	3.17	3.09	5.413	Quantity	27.12
			11.39	11.39	11.39	11.39	11.39	11.39	11.39	19.95	Percentage	99.98
3.57	Jul	110.8	2.9	10.803	2.9	2.9	2.9	4.33	2.9	6.933	Quantity	36.66
			7.9	29.54	7.9	7.9	7.9	11.84	7.9	18.96	Percentage	99.84
3.22	Aug	100	3.3	4.1	3.3	3.3	3.3	6.001	3.3	6.001	Quantity	31

			11	10	11	11	11	19.35	11	19.35	Percentage	99.89
3.01	Sept	90.3	3.35	3.35	3.35	3.35	3.35	6.3	3.35	3.45	Quantity	36.5
			11.24	11.07	11.24	11.24	11.24	21.14	11.24	11.57	Percentage	99.98
2.88	Oct	89.33	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	Quantity	33.4
			11.19	11.19	11.19	11.19	11.19	11.47	11.19	11.47	Percentage	99.98
2.8	Nov	84.54	3.3	3.3	3.35	3.35	3.35	3.2	3.2	5.2	Quantity	32
			11.82	11.82	11.82	11.82	11.82	13.63	9.3	9.3	Percentage	99.93
3.3	Dec	104.54	3.2	3.2	3.35	3.32	3.11	3.5	5.23	2.3	Quantity	34.5
			7.54	9.6	9.7	9.6	9.7	15.15	6.6	6.6	Percentage	99.88

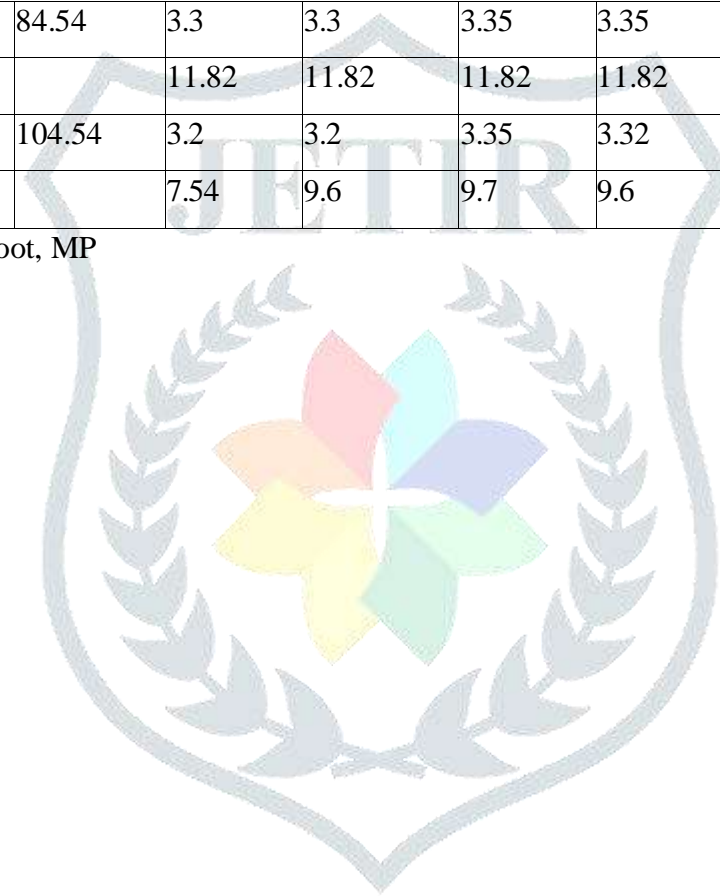Source: Municipal Office, Chitrakoot, MP

Table 7: Category of MSW Nagar Palika Chitrakoot UP - Previous study (2010) *

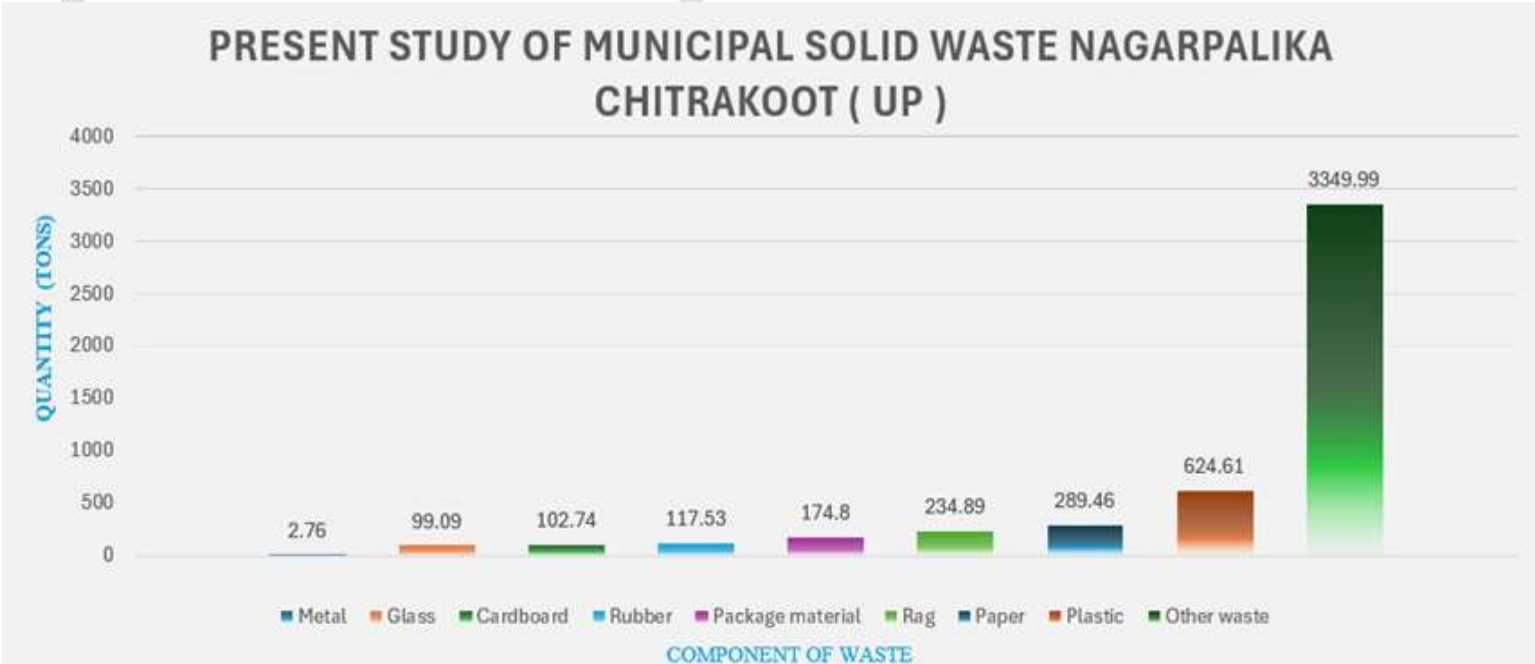| Leather (Ton)	Glass (Ton)	Metal (Ton)	Rubber (Ton)	Rags (Ton)	Plastic (Ton)	Paper (Ton)	Non-Biodegradable (Ton)	Compostable (Ton)	Total MSW (Ton)
3.23	4.12	5.16	9.46	45.70	55.90	63.37	622.58	1241.85	2051.41
0.16	0.20	0.25	0.46	2.2	2.7	3.08	30.3	60.53	%

Source *(Singh.S and Tripathi. I.P ,2011)
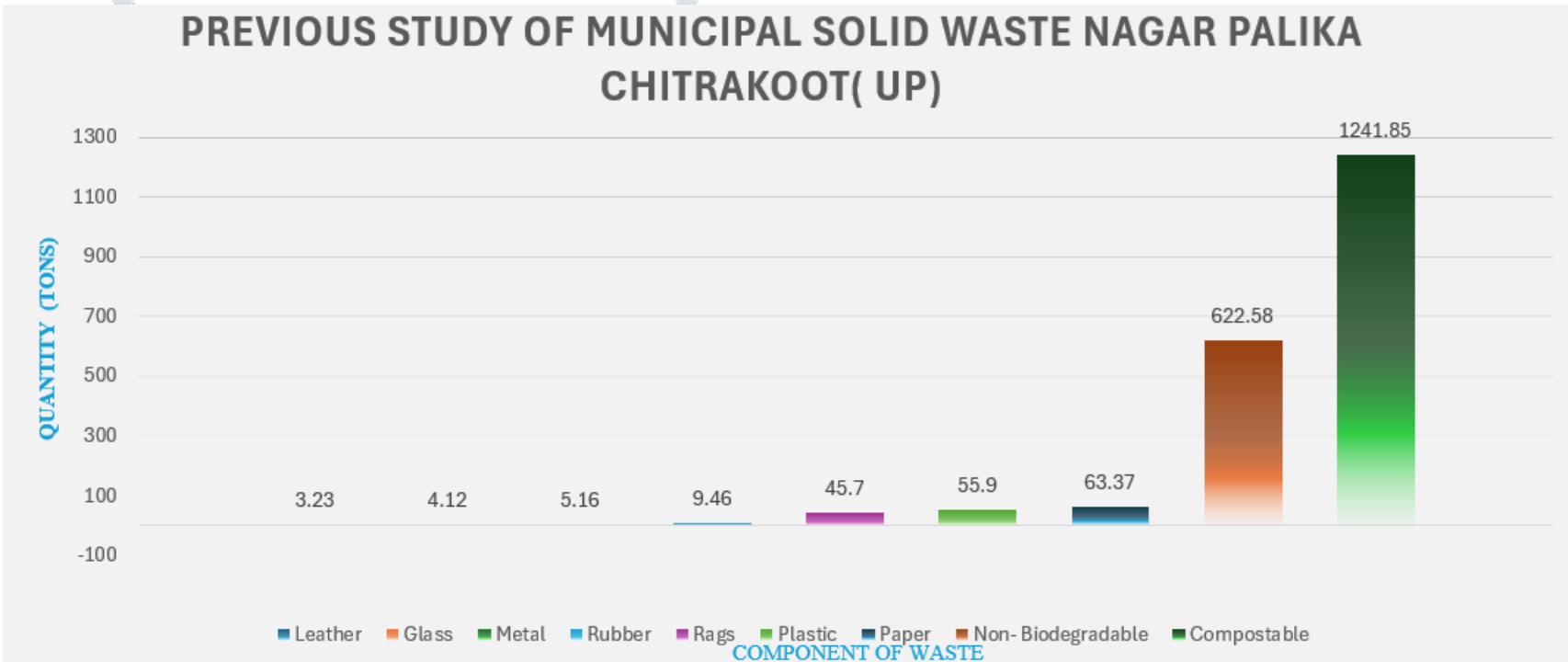
Fig 1: Category of MSW Nagar Palika Chitrakoot UP - Previous study (2010)

Table 8: Category of MSW Nagar Palika Chitrakoot UP - Present study (2024)

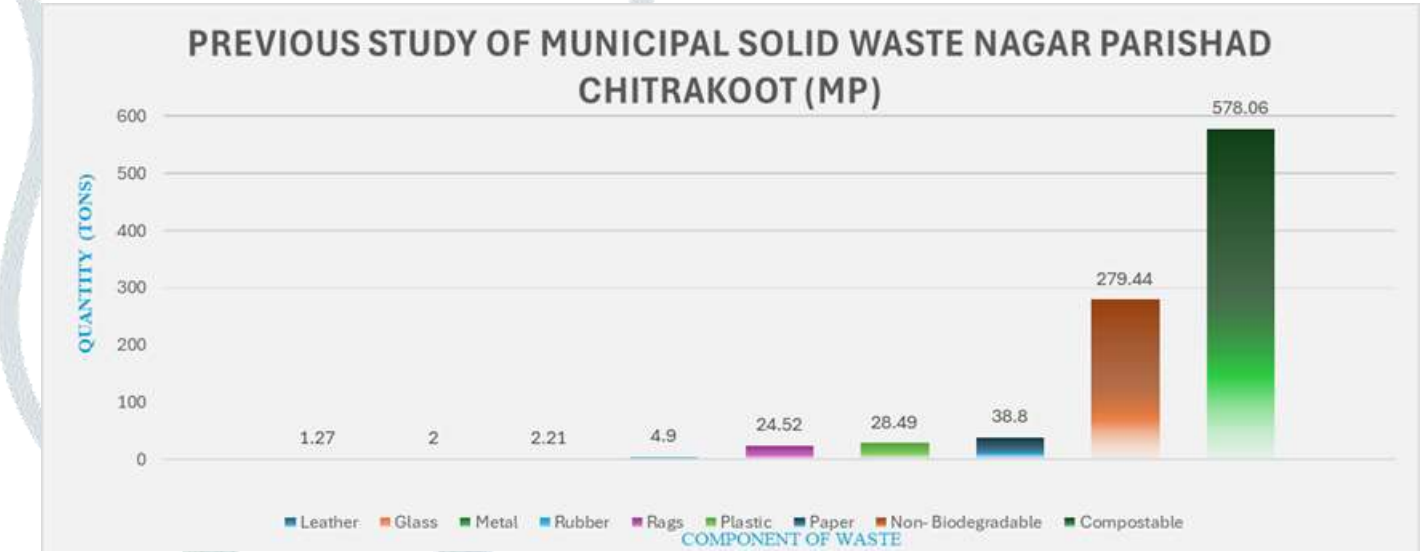| Metal (Ton)	Glass (Ton)	Cardboard (Ton)	Rubber (Ton)	Package material (Ton)	Rag (Ton)	Paper (Ton)	Plastic (Ton)	Other waste (Ton)	Total MSW (Ton)
2.76	99.09	102.74	117.53	174.8	234.89	289.46	624.61	3349.99	5000.12
0.05	1.98	2.05	2.35	3.49	4.69	5.78	12.49	67.00	%

Fig 2: Category of MSW Nagar Palika Chitrakoot UP - Present study (2024)

Table 9: Category of MSW Nagar Parishad Chitrakoot MP - Previous study (2010) *

Leather (Ton)	Glass (Ton)	Metal (Ton)	Rubber (Ton)	Rags (Ton)	Plastic (Ton)	Paper (Ton)	Non-Biodegradable (Ton)	Compostable (Ton)	Total MSW (Ton)
1.27	2	2.21	4.90	24.52	28.49	38.80	279.44	578.06	959.73
0.13	0.20	0.23	0.51	2.55	2.96	4.04	29.11	60.53	%

Source *(Singh.S and Tripathi. I.P ,2011)

Fig 3: Category of MSW Nagar Parishad Chitrakoot MP - Previous study (2010) *

Table 10: Category of MSW Nagar Parishad Chitrakoot MP - Present study (2024)

Rags (Ton)	Metal (Ton)	Glass (Ton)	Rubber (Ton)	Package material (Ton)	Cardboard (Ton)	Paper (Ton)	Plastic (Ton)	Other waste (Ton)	Total MSW (Ton)
36.47	36.77	37.48	42.76	44.42	52.52	58.72	78.27	790.21	1179.42
3.09	3.11	3.17	3.62	3.76	4.45	4.97	6.63	67.00	%

Fig 4: Category of MSW Nagar Parishad Chitrakoot MP - Present study (2024)

4.1.2 Total MSW Waste (Annual) Collection

Municipal solid waste collection has a significant impact on public health and the cleanliness of cities. Waste includes food scraps, ash, plastic, paper, and electronic devices. Collection methods include door-to-door services, municipal containers, curbside collection, or contracted services, often using "ghanta gadi" vehicles. This process involves primary collection at the source and secondary collection in containers for transport to treatment and disposal facilities.

(a) Segregation

Before recycling, waste must be separated at source or in a centralized facility. Waste is classified as biodegradable (e.g. food, paper, garden waste) and non-biodegradable. Non-biodegradable waste includes recyclables (plastic, glass, metal), toxic waste (chemicals, batteries, paint). Municipal authorities should implement a phased program to promote community participation in waste separation.

(b) Storage

Before being transported for treatment, waste is stored in storage stations. This marks the transition from household waste to the waste management system. Since this stage involves interaction between the waste producer and the management system, it is crucial to manage it carefully. When designing the storage facility, municipal authorities must ensure that it is accessible to users, adaptable to the volume of waste generated in a given area, that the waste remains protected from the elements, and that it is visually appealing and easy to use.

(c) Transportation

India faces challenges in municipal solid waste (MSW) disposal due to lack of resources and technical expertise (Kausal et al., 2012). Although waste-to-energy (WTE) initiatives have proven effective in developed countries, they are still in their infancy in India, mainly due to doubts about their financial viability (Sharholy et al., 2008). Chitrakoot Nagar Palika (UP) handles about 13.88 tonnes of MSW per day through a well-organized system that includes door-to-door collection at three designated points. The operational fleet consists of 15 vehicles (0.463 tons per trip, 30 trips per day), four tractors (0.578 tons per trip, 24 trips per day), two additional tractors (1 ton per trip, 2 trips per day), two loaders (3.5 tons per trip, 1-2 trips per day) and four vans (1 ton per trip, 3 trips per day).To promote sustainability, it is advisable to implement composting, recycling and WTE methods. Raising public awareness and implementing stringent policies are essential to improve waste management efficiency and mitigate environmental impact. Nagar Parishad Chitrakoot (MP) handles a considerable amount of municipal solid waste, with an annual generation of approximately 1179.42 tons—equating to

98.28 tons per month and around 3.29 tons per day. The current fleet of waste collection vehicles, including tractors, loaders, and pickups, provides a basic framework for daily waste transportation. However, this level of waste generation underscores the need for a more efficient and scalable waste management system.

(d) Disposal

In Chitrakoot, Uttar Pradesh, Nagar Palika manages MSW, disposing of it at a 1.2-hectare landfill site in Marjadpur. The city has 280 garbage collectors and 150 collection containers (50 large and 100 small), resulting in moderate efficiency. However, challenges remain, such as poor source segregation and outdated disposal methods. In Chitrakoot, Madhya Pradesh, the Nagar Parishad oversees MSW disposal at a 1.6-hectare landfill site in Rajula, with 112 safai karamcharis and only 25 containers. Waste management efficiency is poor due to limited infrastructure, illegal dumping, and unregulated disposal practices.
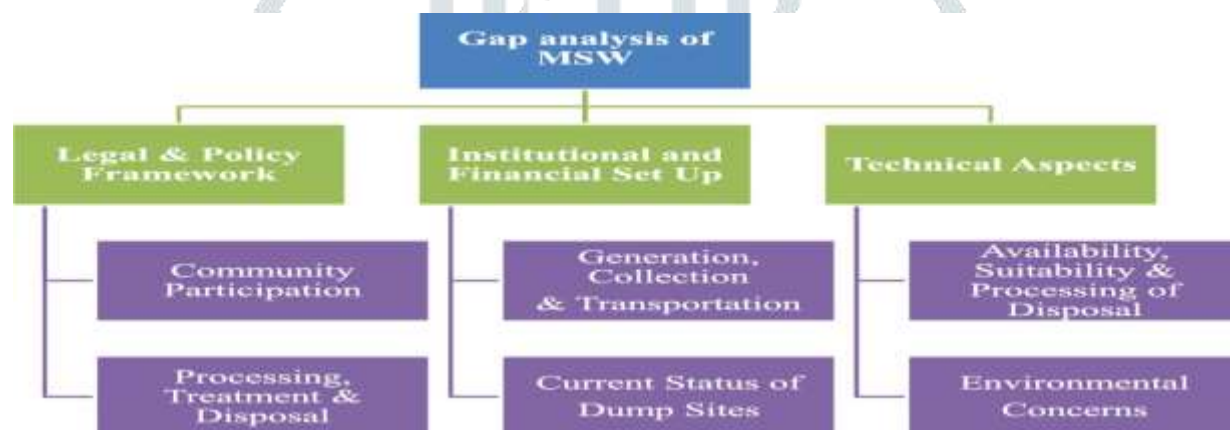
The assessment of information on the current status of solid waste recycling in ULBs compared to the requirements of existing regulations, policies, guidelines, and service level benchmarks (SLBs) will lead to the identification of key gaps in achieving the desired service level and will form the basis for preparing a municipal solid waste management (MSWM) system improvement plan. A diagram has been illustrated to identify these gaps and should be considered when assessing deficiencies in MSWM service delivery. The primary objective of the baseline study is to understand the existing municipal solid waste management system as accurately as possible; analyse the system's deficiencies in relation to the 2016 SWM Standards; and use this information for future planning, implementation, and monitoring. Local conditions will be taken into account when assessing the inadequacy of existing services and in future planning, with due regard to local demographics, geographic location, and social and environmental conditions.

Table 11: Method of Storage MSW Management in Chitrakoot (MP & UP)

Performance indicators	Chitrakoot (MP)	Chitrakoot (UP)
Governing Body	Nagar Parishad	Nagar Palika
Dumping Site Location	Rajula	Marjadpur
Dumping Site Area	4 acres	3 acres
Sanitation Workforce	112 Safai Karamcharis	280 Safai Karamcharis
Number of Dustbins	25 dustbins	50 large + 100 small dustbins
Waste Management Efficiency	Low	Moderate
Key Issues	Littering, unregulated disposal, limited infrastructure	Gaps in segregation, disposal inefficiencies, infrastructure needs

Conclusion

The study underscores a marked increase in MSW generation and a shift in waste composition due to urban growth and lifestyle changes in Chitrakoot. The SWOT analysis of the clean fuel program suggests that it contains several promising elements as it has incorporated the concerns raised in the previous programs. The lessons learned from earlier experiences can be the guiding force in implementing a successful household energy program. The present program has some limitations too. This comparative study of municipal solid waste (MSW) management in Chitrakoot (Uttar Pradesh and Madhya Pradesh) indicates a significant rise in waste generation from 2010 to 2024, which is placing considerable pressure on the current infrastructure. In Uttar Pradesh, waste generation increased from 2,051.41 tons to 5,000.12 tons—a 2.4-fold increase—while Madhya Pradesh experienced a 1.22-fold increase from 959.73 tons to 1,179.42 tons. Both regions predominantly depend on manual street sweeping and household disposal, with minimal source segregation, which adversely impacts downstream waste processing. The secondary collection systems generally function without transfer stations, due to the closeness of disposal sites. Chitrakoot in Uttar Pradesh manages approximately 13.88 tons of waste daily with the aid of 15 pickup vehicles and four tractors, while Chitrakoot in Madhya Pradesh utilizes a smaller yet comparable fleet. It is crucial to bolster public awareness, provide training for municipal staff, and rigorously enforce the Solid Waste Management Rules of 2016. Investment in modern infrastructure and community-led waste initiatives will be essential for achieving long-term enhancements in waste governance across both municipalitie

References

1) Allesch, A., & Brunner, P. H. (2014). Assessment methods for solid waste management: A literature review. Waste Management & Research, 32(6), 461–473

2) Bhide, A. D., & Sundersan, B. B. (1983). Solid waste management in developing countries. Indian National Scientific Documentation Center, New Delhi, India.

3) Del Moro, G., Barca, E., Cassano, D., Di Iaconi, C., Mascolo, G., & Brunetti, G. (2014). Landfill wall revegetation combined with leachate recirculation: A convenient procedure for management of closed landfills. Environmental Science and Pollution Research, 21(15), 9366–9375.

4) El-Salam, M. M. A., & Abu-Zuid, G. I. (2015). Impact of landfill leachate on the groundwater quality: A case study in Egypt. Journal of Advanced Research, 6(4), 579–586.

5) Erdem, M. (2022). Designing a sustainable logistics network for hazardous medical waste collection: A case study in COVID-19 pandemic. Journal of Cleaner Production, 376, 134-192.

6) Ghosh, P., Gupta, A., & Thakur, I. S. (2015). Combined chemical and toxicological evaluation of leachate from municipal solid waste landfill sites of Delhi, India. Environmental Science and Pollution Research, 22(12), 9148–9158.

7) Gibis, B., Artiles, J., Corabian, P., Meiesaar, K., Koppel, A., & Jacobs, P. (2001). Application of strengths, weaknesses, opportunities and threats analysis in the development of a health technology assessment program. Health Policy, 58, 27–35

8) Gworek B., Dmuchowski W., Gozdowski D., Koda E., Osiecka R., Borzyszkowski (2015). J. Influence of a Municipal Waste Landfill on the Spatial Distribution of Mercury in the Environment PLoS One, 10(7), 2015.

9) Heinold, A., & Meisel, F. (2018). Emission rates of intermodal rail/road and road-only transportation in Europe: A comprehensive simulation study. Transportation Research Part D: Transport and Environment, 65, 421–437.

10) Kansal, A., Prasad, R. K., & Gupta, S. (1998). Delhi municipal solid waste and environment – An appraisal. Indian Journal of Environmental Protection, 18(2), 123–128.

11) Kausal, R. K., Varghese, G. K., & Chabukdhara, M. (2012). Municipal solid waste management in India — Current state and future challenges: A review. International Journal of Engineering Science and Technology, 4(4), 1473–1489.

12) Kaza, S., Yao, L. C., Bhada-Tata, P., & Van Woerden, F. (2018). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank.

13) Koda, E., Miszkowska, A., & Sieczka, A. (2017). Levels of organic pollution indicators in groundwater at the old landfill and waste management site. Applied Sciences, 7(6), 638.

14)   Koda, E., Osinski, P., Sieczka, A., & Wychowaniak, D. (2015). Areal distribution of ammonium contamination of soil-water environment in the vicinity of old municipal landfill site with vertical barrier. Water, 7(6), 2656–2672.

15)   Nagarajan, R., Thirumalaisamy, S., & Lakshumanan, E. (2012). Impact of leachate on groundwater pollution due to non-engineered municipal solid waste landfill sites of Erode city, Tamil Nadu, India. Iranian Journal of Environmental Health Science & Engineering, 9(1), 35.

16)   Ohe, T., Watanabe, T., & Wakabayashi, K. (2004). Mutagens in surface waters: A review. Mutation Research/Reviews in Mutation Research, 567(2–3), 109–149.

17)   Sari, N .,Amrina, D. H., & Rahmah, N. A. (2021). The impact of household trash on the environment and economy for people in Sukarame Subdistrict, Bandar Lampung City from an Islamic view. Holistic Journal of Management Research, 6(2), 42–59.

18)   Singh.S and Tripathi. I.P.(2011) source implication and management of the solid waste of Chitrakoot Ph.D. Thesis, M.G.C.G.V, Chitrakoot (Satna)MP.

19)   Srivastava, P. K., Kulshreshtha, K., Mohanty, C. S., Pushpangadan, P., & Singh, A. (2005). Stakeholder-based SWOT analysis for successful municipal solid waste management in Lucknow, India. Waste Management, 25, 531–537.

20)   Tavares, G., Zsigraiova, Z., Semiao, V., & Carvalho, M. D. G. (2009). Optimisation of MSW collection routes for minimum fuel consumption using 3D GIS modelling. Waste Management, 29(3), 1176–1185.

21)   Wolny-Koładka, K., & Malinowski, M. (2015). Assessment of the microbiological contamination of air in a municipal solid waste treatment company. Ecological Chemistry and Engineering A, 22(2), 175–183.

22)   Yoada, R. M., Chirawurah, D., & Adongo, P. B. (2014). Domestic waste disposal practice and perceptions of private sector waste management in urban Accra. BMC Public Health, 14, 697.