

Municipal Solid Waste Management: A Quantitative Analysis of Challenges in Udaipur City

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Abstract — This study delves into the practices of Municipal Solid Waste Management (MSWM) in Udaipur city, Rajasthan. Utilizing a mixed-methods approach, the research integrates waste audits, surveys, interviews, and focus group discussions to comprehensively evaluate the current waste management landscape. The results emphasize the necessity for tailored strategies that account for the distinct challenges associated with waste generation in Udaipur. By focusing on quantitative analysis, the study sheds light on the hurdles confronting municipal solid waste management in Udaipur City. The swift urbanization and population surge in Udaipur have amplified solid waste generation, placing considerable strains on the city's waste management infrastructure. Through surveys, data gathering, and statistical scrutiny, this investigation aims to pinpoint critical challenges, including inadequate waste collection infrastructure, improper segregation practices, limited landfill capacity, and insufficient public awareness. These insights offer valuable guidance for policymakers, urban planners, and stakeholders to devise effective strategies and interventions aimed at enhancing MSWM in Udaipur City and similar urban environments.

Keywords: Municipal Solid Waste Management (MSWM), Udaipur

I. INTRODUCTION

India is one of the leading nations in producing municipal solid waste (MSW), ranking among the top 10 globally. As per a study conducted by The Energy and Resources Institute (TERI), the country produces more than 62 million tons (MT) of waste annually. According to Rajasthan State Pollution Control Board of Udaipur Rajasthan. Currently, around 200 tons per day (TPD) of municipal solid waste (MSW) is delivered to the site from the Municipal and Urban Improvement Trust (UIT) areas of Udaipur City. Among this, 100 TPD constitutes segregated MSW from the Municipal area, while the remaining portion is partially segregated from the UIT area. Notably, waste dumped on the roadside from both the municipal and UIT areas is also unsegregated.

The collection and transportation of MSW to the Balicha site are facilitated by tippers, trucks, and other vehicles deployed by UIT Udaipur and the Municipal Corporation. Additionally, there is a Transfer Station at Ganesh Ghati, Kumharon Ka Bhatta, and Udaipur, provided by the Municipal Corporation. Udaipur, renowned as the "City of Lakes," situated amidst the picturesque Aravalli Hills in Rajasthan, India, presents a captivating fusion of historical richness, cultural vibrancy, and natural splendor. Celebrated for its opulent palaces, notably the majestic City Palace commanding views of Lake Pichola, and alluring lakeside activities like navigating the waters of Lake Pichola, Udaipur transcends conventional tourism. Beyond its architectural

wonders, the city's lively markets, vibrant cultural panorama, and delightful culinary offerings, such as Laal Maas and Ghewar, enhance its enduring allure. Udaipur beckons travellers to immerse themselves in an indelible journey where every nook shares a tale, and the enchantment of Rajasthan unfolds.

The current investigation indicates that the rate of waste production in urban areas of India varies from 200-870 grams/day, contingent on the lifestyle and city size within the region. The research also reveals a yearly increase of approximately 1.3% in per capita waste generation in India. Western Indian cities exhibit the lowest per person waste generation, at only 440 grams/day, followed by East India (500 g/day), North India (520 g/day), and South India. Southern Indian cities record the highest waste generation per person at 560 grams/day. Manipur and Goa represent the states with the minimum and maximum per capita waste generation rates, respectively, at 220 grams/day and 620 grams/day. Municipal Solid Waste (MSW) stands as a tangible testament to the daily consumption patterns of our communities. Comprising the refuse generated by households, businesses, and educational institutions, MSW encompasses a diverse array of materials, ranging from food scraps and paper to plastics, glass, clothing, and yard waste. This category of waste serves as a mirror reflecting our lifestyle choices and consumption habits. The effective management of MSW poses significant challenges, as the sheer volume and variety of materials demand comprehensive strategies to minimize environmental impact and optimize resource recovery. University Municipal Solid Waste (MSW) represents the distinctive waste generated within academic institutions, encompassing a varied mix of materials from lecture halls, offices, cafeterias, and laboratories. Unlike typical MSW, university waste reflects the dynamic nature of academic life. This discussion explores the specific challenges and opportunities associated with managing waste on campuses, emphasizing the importance of fostering a sustainable culture within educational institutions. India represents 18% of the global population and generates 12% of the world's municipal solid waste. The increasing population in India is expected to lead to a significant surge in waste generation, posing management challenges. Despite door-to-door waste collection in many cities, inefficient sorting and disposal facilities hinder effective waste management. In 2016, the MoEFCC introduced the Integrated Waste Management System, including an end-to-end app to align with the government's digitalization initiatives. As universities strive to uphold their commitment to knowledge and research, effective waste management becomes a crucial aspect of building responsible and environmentally conscious campus communities.

II. OBJECTIVES

- 1) Investigating the role of public awareness campaigns and community engagement initiatives in promoting waste reduction and segregation behaviours among Udaipur's population.
- 2) Proposing data-driven solutions and strategies to address the identified challenges and improve MSWM in Udaipur city.
- 3) Analysing the correlation between socioeconomic indicators, such as income levels and education, and waste management behaviours among Udaipur's population & designing targeted interventions to promote sustainable waste practices.
- 4) Identifying key challenges and obstacles faced by stakeholders involved in MSWM in Udaipur.
- 5) Assessing the environmental consequences of uncontrolled dumping and improper disposal of solid waste in Udaipur

III. NEED OF RESEARCH

The need for research on Municipal Solid Waste Management in Udaipur arises from the pressing need to address the quantitative challenges faced by the city. It is crucial for understanding environmental impacts, optimizing resources, ensuring compliance with regulations, enhancing health and safety, and fostering community engagement through quantitative analysis, understanding the specific obstacles can inform targeted solutions. This research endeavors to bridge the gap between theoretical knowledge and practical application, fostering sustainable waste management practices in the city and research holds the potential to revolutionize waste management strategies and improve the overall livability of Udaipur.

A. Research sample

The research sample area is Udaipur urban households and randomly selected from various wards in Udaipur city. This investigative project is focused on scrutinizing the present condition of municipal solid waste management (MSWM) in Udaipur city, Rajasthan. The sample aims to provide a comprehensive understanding of challenges faced in solid waste management, encompassing diverse perspectives from residents, waste collectors, and city administrators.

IV. LITERATURE REVIEW-

Sharma, Bhardwaj, Sharma, Kaushik (2021). The paper outlines challenges in sustainable solid waste management in India, citing a rising population and increasing waste as key issues. Traditional beliefs like "out of sight, out of mind" hinder sustainability efforts. It highlights the World Bank forecast of global waste reaching 3.40 billion tonnes by 2050, with India as the third-largest contributor.

S, (2021). The paper examines waste management challenges in Indian urban areas due to population growth, addressing Ministry of Environment and Forests' regulations. It underscores the significance of Integrated Solid Waste Management (ISWM) and the 2016 Solid Waste Management Rules. The importance of a tiered waste management approach, encompassing reduction, reuse, recycling, and proper disposal methods, is emphasized.

Additionally, the paper highlights the Swachh Bharat Abhiyan mission, focusing on waste management, public engagement, and education.

Shah, Srivastava, Mohanty, Varjani, (2021). Mismanagement of municipal solid waste (MSW) has detrimental environmental and public health consequences, necessitating an environmentally sustainable waste management approach. Waste-to-energy conversion offers a solution to issues like greenhouse gas emissions, contributing to a green environment and a thriving economy. This paper comprehensively reviews MSW generation, detailing current information on technology suitability for energy production, and discusses challenges and perspectives in the research field.

Mehta, Rawal, Pal (2022). This paper is about a special kind of research, we get information from government websites and important research articles. People have already studied how smart cities and being sustainable are connected, but nobody looked at Udaipur before. This paper wants to fill that gap and see how smart city sustainability is linked to tourism in Udaipur. We use information from The Ministry of Housing and Urban Affairs and the Udaipur smart city mission websites tell us a lot about how they are making tourism in Udaipur sustainable. The paper talks about a program to bring back the heritage and some special projects from the smart city mission. These projects make tourist places in Udaipur more attractive and cleaner.

Istrate, Martos, Dufour, Dufour, (2022). The paper presents a framework for analyzing material flows and life cycle environmental performance in municipal solid waste (MSW) management. This adaptable framework predicts responses to changes in waste stream composition, allowing for specific input and output allocations and analysis of life cycle environmental impacts. Its versatility extends to economic analysis and optimization. Stressing the importance of waste composition in MSW management evaluations, the study uses a modular approach, dissecting the system into treatment process modules. The framework covers household, commercial, and street cleaning waste streams, considering interconnected treatment processes, resource and energy recovery, and background systems supplying raw materials and energy.

S, Thorat, Attarde (2023). The paper delves into the surge in municipal solid waste generation in Maharashtra's cities, driven by industrialization, urbanization, and population growth. It highlights the resulting environmental, public health, and socio-economic issues due to improper waste management. Emphasizing the need for isolation in waste management, the paper stresses the importance of well-maintained storage facilities. It suggests a fresh survey to comprehensively study and characterize municipal solid waste in Maharashtra. The recommendation includes collecting multiple samples for statistically reliable results.

Kanyal, Butola, Ambad (2021). The paper reviews biomedical waste management in India, covering definitions, categories, issues, and handling procedures. The World Health Organization classifies medical waste into eight categories, originating from sources like hospitals, clinics, and research laboratories. Hospital waste management is deemed crucial due to increasing amounts influenced by scientific advances. India regulates biomedical waste through

the Biomedical Waste (Management & Handling) Rules 1998, incorporating schedules for waste categories, colour coding, labelling, and treatment standards. The rules address diverse sources like blood banks, autopsy centres, and home health care.

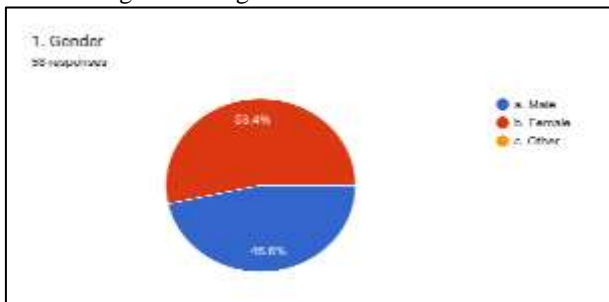
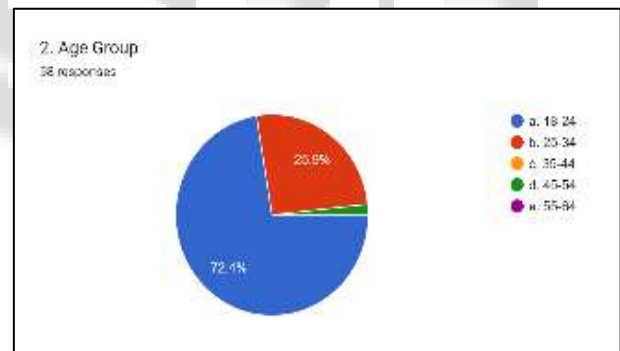
V. METHODOLOGY

Structured surveys targeting the research employs a quantitative approach to analyze challenges in municipal solid waste management in Udaipur city. It utilizes surveys

and data collection techniques to quantify the extent of challenges faced. Statistical analysis is applied to identify patterns and correlations among variables. The methodology integrates both primary and secondary data sources to ensure comprehensive insights. It will collect quantitative data on waste management practices, complemented by qualitative insights from interviews and focus groups. On-site assessments will provide first hand observations of current waste practices. A mixed-methods approach will be employed for data analysis.

Interpretation of Data					
Gender		Male	Female	Other	
			46.6%	53.4%	
Age Group	18-24	25-34	35-44	45-54	55-64
	72.4%	25.9%		1.7%	
Occupation					
Student	Faculty	Administrative Staff	Researcher	Support Staff	
82.8%	6.9%	5.2%	1.7%	3.4%	
Educational Qualifications					
Undergraduate	Graduate	Postgraduate	Doctorate		
41.4%	20.7%	36.2%	1.7%		
Department Affiliation					
Arts and Humanities	Science	Social Sciences	Engineering	Medicine	
19%	31%	17.2%	12.1%	20.7%	
Residential Status					
On-campus resident	Off-campus resident	Off-campus resident			
53.4%	36.2%	10.3%			

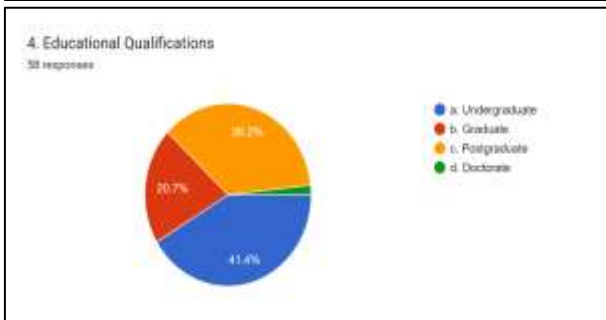
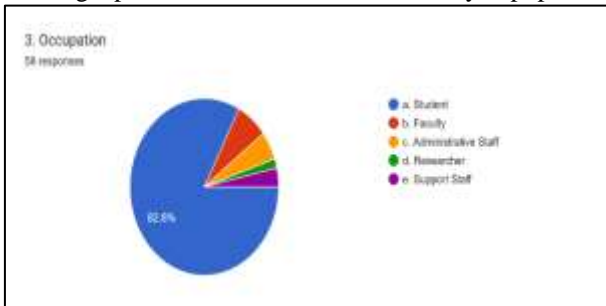
The data analysis of the chart unveils a diverse demographic profile, with a slight gender skew towards females. Predominantly, the respondents are students (82.8%), concentrated in the 18-24 age group (72.4%). Educational backgrounds vary, with undergraduates (41.4%) and postgraduates (36.2%) being the majority. Science and Medicine departments attract a significant share, comprising 31% and 20.7%, respectively. Residentially, 53.4% are on-campus residents, while 36.2% reside off-campus, providing valuable insights for targeted communication and services.



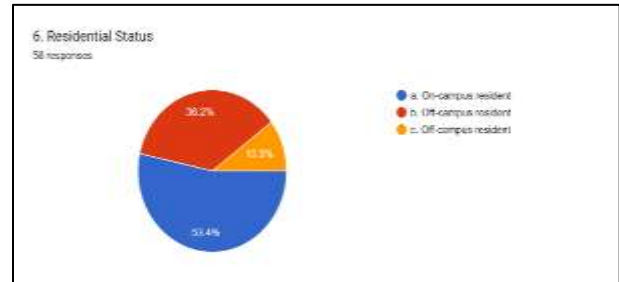
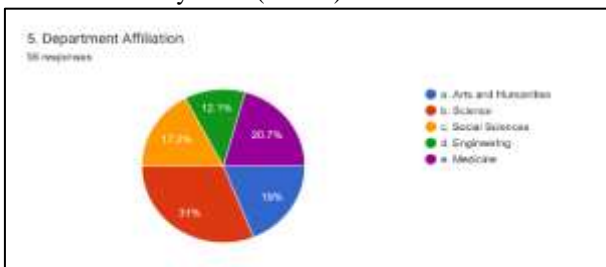
Environmental, Waste Collection, Research, Environmental Activities,					
Environmental Awareness Level	Very High	High	Moderate	Low	Very Low
	12.1%	36.2%	51.7%		
Satisfied are you with the current waste collection system	Very satisfied	Satisfied	Neutral	Dissatisfied	Very dissatisfied
	15.5%	34.5%	41.4%	6.9%	1.7%
You believe there is a need for more research and development	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	27.6%	50%	17.2%	5.2%	

Involvement in Environmental Activities	Actively involved	Somewhat involved	Not involved
	41.4%	53.4%	5.2%

The data reveals a predominantly moderate to high level of Environmental Awareness (12.1% very low, 36.2% low, and 51.7% moderate). Satisfaction with the waste collection system is positive, with 15.5% very satisfied, 34.5% satisfied, and 41.4% neutral. A substantial majority (77.6%) believes in the necessity of more research and development in environmental issues. In terms of involvement in environmental activities, 41.4% are actively engaged, 53.4% somewhat involved, and 5.2% not involved, indicating a proactive stance within the surveyed population.

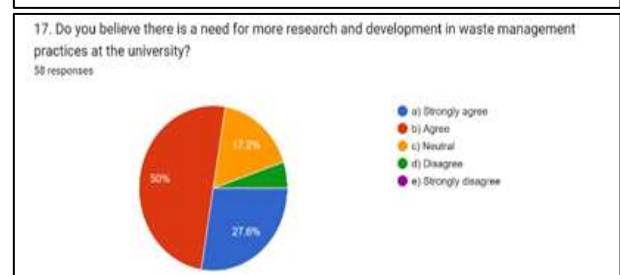
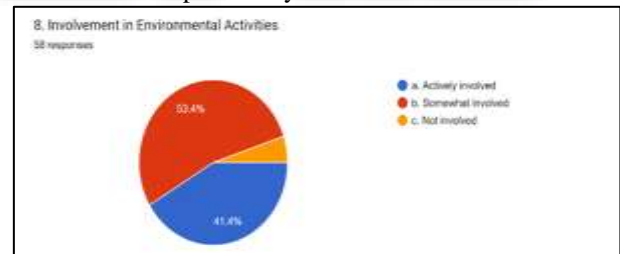


The data analysis explores waste management practices at the university, with 37.9% suggesting increased awareness campaigns, 25.9% favouring better infrastructure, and 20.7% emphasizing stricter regulations for improvement. In leveraging technology for waste management, respondents show interest in IoT-based monitoring (27.6%), mobile apps for awareness (34.5%), and smart bins (29.3%). Educational resources availability includes workshops (32.8%), seminars (17.2%), online courses (6.9%), and printed materials (17.2%). Identified challenges include lack of awareness (43.1%), insufficient bins (19%), inadequate collection services (19%), and inefficient recycling programs (19%). Waste separation bins predominantly consist of general waste (44.8%), followed by plastic (37.9%), paper (10.3%), and organic (6.9%). Waste collection services are most frequently provided on a daily basis (46.6%).

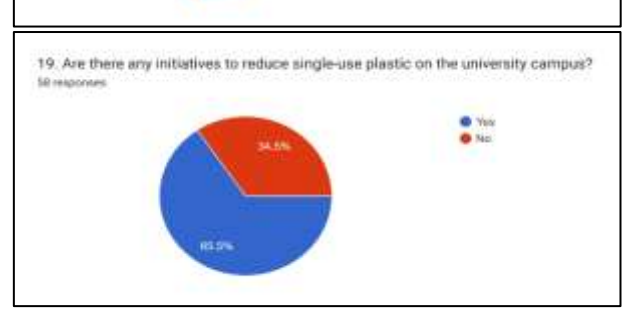
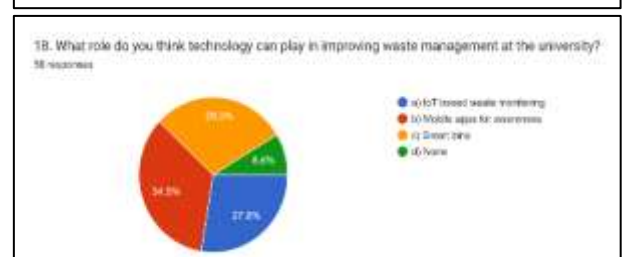
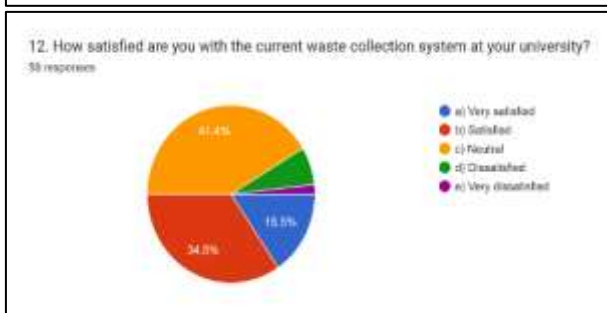
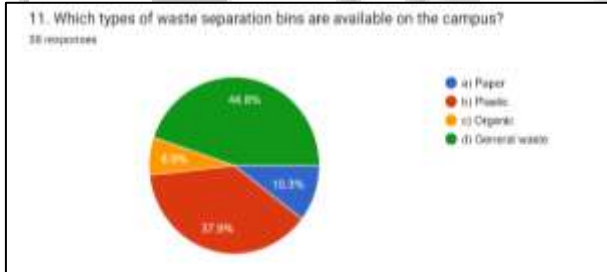
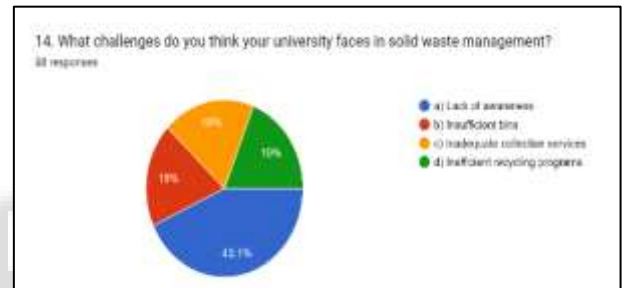
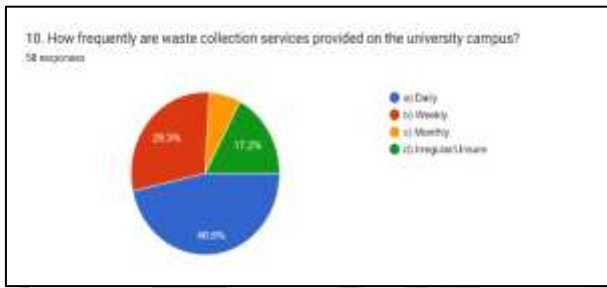


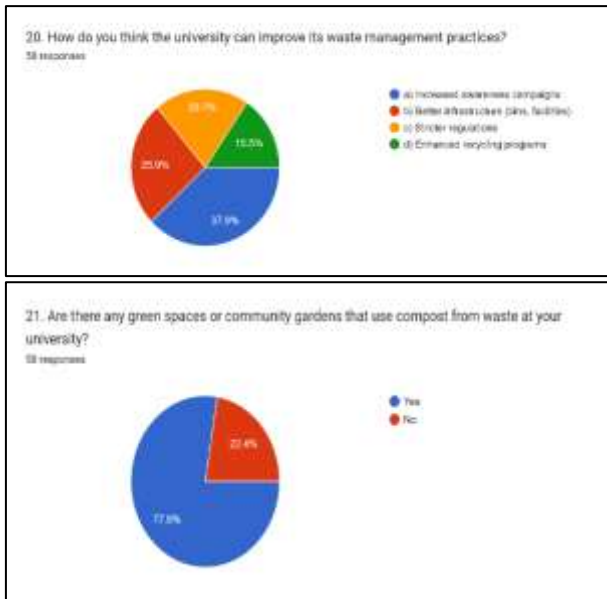
Compost, Reduce Single-Use Plastic, Collaborations with Local Authorities, Recycling Initiatives, Practices		
	Yes	No
Waste management practices at your university	74.1%	25.9%
There any recycling initiatives or programs	79.3%	20.7%
There any collaborations with local authorities for waste management	72.4%	27.6%
There any initiatives to reduce single-use plastic on the university	65.5%	34.5%
There any green spaces or community gardens that use compost	77.6%	22.4%

The university demonstrates a strong commitment to sustainable practices, with 74.1% actively engaged in waste management. Recycling initiatives are prevalent, with 79.3% acknowledging their existence. Collaborations with local authorities for waste management are significant at 72.4%. Moreover, 65.5% report initiatives specifically aimed at reducing single-use plastic, underlining a holistic approach to environmental responsibility.



Practice, Technology, Educational, Challenges, Types, Collection Services					
Do you think the university can improve its waste management practices	Increased awareness campaigns	Better infrastructure	Stricter regulations	Enhanced recycling programs	
	37.9%	25.9%	20.7%	15.5%	
Technology can play in improving waste management	IOT-based waste monitoring	Mobile apps for awareness	Smart bins	None	
	27.6%	34.5%	29.3%	8.6%	
Educational resources are available for students	Workshops	Seminars	Online Courses	Printed Materials	None
	32.8%	27.6%	6.9%	17.2%	15.5%
Challenges do you think your university faces in solid waste	Lack of awareness	Insufficient bins	Inadequate collection services	Inefficient recycling programs	
	43.1%	19%	19%	19%	
Types of waste separation bins are available	Paper	Plastic	Organic	General Waste	
	10.3%	37.9%	6.9%	44.8%	
Frequently are waste collection services provided on the university	Daily	Weekly	Monthly	Irregular/Unsure	
	46.6%	29.3%	6.9%	17.2%	





VI. CONCLUSION

In conclusion, this research underscores the urgent need for tailored strategies to address the challenges of Municipal Solid Waste Management (MSWM) in Udaipur city, Rajasthan. It highlights inadequate infrastructure, improper segregation practices, limited landfill capacity, and insufficient public awareness as key obstacles. Moving forward, targeted interventions, community engagement, and data-driven solutions are crucial for enhancing MSWM practices and mitigating environmental consequences in Udaipur and similar urban areas.

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