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## SOLID WASTE MANAGEMENT AND ENVIRONMENTAL SUSTAINABILITY: A CASE STUDY OF AJMER CITY, RAJASTHAN

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### ABSTRACT

Globally, solid waste management (SWM) is a difficult problem, especially in developing countries that are fast becoming more urbanized. With a sharp rise in garbage production, India faces serious environmental and public health consequences as well as ineffective collection and treatment. A comprehensive case study of Ajmer, Rajasthan, is presented in this research, which looks at the city's current SWM practices, public attitudes, and systemic issues. Using primary data from an Ajmer household survey and a wealth of secondary research on national SWM trends, the study highlights the significant environmental and socioeconomic repercussions of improper waste handling, inefficiencies in waste collection and monitoring, and critical gaps between public awareness and action. The analysis highlights the interconnectedness of SWM deficiencies with broader urban infrastructure issues and underscores the underutilized potential of the '3 Rs' (Reduce, Reuse, Recycle) framework. Drawing lessons from successful SWM models across India, this report offers strategic and policy recommendations tailored for Ajmer, advocating for enhanced source segregation, optimized collection, decentralized processing, integration of the informal sector, and robust data-driven governance to foster environmental sustainability and improve urban living standards.

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## INTRODUCTION

The escalating generation of solid waste represents a critical environmental and public health concern worldwide, with developing nations bearing a disproportionately heavy burden. The effective management of solid waste is foundational to achieving urban sustainability and safeguarding ecological balance.

**Global and National Context of Solid Waste Management:** A complicated worldwide issue, solid waste management (SWM) is most noticeable in developing nations where urbanization and population increase are outpacing the development of infrastructure. India is a prime example of this problem, since it faces a significant and steadily growing amount of waste. According to Subhasish *et al.* (2019), the country now produces 62 million tonnes (MT) of municipal solid trash annually. According to projections, factors such as growing urbanization, population density, economic expansion, and changing consumption patterns would cause an alarming increase to 165 MT by 2030 (CPCB, 2021-22). According to this trajectory, if immediate action is not taken, the current trends in waste output will surpass the infrastructure that is now in place and significantly worsen environmental and public health problems.

A significant concern within India's SWM landscape is the disparity between waste generation and effective management. Only about 70% of the total waste generated is collected, and a mere 12% to 28% undergoes treatment before disposal. This leaves a vast majority of waste untreated and often discarded in uncontrolled landfills or open dumps. The composition of this waste is diverse, encompassing hazardous waste, plastic waste, e-waste, and biomedical waste, with organic waste forming a substantial portion. The current state of affairs highlights a pressing need for efficient and sustainable waste management practices to mitigate environmental degradation and public health risks (Kumar *et al.*; 2017).

**Overview of Ajmer City: Geography, Demographics, and Economic Profile:** Located in the ancient Aravalli Range in the center of Rajasthan, India, Ajmer is a city rich in history and culture. It is a fascinating metropolitan hub that has seen many influences over the centuries due to its advantageous location and rich history. The demographics of the city are indicative of larger patterns of urbanization. In 2024, Ajmer's metro region was expected to have 652,000 residents; by 2025, that number is expected to rise to 665,000. In the 2011 census, there were 2,583,052 people living in the Ajmer district. Rajasthan's urban population has grown rapidly in recent decades, despite the state's overall urbanization percentage being lower than the national average at 25%. Even while this growth

trajectory is advantageous economically, SWM difficulties are inevitably increased. Economically, Ajmer functions as an important manufacturing hub, with significant industries in woolen textiles, cotton, hosiery, pharmaceuticals, and engineering. Agriculture, including poultry and various crops, also contributes substantially to the local economy (Khurshid *et al* 1998). Manufacturing constitutes the largest sector, accounting for 30.8% of employees, followed by Trade and Transportation at 26.87%. The per capita income in Ajmer district was reported at Rs. 1,24,548 at current prices during 2020-21. The socio-economic landscape of Ajmer also includes the presence of informal settlements, with 60% located on private lands and 32% on government-owned lands (India Stat Districts, 2023). The multidimensional poverty headcount ratio for Ajmer district was 18.51%. This demographic and economic profile suggests that a notable portion of the population may be particularly vulnerable to the environmental and health impacts of poor SWM, and some may also be involved in the informal waste collection sector. Therefore, SWM solutions must be inclusive and consider the specific needs of these communities.

**Aims and Objectives:** This research aims to comprehensively assess the current solid waste management practices in Ajmer city. The specific objectives include:

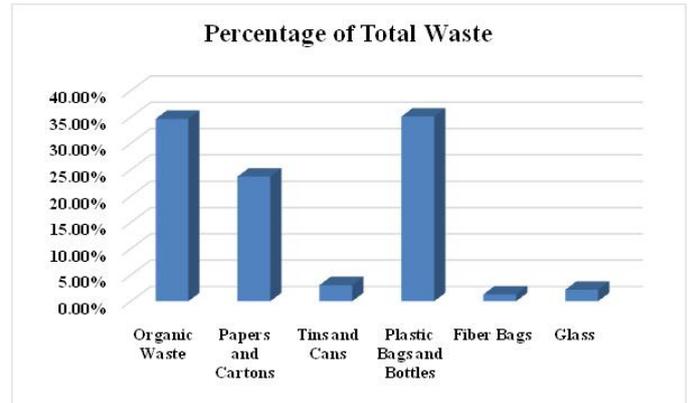
- Assessment of existing waste management practices within the study area.
- Identification of key challenges and issues in the city’s waste management system.
- Evaluation of the effectiveness of current waste management efforts in Ajmer city.

The methodology employed for this study involved a questionnaire-based field survey covering 100 households in Ajmer city. This primary data collection was supplemented by direct personal interviews and observations. Additionally, secondary data was gathered from online case studies and various reports to provide a broader context and comparative analysis (Subhasish *et al*, 2019). The scope of this study focuses primarily on household solid waste management, municipal collection mechanisms, public perceptions of waste services, and the broader aspects of environmental sustainability within Ajmer, contextualized against national SWM trends.

**Solid Waste Management Practices and Perceptions in Ajmer City:** Understanding the local dynamics of waste generation, collection, and public perception is crucial for developing effective solid waste management strategies. This section details the findings from the household survey conducted in Ajmer city.

**Waste Generation and Composition at Household Level:** Eighty percent of the Ajmer population surveyed said they were aware of the procedures involved in solid waste disposal. The main sources of this awareness were public gatherings (24.10%), educational institutions (26.78%), and television (32%). This suggests that attempts to raise public awareness have had a significant impact on the city. According to a study on the composition of household waste, the highest percentages are made up of plastic bags and bottles (35.08%) and organic waste (34.64%). Papers and cartons (23.68%), tins and cans (4.07%), fiber bags (1.31%), and glass (2.19%) are other components (Patan *et al.*, 2015). While the significant plastic component calls for strong recycling infrastructure and reduction methods, the high organic content indicates a significant potential for composting or biomethanation. For home collection, the majority of households (75.83%) utilize dustbins, followed by old buckets (14.16%), plastic bags (5.83%), and cartons (4.16%) (Fig. 1). Despite high awareness of SWM, a notable gap exists in actual segregation practices: only 57% of the population separates biodegradable and non-biodegradable waste, with 43% disposing of them combined. Furthermore, only 38% of residents reported composting organic waste at home. This disparity between knowledge and consistent action indicates that high awareness alone is insufficient; there may be underlying barriers such as convenience, perceived effort, or

inconsistent municipal collection of segregated waste (Jha, & Sodhi, 2019).



**Figure 1. Composition of Household Solid Waste in Ajmer**

This suggests that instead than only spreading knowledge, future interventions must concentrate on encouraging action. 58.4% of people use reusable shopping bags, 17.6% use refillable water bottles, 16.8% avoid products with plastic packaging, and 7.2% choose products with little packaging, demonstrating efforts to reduce plastic in daily life. However, only 24% of respondents regularly choose sustainable or eco-friendly products over non-eco-friendly ones, 40% occasionally, 16% seldom, and 20% never. This implies that there may be a discrepancy between impersonal environmental ideals and actual purchasing choices, which could be brought on by things like price, accessibility, or unclear product sustainability information. To close this gap, policies and market actions are required to increase the accessibility and appeal of sustainable options.

**Table 1. Demographic Characteristics of Ajmer Study Area**

Characteristic	Value	Further Detail
Total Population in Study Area	499	
Head of Family (Surveyed Households)	Male: 83% Female: 17%	Indicates male-dominated household responsibility.
Sex Ratio (Study Area)	111.4 males per 100 females	Indicates a male-biased sex ratio.
Age Structure (Study Area)	Children (0-14 years): 9.21% (46 individuals) Adults/Working (15-64 years): 81.96% (409 individuals) Elders (Above 64 years): 8.81% (44 individuals)	Largest demographic, contributing to waste generation and potential workforce for SWM.
Literacy Rate (Study Area)	84.96% Illiterate: 15%	High literacy rate, potentially aiding awareness campaigns.
Education Status (Surveyed Individuals)	Primary: 55 Secondary: 111 Sr. Secondary: 85 Graduated: 108 Post Graduation: 65	
Marital Status (Study Area)	Married: 59.9% Unmarried: 40%	

The prevalence of organic and plastic waste in households necessitates targeted strategies for processing and resource recovery.

**Municipal Waste Collection and Transportation Systems:** With 86% of households reporting daily collection, the Municipal Corporation (M.C.) in Ajmer exhibits a comparatively high frequency of rubbish collection. For other families, collection occurred irregularly (4%), once every three days (3%), or once every two days (7%). The most common way to collect rubbish is door-to-door (60.37%), which is widely regarded as an effective primary collection system. Community bins (18.86%) and fleet collection trucks (20.75%) come in second and third, respectively. 43 percent of door-to-door

collections take place between 8 and 9 AM. Sixty-four percent of respondents said they had public trash cans close to their homes, with half of them being within 200 meters. However, the frequency of emptying these public bins is less consistent, with only 39.43% emptied daily, and others less frequently (once a week: 30.98%, twice a week: 16.90%, thrice a week: 12.67%). This indicates a potential gap in public bin management. For transporting solid waste from localities, the M.C. primarily uses tractors and tippers (67%), with tractor trailers (11%) and front loaders (22%) also in use. A significant concern associated with these transporting vehicles is littering and illegal dumping, identified as a major problem by 51% of the population. Other issues include environmental pollution (21%), traffic (1%), and accidents (4%). The fact that 23% of the population believes no problems are created by these vehicles suggests varying experiences or perceptions. While the M.C.'s door-to-door collection is a strong point, the less frequent emptying of public bins and the issues associated with transportation vehicles suggest inefficiencies in the secondary collection and transportation phases. This implies that the problem is not merely whether waste is collected, but how it is managed after the initial pickup, leading to secondary environmental degradation and public health nuisances. In terms of sanitation, 70% of the population believes that garbage collectors adhere to proper sanitation protocols.

#### **Public Engagement and Awareness in Local Waste Management:**

The survey revealed a high level of awareness regarding environmental sustainability in Ajmer, with 70% of residents understanding the concept. Furthermore, 61.72% of the population agreed that environmental sustainability is a critical concern for society. This concern translates into action for many, as 75% of residents reported practicing sustainability in their daily lives. Common practices include electricity conservation (32.75%), water conservation and rainwater harvesting (31.03%), and gardening (28.44%). Familiarity with the "3R's" concept (Reduce, Reuse, Recycle) is also high, with 74% of the population aware of it. The perceived importance of the 3R's stems primarily from resource conservation (55.85%), followed by employment generation (24.32%), legal requirements (9.90%), and reduced landfill burden (9.90%). There is a noticeable disconnect between continuous sustainable consumption and environmental care, even with this high awareness and participation in some sustainable actions. As previously said, only 25% of people regularly choose sustainable items, and a sizable portion only do so occasionally or never. This implies that although environmental issues are generally understood and cared for, adoption of sustainable purchasing practices may be hampered by real-world obstacles like price, availability, or perceived inconvenience. To close this gap, policies and market actions are required to increase the accessibility and appeal of sustainable options. Regarding the usage of renewable energy, 55% of people said they regularly use renewable energy sources. Solar panels (41.55%) and rainwater harvesting (37.66%) were the most common methods, followed by energy-efficient appliances (10.38%), electrical vehicles (6.49%), and wind panels (3.89%).

**Community Satisfaction and Challenges in Ajmer's SWM:** With 66% of inhabitants expressing contentment or extremely satisfaction, 31% remaining indifferent, and 3% expressing discontent, the overall level of satisfaction with the M.C.'s garbage management system in Ajmer is moderate. However, there are still a lot of issues with public trash cans and disposal sites. Odor (52.67%) and the spread of cockroaches and mosquitoes (35.77%) are the most commonly mentioned problems. 11.45% of responders also reported seeing a dark liquid flowing. These issues show how better secondary collection, processing, and disposal methods are required to reduce environmental contamination and public health hazards. Inadequate SWM is directly responsible for the issues that homeowners have identified, including pests, stench, and littering from transport vehicles (table 2). However, these issues are often listed alongside broader urban challenges like poor roads, drainage, and general sanitation. This suggests that SWM is not an isolated problem but rather a symptom and contributor to wider urban infrastructure and public health challenges.

The mention of "unplanned urbanization" as a problem further reinforces this interconnectedness. Effective SWM solutions in Ajmer cannot be siloed; they must be integrated into broader urban planning, infrastructure development, and public health initiatives to achieve holistic improvements. Addressing SWM can have positive ripple effects on other urban problems.

**Table 2. Perceived Problems and Potentialities of Study Area in Ajmer**

Problems	Potentialities
Large number of stray animals	Tourism
No public bins nearby the households (for some)	Cultural sites
Water scarcity	Tradition
Poor roads	Peaceful community
Odor (around bins/dumping areas)	Night schools for uneducated women
Poor education facilities	Heritage
Early age marriages	Waste recycling plants
Poor transportation system	Availability of employment
Poor medical facilities	Rich history
Poor drainage	Good environment
Improper traffic management	NGOs such as Tilonia village
Lack of sanitation in public areas	Friendly nature of residents
Social inequality	Availability of labor
Unplanned urbanization	Rose farming
Increasing pollution	Development is taking place at a good pace

The impact of tourism on solid waste generation is also a recognized concern, with 54% of respondents agreeing that tourism increases waste production. This increase is primarily attributed to plastic trash (46.05%) and food waste (39.47%). The effect of new development processes on solid waste is less clear among residents, with 37% believing there is an impact, 34% disagreeing, and 29% unsure. Regarding the allocation of funds by the M.C. for waste management, opinions are divided: 42% of the population believes funds are not used properly, while 58% believe they are used adequately. This mixed perception suggests a need for greater transparency and communication regarding financial management in SWM.

**Conclusions and Recommendations for Sustainable SWM in Ajmer:** The comprehensive analysis of solid waste management in Ajmer city, contextualized within the broader Indian landscape, reveals both opportunities and critical areas for intervention.

**Synthesis of Key Findings for Ajmer City:** Ajmer city, like many rapidly urbanizing centers in India, faces typical urban SWM challenges exacerbated by its growing population and significant tourism activity. The study found a high level of public awareness regarding SWM and environmental sustainability among residents. However, a notable gap persists between this awareness and consistent household practices, particularly in waste segregation at the source and home composting. While municipal waste collection is frequent and largely conducted door-to-door, inefficiencies emerge in the secondary collection and transportation phases, manifested by less frequent emptying of public bins and issues like littering from transport vehicles. The urgent need for better processing and disposal is highlighted by local concerns about odor, pests (such as cockroaches and mosquitoes), and littering around public trash cans and disposal sites. It has been determined that tourism significantly contributes to the rise in solid waste, especially food and plastic trash, hence tourist hotspots require specialized management techniques. The way the community views issues goes beyond SWM to include more general urban infrastructure and social concerns, highlighting how these difficulties are interrelated. Most importantly, locals are aware of the city's significant potential for SWM enhancements, including its tourism appeal, cultural legacy, and strong sense of community. The public's conflicting opinions about how M.C. funds should be used for waste management point to the need for more accountability and openness.

**Strategic Recommendations for Improving SWM Infrastructure and Practices:** To address the identified challenges and leverage the city's potential, the following strategic recommendations are proposed for Ajmer:

- **Enhance Source Segregation:** It is imperative to implement mandatory multi-bin systems (e.g., three-way for wet, dry, and domestic hazardous waste) at the household level. This must be supported by clear, accessible guidelines and consistent enforcement.<sup>3</sup> Concurrently, targeted and continuous awareness campaigns should be conducted, focusing not just on the importance but specifically on how to segregate, emphasizing the tangible environmental and economic benefits to bridge the existing awareness-action gap.
- **Optimize Collection and Transportation:** To avoid overflow, reduce odors, and stop pests from breeding, the M.C. should make sure that all public trash cans are emptied on a regular basis. Modern compactors or enclosed vehicles should replace the current fleet of transportation vehicles in order to reduce illegal dumping and littering during transit, which will enhance environmental quality and public perception. Efficiency, accountability, and route optimization will be further improved by putting in place GPS tracking and real-time monitoring systems for collection trucks and bins.
- **Invest in Decentralized Processing and Resource Recovery:** More zonal or community-level composting facilities are essential given the high organic content of Ajmer's trash. This will provide useful organic fertilizer and lessen the amount of garbage that ends up in landfills. Material Recovery Facilities (MRFs) should be built concurrently to effectively sort and recycle dry waste, especially plastics, which make up a sizable amount of the waste stream. In order to prevent previous failures, a cautious approach is recommended while investigating garbage-to-Energy (WtE) solutions, giving priority to technologies appropriate for the composition of Indian garbage and guaranteeing strict environmental compliance and public acceptance.
- **Address Tourism-Related Waste:** Specific SWM strategies are needed for high-tourism areas like Pushkar and Ana Sagar Lake. This includes increasing bin density, ensuring more frequent collection, and actively promoting the use of reusable alternatives among tourists and local businesses. Collaboration with hotels, restaurants, and tourism operators is essential to promote source segregation and responsible waste disposal within the tourism sector.

**Policy Recommendations for Enhanced Governance and Citizen Engagement:** Beyond operational improvements, robust policy and governance frameworks are essential for sustainable SWM:

- **Strengthen Policy Implementation and Enforcement:** Stricter enforcement of the Solid Waste Management Rules 2016 is paramount, with clear penalties for non-compliance to deter illegal dumping and littering.
- **Integrate Informal Sector:** The informal waste picker sector plays a vital role in recycling. Policies should aim to formalize and support these workers, integrating them into the formal collection and recycling value chain. This includes providing training, safety gear, and ensuring fair wages, which will not only improve their livelihoods but also enhance overall recycling rates.
- **Promote Circular Economy Principles:** A fundamental shift in strategic focus is required, moving from mere waste disposal to a hierarchical approach that prioritizes Reduce, Reuse, Recycle, followed by treatment and then disposal.

Incentives should be introduced to encourage both consumers and businesses to prefer and adopt sustainable and eco-friendly products over non-eco-friendly alternatives.

- **Enhance Data Collection and Monitoring:** Establishing a robust, real-time data collection system for waste generation, composition, and collection efficiency is critical to inform evidence-based planning and decision-making. Regular surveys should be conducted to update baseline inventories and assess environmental and public health risks associated with waste.
- **Foster Public-Private Partnerships:** Leveraging private sector expertise, technology, and financial resources through well-structured Public-Private Partnerships (PPPs) can significantly enhance the efficiency and sustainability of SWM services. Clear contractual obligations and robust performance monitoring mechanisms must be put in place to ensure successful outcomes.

**Future Research Directions:** Further research is recommended to build upon the findings of this study and support the implementation of sustainable SWM in Ajmer:

- A thorough economic evaluation of the advantages and disadvantages of introducing cutting-edge SWM techniques and technology in Ajmer, including a cost-benefit analysis of formalizing the unorganized waste industry.
- Research on the efficacy of various behavioral change and public awareness initiatives designed to raise trash segregation rates and promote sustainable consumption practices within the particular sociocultural setting of Ajmer.
- Feasibility studies for certain decentralized waste treatment technologies, tailored to the unique waste composition and urban structure of Ajmer, such as localized composting units or small-scale biomethanation plants.
- A thorough evaluation of the long-term effects that current Ajmer dumpsites have on the ecosystem and human health, as well as the creation of all-encompassing remediation plans.
- Research into the potential for developing local markets for recycled materials and compost generated from Ajmer's waste stream to enhance economic viability.

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