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Waste Management in Kota City: Challenges and Sustainable Solutions

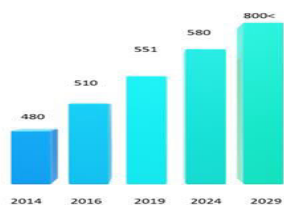
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ABSTRACT: Since the dawn of civilization till yet the problem of managing solid waste is continuous to grow and can't be resolved unless every citizen is aware of the methods of waste disposal and its harmful effects and hence this paper addresses the critical issue of MSWM in terms of Kota city, where rapid urbanization and increasing migration of people from surroundings and distant for various economical, educational and other opportunities has exacerbated the issue of huge amount of waste generation on the one hand and inefficient waste collection and management system has triggered various health and environmental impacts to its residents on other. Despite various framework and policies regarding waste management, Low Awareness, poor enforcement and inadequate infrastructure persist as a major challenge in the city and hence the transformation of this unorganized waste management system presents both challenges and opportunities to enhance public health and environment sustainability. This paper also deals with their solutions along with comparative study of other cities.

I. INTRODUCTION

According to environment protection act of 1990, Waste is defined as any undesirable material which is not in use in its present form. Waste Management is the process which includes collecting, Treating, Recycling and Disposing of different waste materials. Kota is the third largest city of the north-west Indian state of Rajasthan with the population over 1.5 million. It lies mainly on the east (right) bank of Chambal river. The city is known primarily for its various coaching institutes, its Tourism sites and high urban growth. Waste is primarily classified into Biodegradable and Non-Biodegradable. Biodegradable waste includes Food, Plant, Animal and Human waste etc where as non-biodegradable waste includes plastic waste, metallic waste, electronic waste etc. The famous 3-R of waste are: Reuse, Recycle and Reduce.



With the increase in population of city the waste generation capacity of Kota city has also been substantially increased. Figure 1.1 depicts the waste generation of Kota city from different years. According to this figure the current waste generation capacity of Kota city is about 580 ton per day, this includes waste generation from domestic sources, commercial establishments, Industrial establishments etc, and it will cross 800 ton in future if the city will continue to grow to its present trends.

Major cause of this increasing waste generation of city is besides its own residents are various coaching institutes where thousands of students come every year for NEET and IIT preparation this also results in migration of people from surroundings in terms of fruits and vegetable sellers, mess workers etc besides this Kota is also now emerging as a tourism centre in recent years, all this contribute to the growing population of the city and further exacerbate the issue of growing waste management issues.

II. OBJECTIVE AND METHODS

The primary objective of this research paper is to analyze the current waste management practices in Kota city and identify the key challenges and opportunities for improvement. Specific objectives include:

1. To assess the types and volumes of waste generated in Kota.
2. To evaluate the effectiveness of existing waste management infrastructure and policies.
3. To identify the main obstacles to efficient waste management in the city.

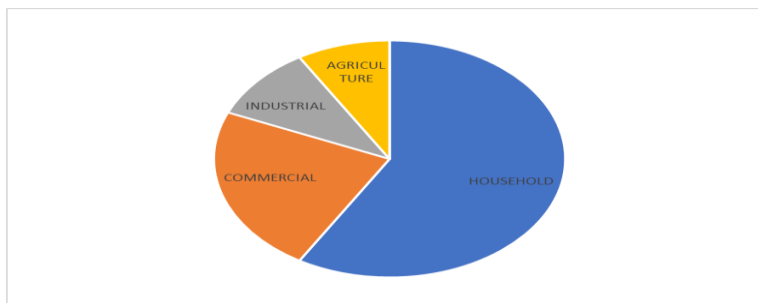
4. To propose sustainable waste management solutions tailored to the unique needs of Kota.

Data Collection Methods: Data collection for this research involves multiple methods to ensure a thorough examination of the waste management system in Kota:

1. **Surveys:** Structured questionnaires are administered to households, businesses, and waste management workers to gather quantitative data on waste generation, segregation practices, and public awareness. The survey questions are designed to capture information about the volume and types of waste produced, the frequency of waste collection, and residents knowledge and attitudes toward waste management .
2. **Interviews:** In-depth interviews are conducted with key stakeholders, including officials from the Kota Municipal Corporation (KMC), representatives from private waste management companies, and local environmental NGOs. These interviews provide qualitative insights into the operational challenges, policy implementation, and strategic initiatives in waste management .
3. **Site Visits:** Field visits to waste collection points, segregation centres, recycling facilities, and landfill sites are undertaken to observe the waste management processes firsthand. These site visits help in understanding the practical aspects of waste handling and the condition of waste management infrastructure in Kota .

Secondary Data Analysis: Relevant secondary data, such as government reports, policy documents, and previous research studies, are reviewed to complement the primary data collected. This helps in building a broader context for the study and corroborating findings from primary sources.

Data Analysis Techniques : The data analysis involves both qualitative and quantitative techniques.



III. DISCUSSION

With population exceeding more than 1.5 million, Kota is the most urbanised city in Rajasthan with 60.31% of its population living in urban areas, the current growth rate of city which is 24.35% (census 2011) is even higher than the national average of 17.70% , Hence with the issue of continuous population growth, the issue of huge waste generation and its management is also raising which require immediate attention. As a major educational hub, Kota attracts thousands of students each year, further contributing to the city's population growth and waste generation, For efficient Waste Management Kota has been divided into Nagar Nigam North and South which has combinedly 150 wards [Kota North 70 wards and Kota South 80 wards] and generates 580 tons of urban waste per day from various sources.

Waste is produced mainly from Households which includes Food waste, Plastics, Metals, Textiles waste etc., Next comes is waste from commercial establishments including Hotels, Shops etc, Then comes Industrial Waste in sequence and lastly Agricultural Waste which includes waste from livestock, Horticulture waste etc.

(Bhatia, 1 January 2019) Solid waste management was considered till late 1990 a liability and a large land was wasted to take such a waste. Of late it was realized that if suitable design measures are adopted this can be a source of revenue generation. Keeping this aspect in view it was decided to develop alternative technologies and approach. It was realized that if suitable technology is adopted it can give a much better return. Keeping this aspect in mind not only simple

technology like composting was used but in this place suitable land filling technology was adopted so that in turn it gives sufficient bio gas apart from it improves the quality of land where it is disposed.

(Prakash, 2017)Due to growth in population, increase in urbanization, waste management, water management, sanitation, clean energy, skill development, innovation in technologies shall become challenge. The opportunities for India as the developing country with young population of demographic dividend shall be created through skill India, digital India initiatives with Smart Sustainable Cities will strengthen the socio-economy, better standard of living and attracts foreign investment to compete with the super power of the world.

(Census , 2011)The Kota Municipal Corporation has population of 1,001,694 of which 528,601 are males while 473,093 are females as per report released by Census India 2011. Current estimated population of Kota Municipal Corporation in 2024 is approximately 1,422,000.

(Patil, 2023)This study discusses theories and case studies which adopted MSW in innovative ways under two broad objectives of design- aesthetics and functionality.

(chauhan, 2022)The inappropriate management of solid wastes contaminates the environment and affects people's health. Because of the growing rate of migration from rural areas in search of employment and a higher quality of life, the solid waste problem in urban areas is severe.

(pope, 2020)Among other factors, rapid global population growth, our development model and patterns of production and consumption have increased waste generation worldwide to unsustainable rates. This rise has led to crises in many countries where waste management practices are no longer sound.

An introductory textbook offering comprehensive coverage of the management of municipal, hazardous, medical, electronic, and nuclear waste. Written by an experienced instructor in the field of solid waste management, this modern text systematically covers the five key types of solid wastes: municipal, hazardous/industrial, medical/biological, electronic, and nuclear, discussing their sources, handling, and disposal.

(Anawar, 2019)This book compiles research findings directly related to sustainable and economic waste management and resource recovery. Mining wastes and municipal, urban, domestic, industrial and agricultural wastes and effluents—which contain persistent organic contaminants, nanoparticle organic chemicals, nutrients, energy, organic materials, heavy metal, rare earth elements, iron, steel, bauxite, coal and other valuable materials.

(singh, 2009)This book deals intensively with every aspect of Organic and Inorganic Waste Management and explains how each type of waste must be correctly dealt with if mankind is to decrease the outbreak of disease, thereby ensuring that all inhabitants of the planet earth have a healthy future.

(meena, 2024) Covering a broad overview of different kinds of wastes and waste recycling methods and sustainable management for soil health, this book focuses on both basic and applied aspects of waste management for sustainable agriculture and how nutrients are made available through waste.

(Varjani, 2024)The waste management sector is in a unique position to transition from a minor source of global greenhouse gas (GHG) emissions to a major contributor to reducing GHG emissions. This book compiles the potential impacts and benefits of various waste management systems in terms of climate impact. It investigates the global climate impact of municipal solid waste, commercial and industrial waste, agricultural waste, and hazardous waste management systems.

(Akansha gupta, 2024)This book explores a diverse spectrum of waste materials, encompassing industrial hazardous and non-hazardous waste, agricultural waste, biomass waste, radioactive waste, municipal solid and liquid waste, as well as e-waste, and investigates their adverse impacts on the environment

(Mathur, 2016) This is high time when each and every individual of Kota City should understand the value of cleanliness in the interest of fellow citizens. The management of solid waste has become one of the essential services

and it is an obligatory duty of municipal bodies to arrange for daily street cleaning and transport, processing and disposal of waste in the urban areas.

(Sahana, 2021) In India, waste remedy is additionally turning into challenging. This article additionally discusses stable waste is generated in city areas, is important motives for waste management. The waste administration and dealing with regulations in India had been delivered by means of the ministry of surroundings and forest.

(Waste Management rules 2016) These rules shall apply to every urban local body, outgrowths in urban agglomerations, census towns as declared by the Registrar General and Census Commissioner of India, 1 [villages with population more than 3000.

KEY FINDINGS

The waste management system in Kota city is managed primarily by the Kota Municipal Corporation (KMC), Kota municipality is divided into- North and South, Kota has 150 wards in total and generates 580 tons of waste per day, The system includes multiple stages: waste generation, segregation, collection, transportation, processing, and disposal.

Despite various efforts by KMC, the system faces several inefficiencies and challenges, particularly in terms of waste segregation and recycling rates (Sharma & Jain, 2017).

TYPES OF WASTE GENERATED

Kota generates various types of waste, including municipal, industrial, and hazardous waste. Municipal waste comprises household waste, market waste, and waste from commercial establishments. Industrial waste includes residues from manufacturing processes, and hazardous waste consists of medical waste, chemical waste, and e-waste (Gupta et al., 2015). According to recent estimates, the city produces approximately 580 tons of municipal solid waste daily.

WASTE SEGREGATION, COLLECTION, AND TRANSPORTATION PROCESSES

Waste segregation at the source is one of the critical components of an efficient waste management system. However, in Kota, the practice of segregating waste into biodegradable and non-biodegradable categories is not widely adopted by residents and businesses. The KMC has initiated various awareness campaigns to promote segregation practices, but the adoption rate remains low, leading to mixed waste collection. The collection process involves door-to-door collection services provided by the KMC, KMC with the help of 430 auto tippers collects door to door waste of city at morning from 6 to 11 am and afternoon 2 to 6 pm covering most urban areas. Waste is typically collected by compactor trucks, which then transport the waste to designated transfer stations, Kota has 4 transfer stations- Sajidehda, Vishwakarma circle, Kherli Phatak and Ummedganj ,From these transfer stations, the waste is transported to the landfill site of Nanta located in the outskirts of the city with the help of capsules, Unfortunately the landfill site often faces issues of overcapacity and inadequate processing facilities , The size of Nanta trenching ground is 30 hectares where 12 lakh cubic meter legacy waste has been accumulated after disposing 5 lakh cubic meter of waste already.

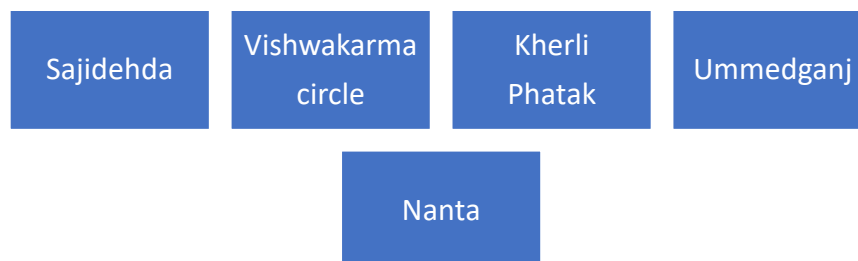


Figure 1.3 Waste Management of Kota City

Challenges in Waste Management Inadequate Infrastructure and Resources

One of the primary challenges facing waste management in Kota city is the inadequacy of infrastructure and resources. The existing waste collection and processing facilities are insufficient to handle the growing volume of waste generated daily, which resulted in accumulation of 12 lakh cubic meter of waste at Nanta disposing site, Many areas of the city lack proper waste bins, collection points, and transportation vehicles, leading to inefficient waste collection and increased littering (Sharma & Jain, 2017). Additionally, the landfill sites are often overburdened and lack the necessary equipment for proper waste processing and disposal, contributing to environmental pollution .



Figure1.2Challenges in Waste Management of Kota city

Lack of Public Awareness and Participation

Public awareness and participation play a crucial role in effective waste management. However, in Kota, there is a significant gap in public knowledge regarding proper waste segregation and disposal practices.

Inefficient Waste Segregation and Recycling Practices Waste segregation and recycling practices in Kota are far from optimal. Despite the introduction of waste segregation policies, the implementation is weak, with a large portion of the waste remaining unsegregated. This results in mixed waste being collected, which complicates recycling efforts and leads to a higher volume of waste being sent to landfills (Sharma & Jain, 2017). Furthermore, the city lacks sufficient recycling facilities and infrastructure to process the segregated waste effectively, limiting the potential for resource recovery and recycling.

Environmental and Health Impacts of Improper Waste Management

Improper waste management has severe environmental and health consequences. Uncontrolled dumping and inefficient waste processing lead to soil and water contamination, air pollution, and the proliferation of disease vectors such as rodents and insects. These environmental hazards pose significant health risks to the local population, including respiratory issues, gastrointestinal diseases, and other health problems (Gupta et al., 2015). The burning of waste, particularly plastics, releases toxic gases, further exacerbating air pollution and health risks.

Financial Constraints and Funding Issues

Financial constraints and insufficient funding are major barriers to improving waste management practices in Kota, In this regard KMC has recently allocated funds for a Site at Balita Kota for demolition of 100 tons of waste per day and a new compost ground particularly for Kota North has also been sanctioned with the capacity of 400 tons.

Case Studies

Successful Waste Management Models from Other Cities/Countries Indore, India Indore, a city in Madhya Pradesh, India, is recognized as a model for urban waste management. The city's transformation began with a strong commitment from the local government to improve cleanliness and waste management practices. Key initiatives included strict enforcement of waste segregation at the source, regular door-to-door waste collection, and the

establishment of decentralized waste processing units. Additionally, Indore implemented comprehensive public awareness campaigns to educate residents about the importance of waste segregation and recycling. As a result, Indore has consistently been ranked as one of the cleanest cities in India, demonstrating the effectiveness of these integrated waste management strategies.

Surat, India

Surat, another Indian city, has also made significant strides in waste management. Following a plague outbreak in the 1990s, the city revamped its waste management system. Surat's approach includes efficient waste collection and transportation, robust waste segregation practices, and the development of infrastructure for processing organic and recyclable waste. The city also engaged the community through education programs and collaborated with private waste management companies to enhance service delivery (Masilamani et al., 2016). These efforts have significantly improved the cleanliness and health standards in Surat, making it a benchmark for other cities in India.

San Francisco, USA

San Francisco is a global leader in waste management, particularly known for its ambitious goal of achieving zero waste. The city has implemented comprehensive policies to reduce waste generation, encourage recycling, and compost organic waste. San Francisco's success is attributed to its strict recycling mandates, innovative waste reduction programs, and extensive public education efforts. The city provides incentives for businesses and residents to minimize waste and has developed an advanced infrastructure for processing recyclables and compostables (SF Environment, 2020). These measures have resulted in a high diversion rate of waste from landfills, showcasing the potential of policy-driven waste management practices.

Summary of Key Findings

The study of waste management practices in Kota city has revealed several critical issues and opportunities for improvement. The current system, managed by the Kota Municipal Corporation (KMC), faces challenges such as inadequate infrastructure, low public participation in waste segregation, and inefficient waste processing. The data indicates that a significant portion of waste remains unsegregated, leading to increased environmental pollution and burdening the landfill sites. Awareness campaigns have shown some positive impacts, but overall effectiveness remains limited and hence to manage city waste sustainably all these loopholes of city waste management system need to be worked upon.

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