Circular Economy and Solid Waste Management: A Case Study of Ahmedabad City Under Swachh Bharat Mission Urban 2.0

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Abstract: *The circular economy is a system designed to keep products and materials in use for as long as possible, extracting maximum value while in use, and then recovering and regenerating them at the end of their service life. This approach contrasts with the traditional "take-make-dispose" linear model. Solid waste management poses a significant challenge, particularly for developing cities like Ahmedabad. Effective management is crucial for environmental protection, public health, and sustainable urban development.*

This study focuses on the Ahmedabad Municipal Corporation (AMC) area to explore the implementation of circular economy principles within solid waste management. By employing empirical research methodologies, including case studies of successful circular economy initiatives within the AMC and analysis of public initiatives related to waste management, the study aims to identify opportunities for waste reduction, reuse, recycling, and recovery. By examining the economic and environmental dimensions of the circular economy in this context, the research seeks to contribute to the development of sustainable waste management strategies for Ahmedabad and other similar urban areas.

Keywords: Circular economy, Solid waste management, Ahmedabad, Swachh Bharat Mission Urban 2.0

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Introduction

Introduction: Circular Economy & Urban Governance

The Circular Economy:

The concept of a circular economy originated in the 1970s with the vision of a world where waste is eliminated. Over the past four decades, this concept has gained significant traction among progressive leaders and advocates. A circular economy is an economic system centered on business models that replace the traditional "end-of-life" concept with strategies that prioritize reducing, reusing, recycling, and recovering materials throughout the production, distribution, and consumption processes. This system operates at multiple levels, encompassing products, companies, consumers, industrial parks, cities, regions, nations, and beyond, with the ultimate goal of achieving sustainable development. Sustainable development encompasses the harmonious integration of environmental quality, economic prosperity, and social equity for present and future generations.

The circular economy aims to fundamentally reshape resource utilization by decoupling economic growth from material extraction. This approach strives to create a more sustainable future that enables natural environments to regenerate resources while safeguarding them from the adverse impacts of industrial waste. Building upon the core principles of reduce, reuse, and recycle, the circular economy has evolved to incorporate recover, redesign, and remanufacturing, forming a comprehensive 6R framework. This framework facilitates a closed-loop system that supports multiple product life cycles, thereby promoting sustainable manufacturing.

The Circular Economy Principles:

Traditionally, environmental design focused on selecting recyclable materials for product development. However, contemporary approaches have evolved to encompass a radical redesign of products and services, prioritizing ecological, economic, and social considerations for a sustainable future. The circular economy emphasizes sustainable raw material utilization, closed-loop manufacturing and production processes, sustainable consumption practices, and the development of robust commodity markets to extend product lifecycles. These elements are fundamental to achieving a circular economy.

Circular Economy and Sustainable Environment:

This is embodied in the definition of sustainability adopted by the United Nations in its Agenda for Development: Development is a multidimensional undertaking to achieve a higher quality of life for all people. Economic development,

social development and environmental protection are interdependent and mutually reinforcing components of sustainable development [Alternate definition: Environmental sustainability is the capacity to improve the quality of human life while living within the carrying capacity of the earth's supporting ecosystems.

Alternate definition: Environmental sustainability is about stabilizing the currently disruptive relationship between earth's two most complex systems: human culture and the living world.

Sustainable development connects with the circular economy through the economic and environmental dimensions, as well as through corporate social responsibility, business's entryway into sustainable development

Linear Economy vs. Circular Economy:

The traditional linear economy model, characterized by a "take-make-dispose" approach, generates substantial amounts of unwanted and often hazardous waste. This model also exerts immense pressure on dwindling natural resources as new raw materials are continuously sought and exploited. To build a sustainable future, a shift towards a circular economy is imperative.

A circular economy prioritizes keeping resources in use for extended periods and recovering and recycling them for subsequent use once their maximum value has been extracted. Unlike the linear model, which exacerbates environmental degradation, the circular economy significantly reduces waste, minimizes the impact of production and consumption, and alleviates pressure on depleting natural resources.

By adopting circular economy principles, we can create a more sustainable and resilient future for generations to come.

Definition of Solid Waste:

Solid waste is primarily categorized into two main types: municipal solid waste and industrial waste. Municipal solid waste, often referred to as trash or garbage, is generated by households and businesses. Industrial waste encompasses a wide range of non-hazardous materials produced during the manufacturing of goods and products. In contrast, hazardous waste poses significant risks to human health and the environment due to its dangerous characteristics.

The Resource Conservation and Recovery Act (RCRA) is a federal law establishing the framework for the proper management of both hazardous and non-hazardous solid waste. It mandates a comprehensive waste management program

overseen by the Environmental Protection Agency (EPA). The term RCRA is commonly used to refer to the law, its associated regulations, and EPA guidance. Under RCRA, solid waste is defined broadly as any discarded material, including garbage, refuse, sludge, and byproducts from various human activities

Waste Classification:

Modern waste management systems categorize waste into several primary types. Municipal waste, originating from households, businesses, and construction activities, is one such category. Hazardous waste, which poses significant risks to human health and the environment, is another. Biomedical waste, specifically generated by healthcare facilities, requires specialized handling. Finally, special hazardous waste encompasses particularly dangerous materials such as radioactive, explosive, and electronic waste

2.2 Categorizing Hazardous Waste:

Hazardous waste is classified based on four primary characteristics:

Ignitability: Substances that easily catch fire or combust at low temperatures.

Corrosivity: Materials that can corrode metal containers or cause skin burns.

Reactivity: Substances that are unstable and readily undergo chemical reactions, often producing toxic or flammable materials.

Toxicity: Wastes that contain harmful substances that can cause death, injury, or illness.

Literature Review:

3.1 Global MSW Generation:

Globally, the annual production of Municipal Solid Waste (MSW) is a significant concern. Currently, around 2.01 billion metric tons of MSW are generated each year, a figure projected to increase by 70% to 3.40 billion metric tons by 2050, according to World Bank estimates. While recycling and composting rates have improved to 13.5% and 5.5% respectively, the overall management of this growing waste volume remains a substantial challenge.

Zero Waste is a set of principles focused on waste prevention that encourages the redesign of resource life cycles so that all products are reused. The goal is for no trash to be sent to landfills, incinerators, or the ocean. Currently, only

9% of plastic is actually recycled. In a zero-waste system, material will be reused until the optimum level of consumption, the definition adopted by the Zero Waste International Alliance (ZWIA).

There is a growing global population that is faced with limited resources from the environment. To relieve the pressures placed on the finite resources available, it has become more important to prevent waste. To achieve zero waste, waste management has to move from a linear system to be more cyclical so that materials, products, and substances are used as efficiently as possible. Materials must be chosen so that it may either return safely to a cycle within the environment or remain viable in the industrial cycle.

The cradle-to-grave is a linear model for materials that begins with resource extraction, moves to product manufacturing, and ends by a "grave", where the product is disposed of in a landfill. Cradle-to-grave is in direct contrast to cradle-to-cradle materials or products, which are recycled into a product at the end of their lives, so that ultimately there is no waste. A Zero waste strategy may be applied to businesses, communities, industrial sectors, schools and homes. Benefits proposed by advocates include:

Saving money, since waste is a sign of inefficiency, the reduction of waste can reduce costs.

Faster Progress, A zero waste strategy improves upon production processes and improving environmental prevention strategies which can lead to take larger, more innovative steps.

Supports sustainability, A zero waste strategy supports all three of the generally accepted goals of sustainability - economic well-being, environmental protection, and social well-being.

Improved material flows, A zero waste strategy would use far fewer new raw materials and send no waste materials to landfills. Any material waste would either return as reusable or recycled materials or would be suitable for use as compost.

Research Objectives:

To Identify specific waste streams suitable for circular economy interventions and assess their feasibility (survey of stakeholders using Likert's scale for agreements on feasibility and intervention for circular economy).

To assess the current state of solid waste management practices in Ahmedabad City, focusing on the implementation of Swachh Bharat Mission Urban 2.0.

To develop a comprehensive framework for promoting (Suggestion for growth of circular Economy in Ahmedabad) circular economy in solid waste management for Ahmedabad City.

Research Methodology:

The proposed mixed-methods approach aligns closely with empirical research principles. By combining qualitative and quantitative research techniques, the study relies on observation, measurement, and experimentation to gather data and evidence. This empirical approach provides a comprehensive understanding of the potential of circular economy in addressing Ahmedabad's solid waste management challenges. Case studies, document analysis, and quantitative data analysis collect and analyze data, while impact assessments evaluate the effectiveness of circular economy interventions. This empirical approach ensures that the research findings are grounded in evidence and can inform policy decisions and sustainable waste management strategies.

Global waste management practices vary significantly. While high-income countries predominantly rely on landfill (40%), recycling/composting (19%), and modern thermal treatment (11%) for disposal, a staggering 33% of waste, particularly in low-income nations, is openly dumped, often through burning.

High-income regions boast nearly 100% waste collection rates, employing advanced technologies like compactor trucks and transfer stations. Source separation is common, facilitated by color-coded bins. In contrast, low- and middle-income countries grapple with lower collection rates (50-80%), often relying on manual labor and basic equipment. Informal sectors play a crucial role in waste management by recovering recyclables.

3R Initiative taken to reduce generation of waste in the city, Initiatives has been taken in all 7 Zones of the city as listed Below: As a part of waste reduction and elimination at source, the 3R (Reduce, Reuse and Recycle) drive was conducted throughout under the Ahmedabad Municipal Corporation. Some of the initiatives taken by the corporation are detailed in next chapter below.

Innovation of Case Studies:

Amardham Lal Gebi Ashram, Ahmedabad:

Amardham Lal Gebi Ashram, situated at the western end of Ahmedabad, is a large facility with multiple units such as Annakshetra (Large mess hall), Gaushala (Cow Shelter), Sant Nivas (Guesthouse), Community Hall, Agriculture/Plantation

field and a small bird care facility. This Ashram caters to hundreds of pilgrims and devotees as well as a large section of poor and needy who depend on it for their daily meal. As a result, the Ashram generates over 200 kg of waste every day. This made the Ashram fall into the category of Bulk-Waste Generator. On the request and support of the Ahmedabad Municipal Council, The Ashram built an in-house Biogas plant with a capacity of 0.23 ton. This utilizes much of the waste generated in the premises to convert into Bio-gas which is further used for cooking in the massive mess hall which caters to the pilgrims and countless other poor and needy, who are served free lunch and dinner in the Ashram premises daily. This Ashram is a leading example of innovation in 3R wherein the waste generated is reused to create social value for the stakeholders.

Figure: 1 Bio-Gas Plant

Figure: 2 Food Cooked with the help of biogas being served to pilgrims and common public.

4.2. Coconut Waste to Handmade Craft:

The city of Ahmedabad faces a significant waste management challenge, with coconut waste comprising a substantial portion. Approximately 4% of the total waste collected, or around 100 tons, is coconut-based, primarily originating from temples, religious ceremonies, and coconut water sales centers. To address this issue, the city has partnered with Brook and Blooms in collaboration with Victoria Garden (Kalash Project).

Over the past year, Brook and Blooms has successfully collected approximately one ton of coconut waste from various temples and coconut water outlets across Ahmedabad. Daily collection efforts have been implemented in all wards to ensure efficient waste management. The collected coconut waste is processed using Dehuskar, Shredder, and screening machines to produce cocopeat, coco-fiber, and coconut bowls. The coconut husk is cut, ground, and buffed to create coconut bowls, which can be used as plant pots or edible cups.

Figure: 3 Coconut Waste

This innovative project aligns with the goals of a clean and self-reliant India. The cocopeat produced from the coconut waste is utilized by the garden department to cultivate trees in various city gardens, promoting their growth and development. Additionally, the coconut bowls can be used to plant small indoor plants or as eco-friendly soft drink cups. The coconut husk can also be transformed into keychains, offering a sustainable alternative to plastic.

MLD MBR Technology based STP at Sardar Vallabhbhai Patel Institute of Medical Science & Research (SVPIMSR):

Sardar Vallabhbhai Patel Institute of Medical Science and Research (SVPIMSR) is 1500 bedded multispecialty hospital and medical college. The hospital is the country's first and largest public hospital made of steel. This is the only hospital to have physiotherapy, medical, and nursing college on the same campus, with separate hostel for boys and girls to accommodate 550 students. The hospital has been inaugurated in January 2019 by honorable Prime Minister of India. The estimation of sewage generation is about 800 KLD so to reuse and recycle sewage generation at SVPIMSR, 1 MLD STP has been set up with MBR Technology. SVPIMSR has been provided with dual plumbing so treated water is used in flushing as well as landscaping in the campus.

The plant is comprising of screening, oil and grease removal system, equalization tank, fine screening, aeration tank, MBR tank and treated water tank. Contract for SITC with 10 yrs operation and maintenance has been given to M/S. S.R. Paryavaran Engineers Pvt. Ltd. Current sewage generation of the hospital is approx.450 KLD which is being treated and reused. The capital cost of the plant is 4.15 Cr. and monthly O & M cost of the plant is Rs.29,00,000/- including energy cost.

Waste Management and Livelihood:

Ahmedabad is situated in the heart of Gujarat; Ahmedabad has a character like no other, defined by a spirit of enterprise. Although Ahmedabad is a bustling metropolitan with reputed institutes and a rapidly growing economy, it is also deeply rooted in tradition. Hundreds of temples, mosques and other pilgrim spots along with a complex maze of neighborhoods called pols make the city come alive. These pols and religious institutions depict the finest example of heritage and culture, making Ahmedabad the first World Heritage City in India. Ahmedabad attracts a large number of tourists from across the country due to its rich heritage and culture.

It sees an approximate inflow of 75 lac tourists annually, including the domestic and international tourists. Major tourist attractions in the city comprise of religious places, and the river Sabarmati, which runs across the city. It is a common practice for the devotees to visit any religious place with offerings of chuniri to goddess. As these offerings to the deities are considered pious and sacred, they cannot be disposed in the dustbins, and hence most of it ends up in nearby water bodies or vacant plots unattended or thrown in any barren areas.

During the Swachh innovative Technology Challenge Ahmedabad Municipal Corporation (AMC) has been approached by NGO named Curtail to Sustain- Parivartan abhiyan with innovative solution for this chuniri. The NGO collecting the chunaris from around 50 temples all over the city by their own. More than 10 under privileged women are working to make the decorative products from collected chunaris. This NGO is working since 2020 and it is estimated that around 12000 of Chunaris were collected and used form making their decorative products.

Figure: 4 Curtail to Sustain Parivartan Abhiyan

Novelty: As the Chunaris offered to goddess are not disposed and thrown in to the River, Well or in barren areas. This initiative helps to reduce the waste of Chunaris by using them to produce different products.

Impact: Reduction in environmental pollution and visible cleanliness of religious heritage and water bodies of the city has been achieved. The solution adopted respects the sentimental value associated with the waste thus brought about a wave of behavior change encouraging people to dispose religious waste systematically.

Financial Sustainability: The project is still in pilot mode and AMC is willing to support them by providing place for work and Chunaries from the

Temples. Each worker in NGOs earned Approx 2500 Rs. Per month which will improve their livelihood.

This project has helped make a significant environmental enhancement in the water bodies and surroundings of religious places by providing scalability to the work of Project. In November 2021, this NGO is awarded by Ministry of Women and Child Development Government of Gujarat during shakti samman samaroh for working toward the livelihood of under privileged women as well as for the better solution of waste management.

Symphony Forest Park (Development as per of CSR activities):

Background:

The park, located at Bodakdev, Ahmedabad and spread across an area of 11000 sq. mtr, is surrounded by upcoming residential neighborhoods and established commercial/office buildings. The corporate staff as well as the nearby residents will be the primary users of the forest park. The area was an empty land owned by AMC, which had few existing tress attracting birds and a lake partially filled with debris. The challenge was to work with the flat topography of the plot filled with debris and waste.

Novel Initiative:

To address this challenge, Symphony Limited sought and was granted permission by Ahmedabad Municipal Corporation to develop the garden on a Public Private Partnership (PPP) basis as part of its CSR activities. The surrounding area consists mainly of commercial buildings. The garden will therefore by primarily used by office goers of the nearby buildings during their breaks. There are a couple of other "family gardens" developed by AMC within a few hundred meters of the proposed garden. These gardens have lawns, children's play area, party lawns, walking tracks etc. and adequately serve the needs of the surrounding residential communities.

Considering all the above, the garden has been envisaged and developed as a small urban forest, a 'lung', with a bio-diverse mix of large, shade-giving trees. Trees which attract birds and butterflies. Upon maturing in a few years, the forest will have a very natural feel, with under-growth, undulating levels, unpaved and meandering tracks and minimal hardscape. The existing pond is reconfigured in to a shallow, but a wider waterbody which hosts fish, frogs and turtles.

Impact:

Forest Park is now home to 300+ species of plants and probably 30+ species of birds visit this park. The forest has been planted with over 25000 plants, few of which are rare, mythological, religious and having ecological value. The park has plenty of fruit bearing trees, flowering shrubs to invite birds, insects, bees and squirrels

Figure: 5 Before Novel Initiation

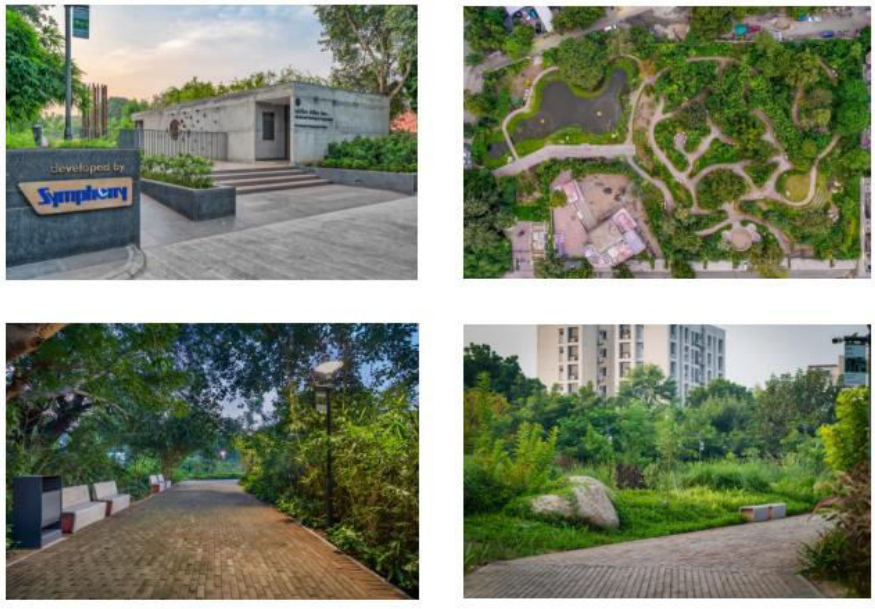

Figure: 6 After Novel Initiation

Conclusion of the Case Study:

Ahmedabad's fight against solid waste management challenges has been significantly bolstered by innovative circular economy initiatives. These projects

demonstrate the city's commitment to sustainability and its ability to transform waste into valuable resources.

Amardham Lal Gebi Ashram: This Ashram, a haven for the needy, has successfully implemented a biogas plant, converting organic waste into clean-burning fuel. By reducing reliance on external energy sources and providing essential services to the community, the Ashram aligns with the principles of circular economy and social sustainability.

Coconut Waste to Handmade Craft: This innovative project has transformed discarded coconut shells into valuable products such as cocopeat and coconut bowls. By creating employment opportunities and promoting sustainable living, this initiative contributes to the circular economy and addresses the challenges of waste management in the city.

SVPIMSR's Wastewater Treatment Plant: The hospital's installation of a state-of-the-art wastewater treatment plant demonstrates the potential for water reuse and recycling in urban areas. By reducing water consumption and minimizing environmental impact, the hospital aligns with the objectives of circular economy and sustainable development.

Waste Management and Livelihood: The initiative to repurpose discarded religious offerings into decorative products showcases the potential of circular economy to address waste management challenges while also providing livelihood opportunities for marginalized communities. By involving local communities and promoting sustainable practices, this project contributes to the circular economy and social empowerment.

Symphony Forest Park: Developed through a public-private partnership, this park demonstrates the potential for corporate social responsibility to contribute to urban greening and biodiversity conservation. By creating a green space and enhancing the quality of life for residents, the park aligns with the principles of circular economy and sustainable urban development. These success stories collectively highlight the potential of circular economy principles to address solid waste management challenges in Ahmedabad City. By reducing waste, promoting resource efficiency, and creating economic opportunities, these initiatives contribute to a more sustainable and resilient urban environment.

Recommendations:

Based on Ahmedabad's successful circular economy initiatives, it is recommended that the city continue to expand and replicate these innovative projects across other urban areas. Further investments should be made in public-private

partnerships, community-driven waste management solutions, and technologies for resource recovery and recycling. Scaling up initiatives like biogas plants, craft-based waste repurposing, and wastewater treatment can enhance resource efficiency while creating sustainable employment opportunities. Additionally, fostering community awareness and participation in circular economy practices will ensure long-term success and broader adoption. By continuing to integrate sustainability into urban planning and policy, Ahmedabad can serve as a model city for sustainable waste management and circular economy practices in India.

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