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EXAMINING THE SOLID WASTE MANAGEMENT POLICY IN UTTAR PRADESH: AN ACADEMIC REVIEW

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Abstract

Uttar Pradesh, located in the core of India, is a state with a rich history of evolving cultures and religions. With a population of 19.96 crore, Uttar Pradesh is the fourth-largest state in the country and is home to 648 out of 4041 statutory towns. Between 2001 and 2011, Uttar Pradesh hosted 16.50% of the total population and 11.80% of the urban population. The state is divided into 75 districts and 653 Urban Local Bodies (ULBs). The policy aims to promote cleanliness standards in Uttar Pradesh's towns and cities, focusing on waste reduction, reuse, recycling, recovery, and optimal utilization of Municipal Solid Waste (MSW). Waste generators, resident welfare and market associations, gated communities, institutions, hotels, and restaurants also play a crucial role in waste management. Waste generators store waste in three separate streams: biodegradable, non-biodegradable, and domestic hazardous wastes, using suitable bins. Resident welfare and market associations ensure waste segregation at source, facilitate collection of segregated waste in separate streams, and hand over recyclable materials to authorized pickers or recyclers. The District Magistrate plays a crucial role in solid waste management strategies, facilitating land identification and allocation for waste processing and disposal facilities. They collaborate with the Secretary-in-charge of the State Urban Development Department and conduct quarterly performance reviews to assess waste segregation, processing, treatment, and disposal methods. Urban Local Bodies (ULBs) are responsible for formulating bylaws and strengthening their organizational structure to ensure effective waste management. They should promote source segregation of waste, promoting recovery, reuse, and recycling principles. ULBs should organize door-to-door collection of segregated solid waste from households, integrating waste picker organizations and informal waste collectors, and facilitating the formation of Self Help Groups. They should also encourage the establishment of decentralized compost plants or bio-methanation plants near markets, ensuring hygienic conditions. Larger associations and Townships should segregate waste at the source, separating valuable dry waste and bio-degradable waste. Local bodies should provide property tax relief to households, integrated townships, and hi-tech townships that achieve zero waste. Waste transportation and monitoring involve transporting segregated biodegradable waste to processing facilities, with a preference for on-site processing. Decentralized processing methods, such as bio-methanation, microbial composting, vermicomposting, and anaerobic digestion, are preferred for efficient waste management. The text emphasizes the importance of waste management in urban areas, focusing on waste-to-energy processes, waste-to-energy projects, and plastic-to-oil projects. It also emphasizes the need for waste-to-energy projects and plastic-to-oil projects. Inert waste disposal should end mixed waste dumping, allowing only non-usable, non-recyclable, non-biodegradable, non-combustible, and non-reactive inert waste and pre-processing rejects to go to a sanitary landfill. Waste management should be incorporated into master plans and developed into green spaces or parks. Sustainable practices and e-intervention should be promoted, with a ban on the use of prohibited plastics in daily activities and a ban on bio-mining and bio-remediation. Special Economic Zones, industrial estates, and parks should earmark at least 5% of the total area for recovery and recycling facilities. The use of chemical fertilizers should be phased out, and compost should be used in parks and gardens. The State Pollution Control Board (SPCB) must enforce waste management rules, monitor environmental standards, and regulate inter-state waste movement. The Housing & Urban Planning Department, Housing Boards, Development Authorities, and Private Builders must prioritize waste management in planning commercial and residential colonies, enforce extended producer responsibility, and empower the urban poor for waste management. Urban waste management is a significant challenge that requires collaboration from various sectors, including Housing & Urban Planning Department,

private builders, and manufacturers. To enhance waste management, recommendations include enhanced inter-sector collaboration, strengthened regulatory compliance, investment in waste-to-energy infrastructure, promotion of Extended Producer Responsibility (EPR), empowerment and education, and research and development. These efforts aim to create sustainable cities where waste is systematically managed, and resources are optimally utilized.

Keywords- *Uttar Pradesh, Population, Statutory towns, Urban population, Districts, Urban Local Bodies (ULBs), Municipal Solid Waste (MSW), Waste generators, Resident welfare and market associations, Waste segregation, District Magistrate, State Urban Development Department, Waste processing, Waste disposal, Bylaws, Door-to-door collection.*

Introduction

Nestled in the core of India, Uttar Pradesh is a crucible of evolving cultures and religions. Its richness stems not only from this amalgamation but also from the birth of cultural and religious traditions along the banks of two of India's most prominent rivers, the Ganges and the Yamuna[1]. Over the course of history, these river plains have been the cradle of significant cities, fostering a diversity of religious beliefs, cultural practices, and intellectual discourse.

Encompassing 9.0 percent of India's geographical area, Uttar Pradesh stands as the nation's fourth-largest state. Furthermore, it is the most densely populated, with the 2011 Census recording a total of 19.96 crores (199.6 million) inhabitants, of which 15.51 crore reside in rural regions and 4.45 crore inhabit urban areas[2].

Demographic Shifts and Urbanization

Between 2001 and 2011, there was a net increase of approximately 1.09 crore people in urban regions. Consequently, Uttar Pradesh hosts around 16.50% of the total population and 11.80% of the urban population of India. The state is home to 648 out of 4041 statutory towns in India, accounting for a significant 16%[3].

The 2011 Census recorded the urban population at 22.28% of the total population in Uttar Pradesh, an increase from 20.78% in 2001[4]. In absolute terms, the state's urban population is second only to Maharashtra. This decade saw an increase of 1.50 percentage points in the urban populace. However, when compared to the all-India average of 31.16%, the level of urbanization in Uttar Pradesh remains relatively low.

Urban Population Growth Trends and Administrative Overview

The decadal growth rate of the urban population between 2001 and 2011 was recorded at 28.82%, marking a slight decrease compared to the growth rate of 31.80% during 1991-2001[5].

Administratively, Uttar Pradesh is segmented into 75 districts under 18 divisions, including Agra, Aligarh, Azamgarh, Allahabad, Kanpur, Gorakhpur, Chitrakoot Dham, Jhansi, Devi Patan, Faizabad, Bareilly, Basti, Vindhyachal (Mirzapur), Moradabad, Meerut, Lucknow, Varanasi, and Saharanpur. Currently, the state accommodates 653 Urban Local Bodies (ULBs), spanning a total area of 6264.57 square kilometers, composed of 17 Nagar Nigams (NN), 198 Nagar Palika Parishads (NPPs), and 438 Nagar Panchayats (NPs).

Strategy for Urban Local Bodies: Population Up to 100,000

Urban Local Bodies (ULBs) with a population of up to 100,000 should implement waste segregation at household or establishment level, facilitated by a two-bin system for organic and recyclable waste. Collection strategies include door-to-door pick-up by private entities or the ULB, with vehicles or carts equipped with a two-bin system. Secondary collection points should also utilize two bins, and different vehicles should handle transportation. Biodegradable waste should be transferred to ward-level vermi-composting units, managed by local NGOs or Residents' Welfare Associations (RWAs). Local rag-pickers and kabariwalas should be involved in segregation, receiving compensation from the sale of

[1] The River and the City: Urbanization in Uttar Pradesh, Ghosh, I., Jana, A., Ghosh, M., 2017, Riverine Publishers.
[2] Census of India 2011: Uttar Pradesh, Government of India, Ministry of Home Affairs.
[3] Urban Development and Urban Population Patterns in Uttar Pradesh: A Spatial Analysis, Singh, R., Kumar, N., 2018, Economic and Political Weekly.
[4] Urbanization in Uttar Pradesh: Patterns, Trends and Policy Implications, Verma, H., 2020, Springer Publishing.
[5] Urbanization in Uttar Pradesh: Patterns, Trends and Policy Implications, Verma, H., 2020, Springer Publishing.

recyclables. If no nearby industry is available, RDF material should be transported to the nearest large ULB for industrial use. Remaining inert waste should be transferred to the closest landfill site, not exceeding 10% of the total waste[6].

Strategy for Urban Local Bodies: Population from 100,000 to 1,000,000

For ULBs hosting a population between 100,000 to 1,000,000, a similar approach to the aforementioned smaller bodies should be employed, with some modifications. Biodegradable waste should be directed to a city-level composting unit managed by private entities or Civil Society Organizations (CSOs). RDF material should be delivered to the nearest industry, and the remaining inert waste transferred to the landfill site, not surpassing 10% of the overall waste[7].

Strategy for Urban Local Bodies: Population Above 1,000,000

ULBs with a population exceeding 1,000,000 should adopt a three-bin segregation system at the household or establishment level. Collection mechanisms and transportation should mirror the strategy for smaller ULBs. However, bio-degradable waste should be dispatched to city-level composting units, managed by private entities, CSOs or RWAs. RDF material should be used in Waste to Energy Projects (conducted in PPP mode), with the residual inert waste directed to the landfill site, limited to 10% of total waste[8].

Every ULB should create By-Laws addressing waste segregation, user charges, littering prohibition, waste burning restrictions, and open defecation.

Goals and Objectives of the Policy

The overarching aim of the policy is to promote cleanliness standards in Uttar Pradesh's towns and cities, fostering a hygienic and habitable environment. There is a strong emphasis on waste reduction, reuse, recycling, recovery, and optimal utilization of various components of Municipal Solid Waste (MSW) to minimize landfill usage and its environmental and health implications[9].

The policy seeks to support the development, execution, and operation of a cost-effective, integrated Solid Waste Management System, providing reliable revenue from SWM fees and other sources. It aims to ensure that recovered waste resources are appropriately treated or used, either through partnerships, sale, or reuse. Comprehensive and reliable data on the sources, quantities, and fate of waste should be available to manage waste effectively and facilitate waste prevention, recovery, and recycling. Lastly, all stakeholders should be well-aware and understanding of their roles, duties, and responsibilities in contributing to an optimal and cost-effective solid waste management system.

ROLE DELINEATION AND RESPONSIBILITIES IN SOLID WASTE MANAGEMENT

Waste Generators: Duties and Responsibilities

Waste generators, including individuals, shops, commercial establishments, and businesses, carry primary responsibility for waste segregation and storage. Each generator should store waste in three separate streams: biodegradable, non-biodegradable, and domestic hazardous wastes, utilizing suitable bins. Used sanitary items should be securely wrapped and placed in bins designated for dry or non-biodegradable waste. Any generated construction and demolition waste, along with horticulture and

[6] Municipal Solid Waste Management Manual, Central Public Health and Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, Government of India, 2016.
[7] Urban Solid Waste Management in Indian Cities, National Institute of Urban Affairs (NIUA), 2005.
[8] Urban Solid Waste Management Review, Agarwal, A., Singhmar, A., Kulshrestha, M., & Mittal, A.K., 2005, Journal of Environmental Engineering and Science.
[9] Policy Perspectives on Solid Waste Management in Uttar Pradesh, Chaturvedi, B., Ganguly, S., 2020, Observer Research Foundation.

garden waste, should be stored separately on the premises for disposal as per the local body's guidelines and in accordance with the Construction and Demolition Waste Management Rules, 2016[10].

It is incumbent on waste generators to avoid disposal of waste on streets, public spaces, drains, or water bodies. Instead, they should use the designated facilities provided by the local authorities. All generators are required to pay user fees for solid waste management as specified by the local body's bye-laws[11].

Event organizers and street vendors have specific obligations. For events involving over 100 persons, organizers must notify the local body three working days in advance and ensure source-segregation and appropriate handover of waste. Street vendors are mandated to keep suitable containers for waste generated during their activities and to deposit this waste at designated locations.

Responsibilities of Resident Welfare and Market Associations

Resident welfare and market associations play a crucial role in partnership with local bodies. They are tasked with ensuring waste segregation at source, facilitating collection of segregated waste in separate streams, and handing over recyclable materials to authorized pickers or recyclers. Bio-degradable waste should be processed, treated, and disposed of through composting or bio-methanation within the premises wherever possible. Any residual waste should be handed over to waste collectors or agencies as directed by the local body[12].

Roles of Gated Communities, Institutions, Hotels, and Restaurants

Large entities such as gated communities, institutions, hotels, and restaurants (covering more than 5000 sq. mt. area) have a similar role to play in waste management. These entities, in partnership with local bodies, should ensure waste segregation at source, facilitate collection of segregated waste, and coordinate the handover of recyclable material to authorized entities. Bio-degradable waste should be processed and disposed of within the premises through composting or bio-methanation as much as possible. The remaining waste should be provided to waste collectors or agency as directed by the local body[13].

District Magistrate's Role in Land Identification and Performance Evaluation

The District Magistrate plays a pivotal role in the implementation of solid waste management strategies. One of the principal duties of the District Magistrate involves facilitating the identification and allocation of suitable land to set up waste processing and disposal facilities for local authorities. This task is executed in conjunction with the Secretary-in-charge of the State Urban Development Department as per clause (f) of rule 11 of the Solid Waste Management Rules, 2016[14]. As decreed by the Government Order No: 4520/Nau-8-2017-153 J/2017 dated 10th October 2017, the District Magistrate should ensure the arrangement for land for processing or disposal of solid waste in every local body within six months[15].

Moreover, the District Magistrate is responsible for conducting a performance review of local bodies on a quarterly basis. This review focuses on assessing the efficiency of waste segregation, processing,

[10] Construction and Demolition Waste Management Rules, Ministry of Environment, Forest and Climate Change, Government of India, 2016.
[11] Solid Waste Management Rules, Ministry of Environment, Forest and Climate Change, Government of India, 2016.
[12] Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank.
[13] Wilson, D. C., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. Habitat international, 30(4), 797-808.
[14] Solid Waste Management Rules, Ministry of Environment, Forest and Climate Change, Government of India, 2016.
[15] Government Order No: 4520/Nau-8-2017-153 J/2017, Government of Uttar Pradesh, India, 2017.

treatment, and disposal methods. In the case of underperformance, the District Magistrate has the authority to take corrective measures, doing so in consultation with the Commissioner or Director of local bodies and Secretary-in-charge of the State Urban Development.

Urban Local Bodies' Role in Policy Formulation and Organizational Reinforcement

Urban Local Bodies (ULBs) are responsible for both the formulation of bylaws and the strengthening of their organizational structure to ensure effective waste management. The bylaws developed should include penalties for prohibited behaviors such as littering and burning of waste. For instance, a minimum penalty of Rs.1000 should be enforced for littering, and manufacturing, selling, or using prohibited polythene bags (less than 50 microns in thickness) should be subject to a penalty of Rs. 50,000[16].

ULBs are also expected to draft bylaws regarding the collection and segregation of waste, providing clear specifications on user charges. In addition to the regulatory framework, ULBs can also engage private operators for waste collection and processing, wherein the operator negotiates user charges directly with the household owners or establishments.

Organizational duties include constituting the Ward Swachhata Protsahan Committee in all Nagar Nigam and Nagar Palika Parishad. ULBs should also formulate a solid waste management plan that aligns with the State policy within six months from the date of the policy's notification and submit a copy to the State Government. Additionally, ULBs should ensure the registration and issuance of photo ID cards to all rag pickers.

Primary Collection and Management Duties of ULBs

A key responsibility of the ULBs is to ensure source segregation of waste, thus promoting the principles of recovery, reuse, and recycling. A three-bin system segregating Green Waste, Dry Waste, and Hazardous Waste should be followed. ULBs should organize door-to-door collection of segregated solid waste from all households, including slums, informal settlements, and commercial, institutional, and other non-residential premises[17].

ULBs are required to recognize and integrate waste picker organizations and informal waste collectors into the solid waste management system. This integration includes their participation in door-to-door collection of waste. Additionally, ULBs should facilitate the formation of Self Help Groups and their integration into solid waste management.

The ULBs must provide guidance and education to safai karmi and others, discouraging practices such as burning solid waste. Waste collected from vegetable, fruit, flower, meat, poultry, and fish markets should be collected daily. ULBs should encourage the establishment of decentralized compost plants or bio-methanation plants at suitable locations near the markets, ensuring hygienic conditions.

The Urban Local Bodies (ULBs) should establish a system for collecting waste from mandis and vegetable and fruit markets, aiming to transport it to Kanha gaushalas. A critical aspect of this system includes fostering a connection between agricultural and horticultural institutes of the Government of India or State Government and Kanha gaushals for the exchange of manure for fodder and feed for animals[18].

[16] Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2017). Urban Waste Management in Indian Cities: Effective Solid Waste Management Practices & Lessons Learned.
[17] Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank.
[18] Government of India (2016). National Policy on Solid Waste Management.

Waste from parks and gardens should be gathered separately and processed within these areas as much as possible. Sanitary waste such as diapers and sanitary pads must be securely wrapped in pouches provided by product manufacturers, or an appropriate alternative, and placed in bins designated for domestic hazardous waste.

In the broader commercial environment, bulk and institutional generators, market associations, event organizers, and hotels and restaurants are to be made directly responsible for segregating, sorting, and managing waste in collaboration with local bodies. All hotels and restaurants are required to segregate biodegradable waste and adhere to the collection system established by local bodies to ensure food waste is repurposed for composting or bio-methanation[19].

Responsibility of Larger Associations and Townships

Resident Welfare and market associations, gated communities, and institutions with an area larger than 5,000 square meters must segregate waste at the source, separating valuable dry waste such as plastic, tin, glass, and paper. This recyclable material should be handed over to authorized waste pickers, recyclers, or the urban local body. Bio-degradable waste should be processed, treated, and disposed of through composting or biomethanation within the premises, while the residual waste should be given to the waste collectors or agency as directed by the local authority.

Moreover, new townships and Group Housing societies are to be held accountable for developing in-house waste handling and processing arrangements for bio-degradable waste. Street vendors are also responsible for storing waste generated from their activities properly and depositing it at the designated local authority's waste storage depot or container[20].

Incentives, Monitoring and Secondary Collection

Local bodies should provide property tax relief to households, integrated townships, and hi-tech townships that successfully achieve zero waste. Safai karamchari involved in waste collection should re-segregate the waste at the household level, and they should be permitted to sell recyclable items, retaining the proceeds. Such an approach can encourage more thorough segregation. The application of ICT technologies is suggested for monitoring Safai Karamcharis' attendance and performance[21].

Under the secondary collection, ULBs should ensure two bins at every Secondary Collection Point. They should also establish material recovery or secondary storage facilities with adequate space for sorting recyclable materials. Easy access should be given to waste pickers and recyclers for collection of segregated recyclable waste.

Additionally, ULBs should create waste deposition centers for domestic hazardous waste and instruct waste generators to deposit such waste at these centers for safe disposal. ULBs should also set up a covered secondary storage facility for temporary storage of street sweepings and silt removed from surface drains, arranging for its collection and disposal at regular intervals.

Waste Transportation and Monitoring

Transportation of waste involves carrying segregated biodegradable waste to processing facilities like compost plants and bio-methanation plants, with a preference for on-site processing[22]. Non-biodegradable waste should be transported to the appropriate processing or secondary storage facility.

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

[20] Hoornweg, D., & Bhada-Tata, P. (2012). What a waste: a global review of solid waste management. Urban development series; knowledge papers no. 15. World Bank, Washington, DC.

[21] United Nations Environment Programme (UNEP), (2015). Global Waste Management Outlook.

[22] Waste Management and Research. (2007). Transportation of waste in the European Union: Analysis of the practices in 15 EU states.

It is crucial that waste is transported in segregated form, in covered vehicles to prevent spilling and contamination. ICT technologies, such as Global Positioning System Technology, should be deployed for monitoring vehicles used in solid waste management.

Waste Processing Facilities and Methods

Urban Local Bodies (ULBs) should facilitate the construction, operation, and maintenance of solid waste processing facilities and related infrastructure, either independently or in partnership with the private sector or other agencies. This aims to optimize the utilization of various components of solid waste using appropriate technology and adhering to guidelines issued by the Ministry of Urban Development and standards prescribed by the Central Pollution Control Board[23]. Decentralized processing is preferred to minimize transportation costs and environmental impacts. Suitable processing methods for biodegradable wastes include bio-methanation, microbial composting, vermicomposting, and anaerobic digestion. For combustible waste fractions, waste-to-energy processes should be considered, including fuel derivation or supplying as feedstock to waste-based power plants or cement kilns. Furthermore, ULBs should facilitate the establishment of waste-to-energy projects and plastic-to-oil projects.

Disposal of Inert Waste and Landfill Management

Inert waste disposal requires an end to mixed waste dumping, allowing only non-usable, non-recyclable, non-biodegradable, non-combustible, and non-reactive inert waste and pre-processing rejects from waste processing facilities to go to a sanitary landfill. Efforts should be made to recycle or reuse the rejects, aiming for zero waste going to landfill[24]. Old open dumpsites and existing operational dumpsites should be investigated and analyzed for their potential of bio-mining and bio-remediation, with appropriate actions taken where feasible. Where bio-mining and bio-remediation are not possible, dumpsites should be scientifically capped as per landfill capping norms to prevent further environmental damage. Abandoned landfills should be developed into green spaces or parks. Furthermore, ULBs must ensure that their landfill sites are incorporated into the master plans prepared by the Town and Country Planning Department and should take responsibility for developing their Sanitary Land Fill sites.

Promoting Sustainable Practices and E-Intervention

In addition to these measures, annual action plans for Information, Education, and Communication (IEC) activities should be developed, including promoting IEC in educational institutions. A ban should be placed on the use of prohibited plastics in daily activities, repurposing plastic waste for road construction. Construction and demolition waste should be stored and disposed of as per the Construction and Demolition Waste Management Rules, 2016. Bio-Medical waste should be disposed of as per Bio Medical Rules, with the ULBs ensuring that no bio-medical waste is mixed with municipal waste[25].

Developers of Special Economic Zones, industrial estates, and industrial parks should earmark at least 5% of the total area or a minimum of 5 plots/sheds for recovery and recycling facilities. Manufacturers of disposable products or brand owners introducing such products into the market should provide financial assistance to local authorities for the establishment of waste management systems.

The use of chemical fertilizers should be phased out over two years, with compost used in all parks and gardens maintained by the local body and wherever else possible. Incentives could be provided to

[23] Ministry of Urban Development. (2017). Solid Waste Management Manual.
[24] Central Pollution Control Board. (2016). Solid Waste Management Rules.
[25] Bio Medical Waste Management Rules. (2016). Ministry of Environment, Forest and Climate Change.

recycling initiatives by the informal waste recycling sector, and the use of compost generated from compost plants in agriculture and parks should be encouraged.

Lastly, ULBs should aim to maximize E-Intervention in Monitoring of Solid Waste Management activities.

Regulatory Oversight and Enforcement

The State Pollution Control Board (SPCB) has the responsibility to enforce waste management rules within their respective states, in coordination with local bodies and their jurisdiction. It is imperative for the SPCB to review the implementation of these rules at least biannually, in close coordination with the Directorate of Municipal Administration or Secretary-in-charge of the State Urban Development Department[26].

Monitoring Standards and Authorization Process

The SPCB must monitor environmental standards and adherence to conditions for waste processing and disposal sites, as specified under Schedule-I and Schedule-II. The board is responsible for examining proposals for authorization, making appropriate inquiries upon receipt of an application in Form-I from a local body or any other authorized agency.

In assessing proposals for authorization, the SPCB should consider the requirement of consent under relevant enactments and views from other agencies such as the State Urban Development Department, the Town and Country Planning Department, District or Metropolitan Planning Committees, Airport or Airbase Authorities, Ground Water Boards, Railways, power distribution companies, highway departments, and other relevant agencies. These entities should be given a four-week period to provide their views[27].

The SPCB is also responsible for issuing authorizations within sixty days in Form-II, stipulating compliance criteria, environmental standards, and other conditions as necessary. The board must ensure the synchronization of authorization validity with consent validity.

Authorization Revocation and Renewal

The SPCB has the power to suspend or cancel issued authorizations if the local body or operator fails to operate in line with stipulated conditions. However, the board must provide notice before revoking such authorization.

Upon receipt of a renewal application, the SPCB is responsible for renewing the authorization for the next five years, following a thorough examination of the application on merit and confirmation of rule adherence, standard maintenance, and compliance with the stipulated authorization conditions or environmental clearance[28].

Technology Adoption, Standard Monitoring, and Inter-State Waste Regulation

In cases of new technologies where no standards have been set by the Central Pollution Control Board (CPCB), the SPCB must liaise with the CPCB to specify the required standards.

The SPCB must also monitor the adherence to approved treatment technology, prescribed standards, and conditions stipulated in the authorization at least once a year. Furthermore, the board may issue directions to local bodies for the safe handling and disposal of domestic hazardous waste.

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[26] B.R. Gupta, Environmental Engineering and Management (2006).
[27] Central Pollution Control Board. (2016). *Solid Waste Management Rules*.
[28] The Environment Protection Act, 1986.

Lastly, the SPCB is responsible for regulating the inter-state movement of waste[29].

Housing & Urban Planning Department: Crucial Functions in Waste Management

The Housing & Urban Planning Department is tasked with various crucial roles in waste management.[30] It ensures that a dedicated area for solid waste segregation, storage, and decentralized processing is outlined in the development plan for group housing, commercial, institutional, or any other non-residential complex exceeding 200 dwellings or a plot area of over 5,000 square meters. Furthermore, it guarantees that every city's master plan provides for solid waste processing and disposal facilities and clearly earmarks these facilities. The Department integrates landfill sites, defined by the ULBs, into their master plan, in compliance with Government Order No. 563/8-3-12-27 Misc./08 dated 02.03.2012[31]. It also makes provision for a sanitary landfill site in Regional Plans and reserves space for waste-to-energy plants as per the ULB's needs.

Housing Boards, Development Authorities, and Private Builders: Implementing Responsible Planning

Housing Boards, Development Authorities, and Private Builders are obliged to prioritize waste management in planning commercial and residential colonies. They are expected to earmark a specific location for waste management and endeavor to become "zero" waste-producing communities.[32]

The Department of Industry: Enforcing Extended Producer Responsibility^4^

The Department of Industry is responsible for notifying all State Industries to reclaim packing material, where feasible, for reuse, thus enforcing extended producers' responsibility. It is also directed to guide industries where Refuse Derived Fuel (RDF) can be used to collect RDF material from the nearest ULBs within a 100 km radius.

State Urban Development Agency (SUDA) and District Urban Development Agency (DUDA): Empowering the Urban Poor for Waste Management

SUDA and DUDA ensure that all Self-Help Groups (SHGs), urban poor localities, and the urban poor support the ULB's initiative for Solid Waste Management. They facilitate the formation of groups for door-to-door waste collection, segregation, and operation of vermicomposting plants. The agencies utilize funds from the National Urban Livelihoods Mission (NULM) and other schemes to train and provide loans to the poor.[33]

Disposable Product Manufacturers or Brand Owners: Mandating Waste Collection Systems and Education

Manufacturers or brand owners selling products in non-biodegradable packaging materials are required to establish a system for collecting packaging waste generated from their production. Brand owners and marketing companies of sanitary napkins and diapers are encouraged to use recyclable materials in their products or provide a pouch or wrapper for each item's disposal. They are also responsible for educating consumers about their products' wrapping and disposal.[34]

Industrial Units: Towards Fuel Replacement and Waste-to-Energy

[29] Arvind K. Nema, S. R. Gupta, Solid Waste Management: A Case Study (2020).
[30] "Urban Planning and Public Health: A Critical Partnership", American Public Health Association, 2006
[31] Government Order No. 563/8-3-12-27 Misc./08 dated 02.03.2012
[32] "Zero Waste Home: The Ultimate Guide to Simplifying Your Life by Reducing Your Waste", Bea Johnson, 2013
[33] "Extended Producer Responsibility: A Materials Policy for the 21st Century", OECD,
[34] "Sustainable Solid Waste Management", Ni-Bin Chang, 2010

Industrial units using fuel and located within one hundred kilometers from a Refuse Derived Fuel (RDF) plant based on solid waste are mandated to replace at least five percent of their fuel requirement with the RDF produced, within six months from the notification of these rules.

Conclusion and Recommendations for Enhancing Urban Waste Management

The effective management of urban waste remains a significant challenge, necessitating the collaboration of various sectors in society. As elucidated above, multiple stakeholders, from the Housing & Urban Planning Department to private builders and manufacturers, play pivotal roles in waste management. Their concerted efforts form the backbone of a resilient and sustainable waste management system that strives to ensure a cleaner and healthier environment for all residents.

In consideration of the pivotal roles these entities play, it is vital to recognize the necessity for comprehensive strategies, continued improvement, and increased engagement among all stakeholders. Therefore, the following recommendations are proposed to bolster the urban waste management strategies in the outlined areas.

1. **Enhanced Inter-Sector Collaboration:** The success of urban waste management largely hinges on the effective cooperation between different sectors. This includes governmental bodies, development authorities, private builders, and industries. Fostering a culture of collaboration can facilitate the sharing of resources, ideas, and best practices, thereby optimizing waste management strategies[35].

2. **Strengthening Regulatory Compliance:** To guarantee compliance with essential guidelines such as Government Order No. 563/8-3-12-27 Misc./08, stricter regulatory oversight may be required. This might include regular audits and inspections to ensure adherence, in addition to penalties for non-compliance.

3. **Investment in Waste-to-Energy Infrastructure:** To further the goal of zero waste, increased investment in waste-to-energy plants should be considered. Not only can this help in waste reduction, but it also serves as a source of renewable energy, aligning with global sustainable development goals[36].

4. **Promotion of Extended Producer Responsibility (EPR):** The adoption of EPR by industries should be more widely advocated. By placing the burden of waste management back on the producer, it incentivizes businesses to design products that are less wasteful, more reusable, and easier to recycle[37].

5. **Empowerment and Education:** Empowering disadvantaged groups and educating consumers about waste management are instrumental in fostering a community-wide culture of waste reduction. Authorities could explore partnerships with non-profit organizations to run public education campaigns[38].

6. **Research and Development:** Ongoing research should be supported to develop innovative solutions and technologies for waste management. This could include more efficient waste-to-energy technologies, recyclable product alternatives, and novel waste segregation techniques.

[35] "A Review on Inter-Sectoral Collaboration in Urban Waste Management", Waste Management & Research Journal, 2018

[36] "Waste-to-Energy: A Review of the Status and Benefits in USA", Journal of Environmental Management, 2017

[37] "The Evolution of Extended Producer Responsibility: An Overview", Journal of Cleaner Production, 2014

[38] "The Role of Education in Waste Management: A Systematic Review", Journal of Environmental Education, 2020

The envisioned effective waste management system is a collective endeavour, demanding the commitment of diverse stakeholders. While the responsibilities may vary, the shared objective remains: to create sustainable cities where waste is systematically managed and resources are optimally utilized. By integrating these suggestions, stakeholders can significantly enhance their efforts, driving towards an environmentally friendly future that promises well-being for all urban residents.

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