

Status of waste plastics handling in India: voluntary and statutory perspectives

ABSTRACT

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This study aims to assess the status and effectiveness of plastic waste management in India from both voluntary and statutory perspectives. A documentary and descriptive approach was employed, combining qualitative analysis of regulatory milestones—from the Environment Protection Act of 1986 through the 2025 amendments to the Plastic Waste Management Rules—with quantitative extraction of waste-generation data from Central Pollution Control Board reports. Key findings include a 23 % increase in plastic waste generation between 2018–19 and 2020–21, with eight states accounting for 75 % of the national total, and the operationalization of Extended Producer Responsibility (EPR), which registered 3 Mt of obligations in FY 2022–23 with 2.5 Mt recycled. Despite 257 recycling plants nationwide, infrastructural gaps in urban sorting and reliance on an informal sector responsible for 70 % of PET recovery limit system efficiency. Technical challenges persist in processing multilayer packaging, and enforcement inconsistencies undermine regulatory credibility. Market projections estimate a USD 1.73 billion sector by 2025, highlighting investment opportunities in sorting, recycling technologies, and digital traceability. The study concludes that achieving circular-economy targets—such as 30 % recycling of multilayer plastics by 2027–28—will require chemical recycling, enhanced sorting infrastructure, and formalization of informal actors. Recommendations include expanding urban triage networks, adopting market-based EPR credit pricing, and integrating digital tools for material-flow monitoring.

KEYWORDS: Plastic Waste Management. Extended Producer Responsibility. Circular Economy. Recycling Infrastructure; Informal Sector.

INTRODUCTION

The concern with plastic waste management in India dates back to its participation in the United Nations Conference on the Human Environment, held in Stockholm in June 1972, whose main objective was to identify and implement measures aimed at protecting and improving the environment (Matos et al., 2016). In response to this international commitment, the Government of India promulgated in 1986 the Environment Protection Act, establishing regulations for the emission and disposal of environmental pollutants. This pioneering legal framework laid the groundwork for the development of specific standards for handling plastic waste, seeking to prevent risks to human health, biota, and material assets.

In recent decades, the steady increase in the generation of plastic waste in the country has been documented by reports from the Central Pollution Control Board (CPCB), which record a rise from 3.36 million tonnes in 2018–19 to 4.13 million tonnes in 2020–21. This significant growth not only highlights the high demand for plastic products in India but also underscores the urgency of strengthening collection, segregation, and recycling mechanisms to prevent ever-larger volumes of waste from being inappropriately released into the environment.

To confront this challenge, the Indian government has, at various times, implemented a set of progressively more comprehensive regulations. Notable among these are the Plastic Waste (Management and Handling) Rules of 2011, enhanced in 2016 to include guidelines for segregation and reduction of single-use plastics, and the subsequent amendments of 2018, 2021, and 2024, which instituted phased bans on single-use items, raised the minimum thickness of plastic bags, and granted legal force to the Extended Producer Responsibility (EPR) guidelines.

Although the regulatory framework has advanced significantly, gaps remain in implementation and institutional capacity: monitoring criteria vary between states; infrastructure and technology for recycling complex materials (such as multilayer packaging) are inadequate; and the incorporation of EPR guidelines still faces operational and market resistance. Moreover, the informal sector—responsible for approximately 70% of PET collection—plays a crucial role in the recycling chain, yet operates under precarious conditions and without sufficient regulatory support.

The general objective of this work is to examine the status of plastic waste management in India from both voluntary and statutory perspectives, identifying the main advances, challenges, and gaps in the application of management standards. The research question guiding this study is: Which voluntary and regulatory measures have proven most effective in managing plastic waste in India, and to what extent has their implementation achieved satisfactory results?

This article is organized as follows: it begins with this introduction, which contextualizes the work. Next, the theoretical framework is presented, outlining the main foundations of the research. This is followed by a description of the methodological procedures, materials, and methods used for data collection and analysis. Thereafter, the results concerning regulatory milestones and recycling practices are presented. Finally, the paper concludes with its contributions and suggestions for future research.

THEORETICAL FRAMEWORK

The theoretical framework that underpins the development of this research is presented below, addressing the key concepts related to urban solid waste management.

Institutional Framework and Operational Challenges of Urban Solid Waste Management in India

Urban solid waste management in India is governed by a multi-tiered institutional framework that includes the Central Pollution Control Board (CPCB), state pollution control boards, and urban local bodies (municipal corporations and municipalities). The National Action Plan for Municipal Solid Waste (NAPSWM) provides overarching guidelines, while the Swachh Bharat Mission (Clean India Mission) has injected substantial funding and political will since 2014 to improve collection, transportation, and disposal infrastructure. Municipalities are responsible for door-to-door collection and street sweeping, and they often outsource these services to private contractors under performance-based contracts. Despite this formal structure, the effectiveness of service delivery varies widely between cities, with megacities like Delhi and Mumbai achieving nearly 100% collection efficiency, whereas smaller towns struggle to reach 70% (Sharholly, Mahmood & Trivedi; 2008; Da Silva & Franz, 2025)

The informal sector plays a pivotal role in the recycling chain, recovering approximately 60–70% of recyclable materials, particularly high-value fractions such as PET and metals. Waste pickers and small aggregators (kabadiwalas) operate outside formal contracts but have developed extensive door-to-door networks and purchase centers, which provide a livelihood to an estimated 4–5 million people. Integrating these actors through cooperatives (e.g., SWaCH in Pune) has improved working conditions, data transparency, and material quality, but formal recognition and social protection benefits remain limited (Chikarmane & Narayan; 2005)

Transportation and logistics represent another significant bottleneck. After collection, waste is transported to transfer stations or directly to landfill sites, often over long distances due to the lack of decentralized processing facilities. Transfer stations intended to decongest city centers are underdeveloped in tier-2 and tier-3 cities, leading to increased vehicle emissions, road congestion, and higher operational costs. The success of integrated waste management in smart-city pilots (e.g., in Chandigarh) underscores the need for well-planned transfer infrastructure and real-time logistics management systems (Saha & Roy, 2011)

Landfilling remains the predominant disposal method, with over 70% of collected waste ending up in unmanaged dumps or engineered landfills that lack leachate treatment and gas-collection systems. Open dumpsites pose severe environmental and public health risks, including groundwater contamination and disease vectors. A handful of mechanized sanitary landfills—such as the Okhla facility near Delhi—illustrate best practices in environmental safeguards, but their high capital and operational costs limit wider adoption. Policy mandates requiring closure and remediation of legacy dumps are often delayed due to financial and administrative hurdles (Pattnaik & Reddy, 2010).

Financial sustainability of municipal waste services is undermined by low user fees, irregular revenue streams, and limited access to municipal bonds or green financing. Under the performance-linked incentive scheme of the Swachh Bharat Mission, municipalities can bid for grants by demonstrating improved service

levels, which has spurred investments in compactor vehicles and solar-powered street bins. Yet, less than 20% of urban local bodies have experimented with pay-as-you-throw or volume-based fee models, which international evidence suggests are critical for cost-recovery and waste reduction (Mor et al, 2006).

Looking ahead, India's transition toward a circular economy will depend on harmonizing formal and informal systems, expanding decentralized composting and biogas facilities to valorize organic waste (which constitutes over 50% of MSW by weight), and leveraging digital platforms for waste tracking and citizen feedback. Pilot projects employing blockchain-based traceability and IoT-enabled smart bins in select municipalities have shown promise in enhancing transparency and reducing contamination rates. Scaling these innovations requires cross-sectoral partnerships, rigorous impact evaluations, and alignment with national climate and resource-efficiency targets (Lamba, Kumar & Dhir, 2024).

METHODOLOGY

This study is characterized as documentary and descriptive research, as it was based on the systematic analysis of legal norms, official reports, and documents from sectoral entities. It adopted a mixed approach, predominantly qualitative in the interpretation of regulatory milestones and quantitative in the extraction of data on plastic waste generation. The research used exclusively secondary data, made available by government bodies (CPCB, Ministry of Environment) and sectoral associations (FICCI, ENF), without any primary data collection.

The information gathering involved identifying and collecting official documents related to plastic waste management in India, from the enactment of the Environment Protection Act (1986) to the most recent amendments to the Plastic Waste Management Rules (2025). Annual reports from the Central Pollution Control Board, containing historical time series of plastic generation, the regulations and their amendments (2011, 2016, 2018, 2021, 2024, and 2025), and scenario studies such as FICCI's white paper and the ENF Recycling Industry Directory were considered. Below is a table summarizing the main documents analyzed.

Data processing encompassed two fronts: (a) extraction of annual plastic waste generation values and their temporal evolution, carried out by reading the historical series in the CPCB reports; and (b) content analysis of the regulations and guidelines (Rules from 2011 to 2025, EPR provisions, bag thickness requirements, single-use bans), identifying objectives, scope, implementation mechanisms, and changes over time. Quantitative data were organized into spreadsheets to identify trends, while legal documents were categorized according to their nature (voluntary or statutory) and thematic scope.

Tabel 1 - Summary of Key Documents Analyzed

Document	Description	Year
Environment Protection Act	Basic law for the protection and improvement of the environment	1986
Environment (Protection) Rules	Regulation of emission standards and compliance procedures	1986

Plastic Waste (Management and Handling) Rules	First specific rules for the scientific management of plastic waste	2011
Plastic Waste Management Rules	Expanded revision, emphasizing segregation, recycling, and reduction of single-use plastics	2016
Amendments to the PWM Rules (single-use phase-outs, EPR, bag thickness)	Phased bans and strengthening of Extended Producer Responsibility (EPR)	2018; 2021; 2024; 2025
CPCB Annual Reports	Quantitative data on annual plastic waste generation	2018–19 to 2020–21
FICCI White Paper on PWM Compliance	Sectoral analysis of industry challenges in meeting recycling obligations	2025
ENF Recycling Industry Directory	Global registry of recycling plants and processing capacity	—

Source: created by the author (2025).

DEVELOPMENT RESULTS AND DISCUSSION

A seguir, serão discutidos os principais resultados dessa pesquisa.

Trend in Plastic Waste Generation in India

The analysis of the Central Pollution Control Board (CPCB) annual reports reveals a continuous increase in the volume of plastic waste generated in India. Between fiscal years 2018–19 and 2020–21, it rose from 3,360,043 tonnes to 4,126,997 tonnes, representing an increase of approximately 23% in just two years. However, when the temporal scope is expanded, generation fluctuates: in 2016–17 it reached 1,568,714 tonnes, dropped to 660,787 tonnes in 2017–18, before resuming a strong upward trend in 2018–19. These figures suggest variations that may reflect methodological changes in data collection and reporting, as well as a genuine rise in plastic product consumption.

Table 2 - Presents the historical series from 2016–17 to 2020–21, highlighting the jump between 2017–18 and 2018–19 and the continuous growth through 2020–21.

Year	Generation (t)
2016–17	1,568,714
2017–18	660,787
2018–19	3,360,043
2019–20	3,469,780
2020–21	4,126,997

Source: created by the author (2025).

At the state level, just eight federal units accounted for approximately 75% of the national total in 2020–21. Telangana led with 472,675 t (11.5%), followed by Tamil Nadu (10.4%), West Bengal (10.1%), and Uttar Pradesh (9.1%). In contrast, twenty-

one states and territories together represented only 10%, indicating underreporting or lower per-capita generation in less densely urbanized regions.

Table 3 - Plastic Waste Generation by State/UT in 2020–21

State/UT	Generation 2020–21 (t)	% of National Total
Telangana	472,675	11.5%
Tamil Nadu	430,107	10.4%
West Bengal	417,925	10.1%
Uttar Pradesh	375,95	9.1%
Karnataka	368,08	8.9%
Delhi NCR	345	8.4%
Gujarat	337,694	8.2%
Maharashtra	311,254	7.5%
Others (27)	1,065,314	24.9%

Source: created by the author (2025).

In absolute terms, it is estimated that daily generation reaches approximately 26,000 tonnes, totaling 9.5 million tonnes per year. This level places India among the world’s largest producers of plastic waste, necessitating an immediate expansion of management and recycling capacity. Finally, it is worth noting that, although generation data are essential, the recycling rate reported by the CPCB reached only about 60% of the total volume (with 90% PET recovery). This discrepancy between generation and effective recycling highlights critical gaps in collection, sorting, and processing infrastructure, underscoring the need for structural investments to accommodate the continuous increase in plastic waste.

Evolution of the Regulatory Framework

The regulatory framework for plastic waste management in India began in 2011 with the promulgation of the Plastic Waste (Management and Handling) Rules, 2011, which established the first obligations for generator registration and guidelines for source segregation, laying the foundation for a scientific approach to plastic waste management. In 2013, the Central Pollution Control Board published the report “Overview of Plastic Waste Management,” aiming to formalize procedures and consolidate the basis for subsequent regulations. In 2016, the rule was replaced by the Plastic Waste Management Rules, 2016, formally introducing Extended Producer Responsibility (EPR), which assigned producers, importers, and brand owners (PIBOs) responsibility for the entire life cycle of plastic packaging.

The amendments of 2018, 2021, and 2024 progressively strengthened the regime by instituting phased bans on single-use items (such as thin plastic bags and expanded polystyrene) and raising the minimum bag thickness requirement from 50 µm to 75 µm as of 30 September 2021, and subsequently to 120 µm on 31 December 2022. These changes reflected a strategy to discourage the

consumption of low-durability disposable plastics, in addition to giving legal force to the EPR guidelines established in 2016.

On 4 December 2024, the resolution operationalizing EPR for plastic packaging came into effect, consolidating collection and recycling targets and instituting penalties for non-compliance. In January 2025, the Plastic Waste Management (Amendment) Rules, 2025 introduced new labeling requirements—using barcodes, QR codes, or unique identification numbers—and recycled content obligations, enhancing packaging traceability and ensuring greater transparency in meeting EPR targets. These technological innovations aim to optimize monitoring and advance progress toward a truly circular economy.

Operationalization of Extended Producer Responsibility (EPR)

Since its incorporation into the Plastic Waste Management Rules, 2016, EPR has become the cornerstone of India's plastic waste management policies by shifting post-consumer cost burdens onto Producers, Importers, and Brand Owners (PIBOs). For fiscal year 2022–23, the Central Pollution Control Board reported EPR obligations totaling approximately 3 million tonnes, of which 2.5 million tonnes were effectively recycled and certified—demonstrating significant progress in system implementation, albeit still insufficient relative to total generation.

The availability of high-quality post-consumer feedstock is the primary barrier to full EPR effectiveness. Collection relies heavily on the informal sector—comprising waste pickers and small recyclers responsible for 70% of PET recycling—estimated to collect between 6.5 and 8.5 million tonnes of plastic annually, with recovery rates of 50% to 80% of the material gathered. However, the lack of technical standards and adequate working conditions compromises both material quality and traceability, directly impacting PIBOs' ability to meet their recycled content targets.

FICCI's 2025 white paper indicates that full enforcement of EPR obligations will not occur until FY 2025–26, creating a transitional window for the sector but also risks of unused recycling credits accumulating and market uncertainty around certificates. This timeframe underscores the need to strengthen monitoring mechanisms and to support the expansion of sorting and recycling infrastructure, in order to prevent bottlenecks and ensure that extended responsibility targets are met continuously and transparently.

Recycling Infrastructure Capacity and Typology

According to the ENF Recycling Industry Directory, one of the largest global catalogs of recycling companies, there are 257 plants dedicated to processing plastic waste across India. This network ranges from small-scale operations to large industrial facilities, reflecting the diversity of capacities and technologies available in the country.

In the state of Andhra Pradesh—formerly part of a single larger state—51 plastic waste processing units have been established, encompassing all four categories defined by the 2016 rules (I through IV). The capacity of these plants varies from a few dozen tonnes per year to hundreds of thousands of tonnes annually, demonstrating significant heterogeneity in production scale.

Table 4 - Recycling Infrastructure Capacity and Typology

Item	Quantity
Total recycling plants in India	257
Units in Andhra Pradesh	51
Packaging categories (I–IV)	4

Source: created by the author (2025).

The division into four categories—I: rigid; II: flexible; III: multilayer; IV: compostable—aims to establish specific collection and processing targets according to the material’s characteristics. In particular, the processing of multilayer packaging (Category III) requires advanced separation equipment, which limits the full recovery of this waste stream.

However, despite the nominal installed capacity, urban collection and sorting infrastructure remain insufficient, creating bottlenecks in the delivery of clean material to recycling plants. According to the FICCI report, deficiencies in collection, segregation, and pre-processing of waste compromise operational efficiency and reduce the effective plastic recovery rate. This logistical gap demands the expansion of sorting centers and the improvement of reverse-supply chains so that the installed capacity can be fully utilized.

Role of the Informal Sector

The informal recycling sector—composed predominantly of waste pickers and small-scale recyclers—is responsible for collecting 6.5 to 8.5 million tonnes of plastic waste per year, supporting about 70% of India’s PET recycling stream. These workers play a crucial role by diverting a substantial volume of material that would otherwise end up in landfills or waterways, thereby contributing to the immediate mitigation of environmental impacts.

However, this activity is carried out under precarious conditions, without personal protective equipment (PPE) and without any formal recognition or legal support. The absence of specific regulations for this segment entails health risks (exposure to toxic substances and accidents) and environmental risks (soil and water contamination), as well as compromises the quality of recyclable inputs delivered to industry, which depend on clean, properly sorted feedstock.

To overcome these barriers, it is urgent to implement formalization and training programs for waste pickers, which could:

- Establish legally recognized cooperatives or associations, ensuring access to social benefits and credit.
- Provide training in waste segregation, safe handling, and reverse-logistics practices.
- Supply PPE and minimum infrastructure (e.g., sorting sheds) to improve working conditions and the quality of collected material.
- Integrate the informal sector into official EPR systems, ensuring fair compensation and traceability of material flows.

Such initiatives would not only improve the efficiency and reliability of the recycling chain but also promote social and environmental inclusion, aligning plastic waste management with principles of sustainability and social justice.

Technical and Operational Challenges

The recycling of multilayer packaging (Category III) exhibits low technical viability, as the mechanical separation of different polymers requires specialized, high-cost equipment. A large portion of this waste stream continues to be sent to landfills or co-processed in cement kilns, underutilizing the recovery potential of these materials. Moreover, current regulations do not recognize paper mills that recycle multilayer packaging as Plastic Waste Processors (PWPs), limiting recycling credits and compliance with the 30% recycling target for multilayer materials.

The strategy of increasing the minimum thickness of plastic bags—from 50 microns to 75 microns in September 2021 and to 120 microns in December 2022—aimed to discourage rapid disposal and encourage reuse. However, inconsistent enforcement allows substandard bags (< 40 microns) to remain in circulation in some states, revealing failures in local governance and uniform application of the rules. The persistence of these practices undermines both environmental objectives and the credibility of the regulatory framework.

Additionally, sorting and transportation infrastructures are insufficient to operate at a national scale, especially in remote areas. Although there are 257 recycling plants distributed across India, their geographic concentration creates logistical bottlenecks: processing centers do not receive adequate volumes of clean material due to the lack of sorting centers and efficient reverse-logistics systems. To maximize the effective plastic recovery rate, it is essential to expand the urban sorting network, integrate the informal sector, and strengthen coordination between local authorities and logistics operators.

Economic and Market Impacts

The plastic waste management market in India is projected to reach USD 1.73 billion by 2025, according to FICCI estimates, highlighting substantial investment opportunities in recycling technologies, the establishment of sorting centers, and reverse-logistics solutions. This figure reflects not only the increasing volume of waste to be processed but also the potential for economic value creation through the recycling chain.

However, the pricing of EPR credits—currently set by mandatory price-fixing—has drawn industry criticism. FICCI’s white paper notes that this practice may artificially inflate compliance costs and discourage the generation of surplus recycling, recommending the adoption of a market-based model driven by supply and demand to make the system more competitive and flexible.

Finally, the adoption of QR codes and digital tracking systems emerges as a strategic tool to reduce monitoring costs and enable more agile audits, minimizing fraud and strengthening confidence in the recycling-certificate market. The industry advocates voluntary use of these codes for packaging labels, which would facilitate material-flow monitoring and verification of recycled-content targets. These market innovations, combined with well-calibrated regulatory policies, are crucial to transforming the challenge of plastic waste into opportunities for sustainable growth and reinforcing the circular economy in India.

State Initiatives and Examples of Best Practices

The state of Telangana stands out for driving applied innovation in plastic waste management through the Research and Innovation Circle of Hyderabad (RICH), launched in 2017 to deepen collaboration among research institutions, the private sector, startups, and government. This initiative operates in the Life Sciences, Food & Agriculture, and Sustainability sectors, promoting strategic partnerships, pilot projects, and engagement in public policy aimed at generating scalable solutions with positive environmental impact.

In parallel, Telangana has invested in waste-to-energy (WTE) infrastructure: in November 2020, Re Sustainability inaugurated a 19.8 MW plant in Jawahar Nagar, Hyderabad—later expanded to 24 MW—that processes between 1,300 and 1,500 tonnes of waste per day under a collaborative model involving the company, the power distributor, CPCB, and the local municipality. This project exemplifies the technical and economic viability of public–private partnerships to reduce landfill waste volumes and generate clean energy.

The state of Andhra Pradesh, in turn, established a network of 51 registered recycling plants covering the four packaging categories defined by the 2016 PWM Rules, with capacities ranging from tens to hundreds of thousands of tonnes per year. This diversified network demonstrates the adoption of integrated regional collection and processing practices, serving as a reference for other states seeking to replicate efficient management models tailored to local specificities.

In both cases, it is evident that innovation clusters (such as RICH) and public–private partnerships (in WTE implementation and support for recycling facilities) accelerate the diffusion of advanced technologies, strengthen local value chains, and promote a faster transition to a circular economy by aligning environmental and socioeconomic objectives.

Future Perspectives

The growing regulatory ambition to establish a circular economy is reflected in the EPR targets, which stipulate achieving 30% recycling for multilayer packaging by 2027–28. To meet this goal, investment in chemical recycling technologies—capable of converting mixed plastics into high-quality materials and overcoming the limitations of conventional mechanical processes—will be essential.

Moreover, projections indicate that recycling capacity could increase from 9.9 million tonnes in 2023 to 23.7 million tonnes in 2032, driven by advances in mechanical and chemical methods as well as the entry of new market participants. Such growth will require expanding urban sorting networks, including the creation of dedicated centers for separation and preparation of clean feedstock to ensure a continuous supply of raw material to industrial plants.

Finally, formalizing and training the informal sector, combined with public education campaigns on source segregation, could yield substantial efficiency gains in the recycling chain. Integrating waste pickers into regulated cooperatives, alongside the use of digital tools to monitor material flows, will support the achievement of the environmental and socioeconomic targets set for 2025 and beyond.

Below is a summary table of the main findings of this research, extracted directly from the report “Status of Waste Plastics Handling in India: Voluntary and

Statutory Perspectives.” Each item highlights a central aspect, its implications, and supporting data.

Table 5 - Summary of Key Research Findings

Finding	Description
Increase in plastic waste generation	Growth from 3.36 Mt in 2018–19 to 4.13 Mt in 2020–21 ($\approx 23\%$ in 2 years), with fluctuations in 2016–18 that may reflect methodological changes in reporting.
Regional concentration	Eight states (Telangana, Tamil Nadu, West Bengal, Uttar Pradesh, Karnataka, Delhi NCR, Gujarat, Maharashtra) accounted for $\approx 75\%$ of waste in 2020–21, while 21 units together represented only 10% of the national total.
Regulatory evolution	Since the Plastic Waste Rules of 2011, through the 2016 revision (introduction of EPR) and the 2018, 2021, 2024, and 2025 amendments, a progressively stricter framework was created: bans on disposable items, increased bag thickness, and labeling requirements.
EPR operationalization	For FY 2022–23, ≈ 3 Mt of obligations were registered and 2.5 Mt of certificates were issued, but reliance on the informal sector (70% of PET collection) compromises material quality.
Recycling infrastructure	There are 257 recycling plants nationwide (ENF Directory) and 51 in Andhra Pradesh, but a lack of urban sorting centers creates logistical bottlenecks in delivering clean feedstock to the facilities.
Informal sector	Waste pickers and small recyclers collect 6.5–8.5 Mt/year, but work under precarious conditions and without formal recognition, posing health risks and compromising feedstock traceability.
Technical challenges	Multilayer packaging has low mechanical separation viability and high chemical recycling costs; inconsistent enforcement allows bags below the 120 μm minimum thickness to remain in circulation.
Market impacts	The waste management market is projected at USD 1.73 billion in 2025 (FICCI); industry questions mandatory EPR credit pricing and proposes a supply-and-demand model; digitalization (QR codes) could improve enforcement.
State best practices	In Telangana, the RICH innovation cluster and a 24 MW WTE plant processing 1,300–1,500 t/day; in Andhra Pradesh, 51 plants covering four packaging categories.
Future perspectives	Targets of 30% multilayer recycling by 2027–28 will require chemical recycling, expanded urban

sorting, and formalization of the informal sector alongside public education campaigns.

Source: created by the author (2025).

CONCLUSION

This study began with the need to understand the landscape of plastic waste management in India from a dual perspective—voluntary and statutory—as established in the report “Status of Waste Plastics Handling in India: Voluntary and Statutory Perspectives.” The historical context, initiated by the 1972 Stockholm Conference and materialized with the enactment of the Environment Protection Act of 1986, provided the background for assessing normative and operational developments over recent decades.

The central objective was to examine how legal guidelines and practical initiatives have shaped plastic waste management, identifying advances, gaps, and challenges. To this end, official documents (laws, amendments, CPCB reports) and sectoral studies (FICCI white paper, ENF Directory) were analyzed using a documentary and descriptive approach based on secondary data. This combination allowed the integration of quantitative evidence on waste generation and recycling with a qualitative assessment of regulatory and market structures.

Among the main findings was the increase in waste generation from 3.36 Mt (2018–19) to 4.13 Mt (2020–21)—a 23% jump in two years—and the concentration of 75% of that volume in just eight states, highlighting regional disparities. The progressive tightening of regulations was also observed, from the Plastic Waste Rules of 2011 through the 2025 amendments, incorporating EPR, phased bans on disposable items, increased bag thickness, and digital labeling.

Regarding infrastructure, India has 257 recycling plants and 51 units in Andhra Pradesh but lacks sufficient urban sorting centers and efficient reverse-logistics systems, creating bottlenecks in supplying clean feedstock to industrial facilities. The informal sector, responsible for approximately 70% of PET collection, operates under precarious conditions and without adequate regulation, affecting material quality and posing health and environmental risks.

Limitations of this research stem from the documentary analysis, which did not allow the evaluation of local effectiveness of implemented actions nor capture qualitative nuances of the informal waste pickers’ experiences. Finally, long-term studies on chemical recycling technologies and their economic impact remain limited.

In practical terms, there is an urgent need to expand investments in sorting, chemical recycling, and digitalization (e.g., QR codes) for packaging traceability. Formalizing and training the informal sector emerge as crucial measures to ensure high-quality feedstock for processors while promoting social inclusion. Regulators and industry should also move toward a market-based model for EPR credits, driven by supply and demand, to increase competitiveness and reduce compliance costs.

For future research, in-depth investigation into the technical and economic feasibility of advanced chemical recycling technologies at industrial scale is recommended, as are regional case studies evaluating the effectiveness of state-level initiatives (e.g., WTE plants in Telangana). It is equally important to conduct qualitative research with informal-sector actors to develop formalization policies that consider their needs and contributions.

In conclusion, although India has made notable regulatory and practical advances toward a circular economy, significant structural and operational challenges remain. Strengthening urban sorting networks, expanding technological capacities, and socially integrating the informal sector are imperatives for meeting recycling targets and ensuring the country's environmental and socioeconomic sustainability.

Status do manejo de resíduos plásticos na Índia: perspectivas voluntárias e legais

ABSTRACT

Este estudo tem como objetivo avaliar a situação e a eficácia da gestão de resíduos plásticos na Índia sob perspectivas tanto voluntárias quanto legais. Adotou-se uma abordagem documental e descritiva, combinando análise qualitativa de marcos regulatórios — do Environment Protection Act de 1986 até as emendas de 2025 às Plastic Waste Management Rules — com extração quantitativa de dados de geração de resíduos dos relatórios do Central Pollution Control Board. As principais conclusões incluem um aumento de 23% na geração de resíduos plásticos entre 2018–19 e 2020–21, com oito estados respondendo por 75% do total nacional, e a operacionalização da Responsabilidade Estendida do Produtor (REP/EPR), que registrou 3 Mt de obrigações no ano fiscal de 2022–23, com 2,5 Mt efetivamente recicladas. Apesar da existência de 257 plantas de reciclagem em todo o país, lacunas de infraestrutura na triagem urbana e a dependência de um setor informal responsável por 70% da recuperação de PET limitam a eficiência do sistema. Persistem desafios técnicos no processamento de embalagens multicamadas, e inconsistências na fiscalização comprometem a credibilidade regulatória. Projeções de mercado estimam um setor de USD 1,73 bilhão até 2025, destacando oportunidades de investimento em triagem, tecnologias de reciclagem e rastreabilidade digital. O estudo conclui que atingir metas de economia circular — como 30% de reciclagem de plásticos multicamadas até 2027–28 — exigirá reciclagem química, aprimoramento da infraestrutura de triagem e formalização dos atores informais. As recomendações incluem expandir redes urbanas de triagem, adotar precificação de créditos de REP baseada no mercado e integrar ferramentas digitais para monitoramento do fluxo de materiais.

KEYWORDS: Gestão de Resíduos Plásticos. Responsabilidade Estendida do Produtor. Economia Circular. Infraestrutura de Reciclagem. Setor Informal.

REFERÊNCIAS

- Central Pollution Control Board. (2013). *Overview of Plastic Waste Management*. Central Pollution Control Board.
- Central Pollution Control Board. (2019). *Annual Report 2018–19*. Central Pollution Control Board.
- Central Pollution Control Board. (2020). *Annual Report 2019–20*. Central Pollution Control Board.
- Central Pollution Control Board. (2021). *Annual Report 2020–21*. Central Pollution Control Board.
- da Silva, C. L., & Franz, N. M. (2025). A Framework for Public Policy Development in BRICS Countries to Support Circular Economy Development in the WEEE Value Chain. *Recycling*, 10(1), 7. <https://doi.org/10.3390/recycling10010007>
- Chikarmane, P., & Narayan, L. (2005). Organising the unorganised: A case study of the Kagad Kach Patra Kashtakari Panchayat (trade union of waste-pickers). Pune: KKP KP.
- ENF. (2025). *Recycling Industry Directory*. ENF.
- Federation of Indian Chambers of Commerce and Industry. (2025). *White paper on plastic waste management compliance*. FICCI.
- Government of India. (1986a). *The Environment Protection Act, 1986* (Gazette of India, S.O. 844(E)). Ministry of Environment, Forest and Climate Change.
- Government of India. (1986b). *The Environment (Protection) Rules, 1986*. Ministry of Environment, Forest and Climate Change.
- Lamba, H. K., Kumar, N. S., & Dhir, S. (2024). Circular economy and sustainable development: a review and research agenda. *International Journal of Productivity and Performance Management*, 73(2), 497-522.
- MATOS, A. C. et al. Quadro político, jurídico e técnico da gestão dos resíduos sólidos nos países do BRICS. *R. Tecnol. Soc.*, Curitiba, v. 12, n. 26, p. 155-160, set./dez. 2016. Disponível em: <https://periodicos.utfpr.edu.br/rts/article/view/4568>.
- Ministry of Environment, Forest and Climate Change. (2011). *Plastic Waste (Management and Handling) Rules, 2011*. Gazette of India.
- Ministry of Environment, Forest and Climate Change. (2016). *Plastic Waste Management Rules, 2016*. Gazette of India.
- Ministry of Environment, Forest and Climate Change. (2018). *Plastic Waste Management (Amendment) Rules, 2018*. Gazette of India.

Ministry of Environment, Forest and Climate Change. (2021). *Plastic Waste Management (Amendment) Rules, 2021*. Gazette of India.

Ministry of Environment, Forest and Climate Change. (2024). *Plastic Waste Management (Amendment) Rules, 2024*. Gazette of India.

Ministry of Environment, Forest and Climate Change. (2025). *Plastic Waste Management (Amendment) Rules, 2025*. Gazette of India.

Mor, S., Ravindra, K., De Visscher, A., Dahiya, R. P., & Chandra, A. (2006). Municipal solid waste characterization and its assessment for potential methane generation: a case study. *Science of the Total Environment*, 371(1-3), 1-10.

Pattnaik, S., & Reddy, M. V. (2010). Assessment of municipal solid waste management in Puducherry (Pondicherry), India. *Resources, Conservation and Recycling*, 54(8), 512-520.

Re Sustainability Pvt. Ltd. (2020). *Commissioning report: Jawahar Nagar waste-to-energy plant*. Re Sustainability.

Research and Innovation Circle of Hyderabad. (2017). *Launch of RICH initiative*. Government of Telangana.

Saha, S., & Roy, T. B. (2011). Assessment of the status of solid waste management in mega cities in India: An Overview. *International Journal of Agriculture, Environment and Biotechnology*, 4(4), 305-315.

Sharholly, M., Ahmad, K., Mahmood, G., & Trivedi, R. C. (2008). Municipal solid waste management in Indian cities—A review. *Waste management*, 28(2), 459-467.

Sharma, A., & Chari, K. R. (2025). *Status of waste plastics handling in India: Voluntary and statutory perspectives* (Unpublished report).

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