

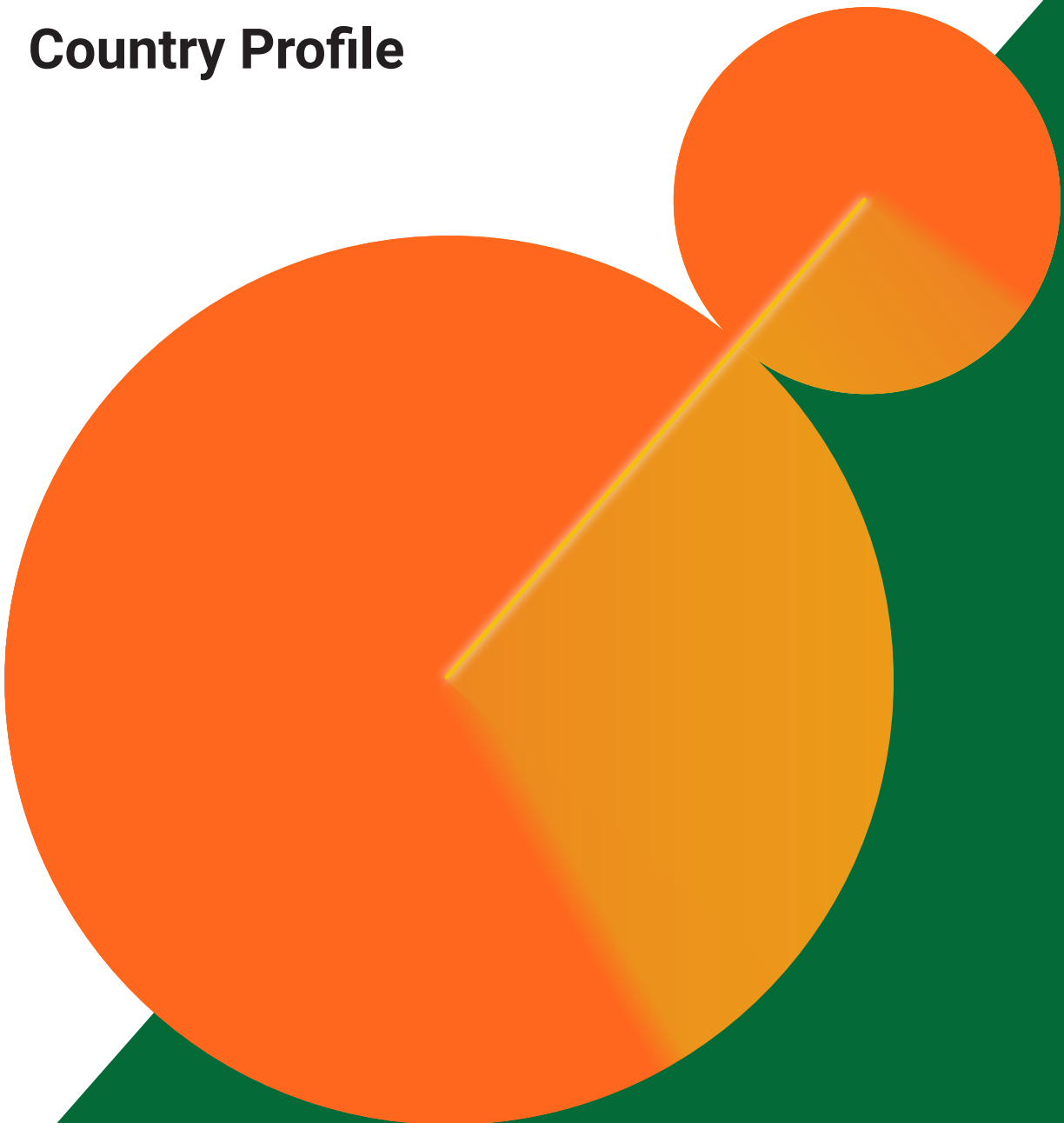
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PLASTIC POLICIES IN INDIA

Country Profile



Acknowledgements

This Country Profile on plastic policies in India was prepared on behalf of the EU SWITCH-Asia Policy Support Component (PSC) by Ms. Maro Luisa Schulte and Dr Per-Olof Busch under the supervision of Ms. Cosima Stahr and Dr Zinaida Fadeeva, Team Leader, SWITCH-Asia Policy Support Component.



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Abbreviations

BIS	Bureau of Indian Standards
CAGR	Compound annual growth rate
CPCB	Central Pollution Control Board
CSIR NEERI	Council of Scientific & Industrial Research – National Environmental Engineering Research Institute
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DFRL	Defence Food Research Laboratory
DRDO	Defence Research and Development Organisation
EA	Earth Action
EPR	Extended producer responsibility
FMCG	Fast-moving consumer goods
MSW	Municipal solid waste
NITI Aayog	National Institution for Transforming India
PWM	Plastic waste management
RDF	Refuse-derived fuel
SBM	Swachh Bharat Mission
SUP	Single-use plastics
SWM	Solid waste management
TERI	The Energy and Resources Institute
ULBs	Urban local bodies
UNDP	United Nations Development Programme

1. Context

Estimates suggest that India generated over 10,829,000 tonnes of plastic waste in 2023, resulting in 7.6 kg of plastic waste per capita (Figure 1). This amount is significantly less than one-fourth of the global average for waste (31.9 kg), and less than half the average in countries that are covered by the SWITCH Asia programme (20.1 kg) (EA 2024). Of the generated plastic waste, a total of almost 7,430,000 tonnes, or nearly 70%, is mismanaged. Per capita, this is slightly more than 5,2 kg of plastic waste that is mismanaged. The share of mismanaged plastic waste is thus less than half of the global average of 12.5 kg per capita, and the average of 12.2 kg per capita in countries where the SWITCH Asia programme is active (EA 2024). In absolute terms, given its large population, these relatively low per Capita figures still result in India being the country with the highest amount of mismanaged plastic waste today, in a scenario of growing plastics production.

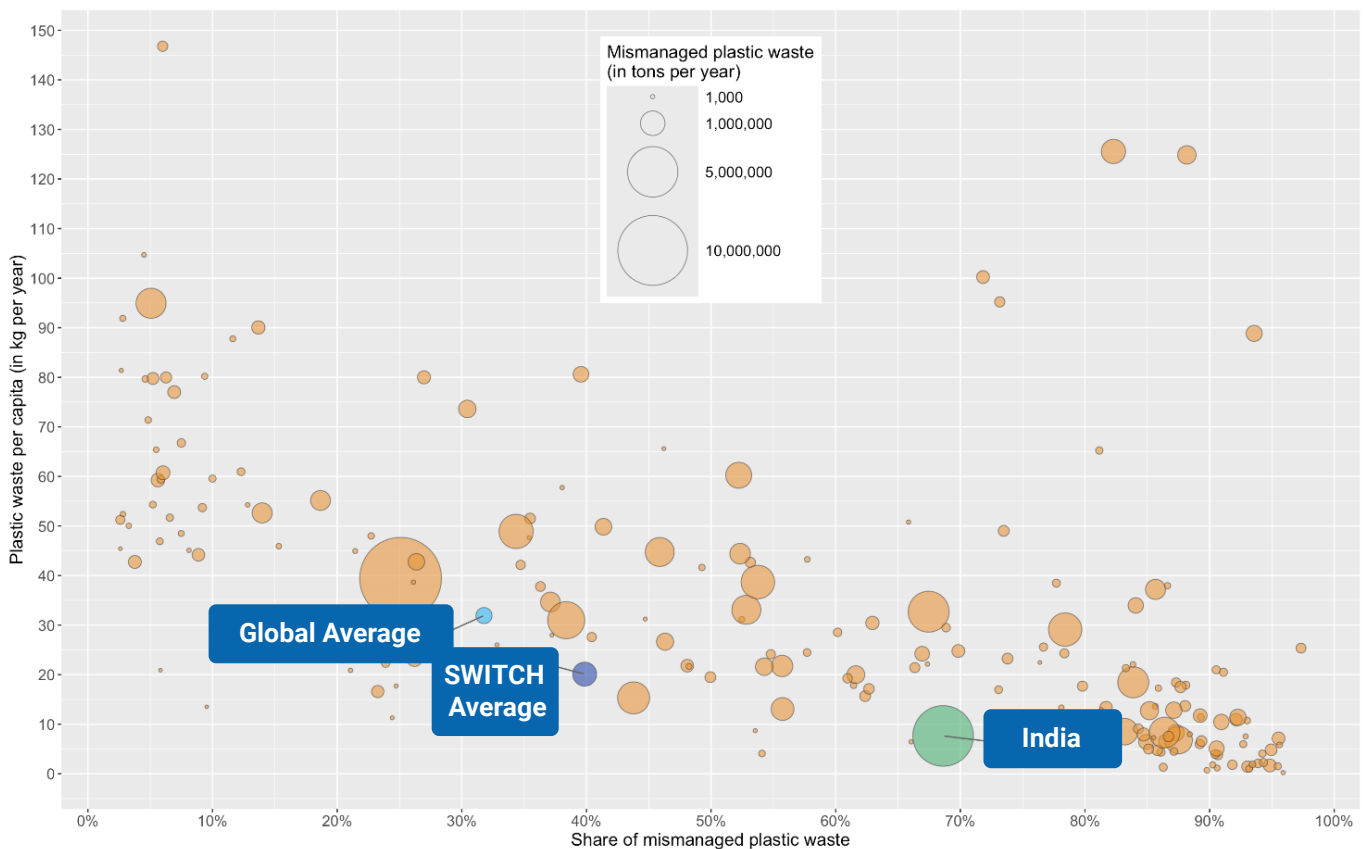


Figure 1. Plastic waste in India in 2023

Source: Earth Action 2024 data

Rank of India in global comparison (out of 192)	
Plastic waste in metric tonnes	190
Plastic waste per capita (kg/year)	38
Mismanaged plastic waste in metric tonnes	191
Mismanaged plastic waste per capita (kg/year)	61
Share of mismanaged plastic waste	104

India's plastic industry is a significant contributor to the country's economy and is currently experiencing substantial growth. The market size of this sector has been estimated to be USD 46.48 billion in 2024, with projections indicating it will reach USD 52.72 billion by 2029. These estimates represent a compound annual growth rate (CAGR) of over 6.5% during the forecast period of 2024–2029, demonstrating the industry's robust expansion (Mordor Intelligence 2024). Another source estimates that the Indian plastic market will grow from USD 45.7 billion in 2019 to reach USD 73.4 billion by 2025, indicating an even more optimistic CAGR of 8.49% (6Wresearch 2023). While the specific contribution to India's GDP could not be identified by the authors, substantial market size and growth rate suggest that the plastic industry plays a crucial role in the nation's economic development. The importance of the Indian plastic market is further underscored by its influence on various end-use markets such as automotive, electronics, and construction (OMR Global 2022), and is driven by a growing appetite for consumer products, the expanding need for both packaging solutions and governmental policies aimed at improving public health through improved sanitation and hygiene standards (6Wresearch 2023). While more than half of the plastics consumed in India are used by the packaging sector, the second largest plastics-user is the building and construction sector, followed by agriculture and the automotive sector (Hossain et al. 2022).

It is worth noting that the plastic industry in India has shown strong growth in the past as well. Between 2010 and 2015, the industry experienced a compound annual growth rate (CAGR) of 10% in volume, with production increasing from 8.3 million metric tonnes (MMTPA) per annum in 2010 to 13.4 MMTPA in 2015 (Centre for Financial Accountability 2022).

The market structure of the Indian plastic industry has become more and more fragmented in recent years (2017–2022). It is now estimated to be moderately competitive, with a mix of large corporations as well as small and medium-sized enterprises (SMEs), as is indicated by the Herfindahl-Hirschman Index (HHI) that moved from 2,689 in 2017 to 1,570 in 2022 (6Wresearch 2024).¹

Plastic-related trade data corroborates the important role of the plastic industry for the country's economy. In 2022, India's overall trade volume of plastic-related products and goods amounted to USD 64.8 billion, equal to 5.5% of the country's total trade volume in products and 2.3% of the global trade volume, according to UNCTAD data. India is a net importer of plastic-related goods and products, with a negative trade balance of almost USD 16.8 billion in 2022 (Figure 2). Imports consisted mainly of plastics in primary forms (worth almost USD 18.64 billion) and additives used in plastics (worth USD 7.15 billion), which together amounted to almost 63% of India's total imports. If all feedstocks and precursors used in plastics in India (USD 4.5 billion) are added to intermediate forms of plastics used (USD 4.3 billion), i.e. all the ingredients used to produce manufactured plastic products, the total represents 90% of all plastics related imports in the country. If such high quantities of imported feedstocks are required, the conclusion can be drawn that India has a very large plastics manufacturing industry. The question remains whether this industry is producing plastic for the foreign or the domestic market. Indeed, the only two product categories where India shows a positive trade balance are intermediate manufactured goods (USD 0.7 billion) and final manufactured goods (USD 4.1 billion). Since these balances are small compared to the overall trade balance for virgin plastics and the required additives, it can be assumed that plastic production in India is targeting domestic demand, an assumption corroborated by the export volumes in these two categories, which reach only USD 2.8 billion and USD 8.1 billion, respectively (UNCTAD).

One particular sub-sector of the plastics industry is the bioplastic industry in India, which is experiencing significant growth and attracting considerable attention due to increasing environmental awareness and the need for seemingly sustainable alternatives to traditional plastics. Older sources in 2020 suggested a CAGR of 23.91% in this sector, projecting the market to reach USD 754.7 million by 2025 (Research and Markets 2020). As of 2023, the Indian bioplastics market was estimated at a value of USD 447.3 million. In the coming years, the sector is projected to undergo continued upward growth. According to market forecasts, the Indian bioplastics market is expected to reach USD 1.81 billion by 2030, reflecting a CAGR of 22.1% (Maximize Market Research 2024).

¹ The HHI is a measure used to determine the level of market concentration and competition within an industry.



Figure 2. Plastic-related trade in India in 2022

Source: UNCTAD data

The rapid growth of the bioplastics industry in India can be attributed to several factors. There is an increasing environmental consciousness among both consumers and businesses that is driving the demand for sustainable alternatives to conventional petrochemical-based plastics (Knowledge Sourcing Intelligence 2022). Bioplastic derived from renewable biomass sources such as plants is perceived as an eco-friendlier option, even though there are currently no criteria² for whether a product made from bioplastics will biodegrade in the environment, or only under specific artificial conditions (Maximize Market Research 2024). And the term ‘bioplastic’ can be misleading to consumers, who may assume that these substances are environmentally friendly and will break down into harmless or compostable matter, even though there is no evidence for this. Some bio-based plastics such as bio-PE have the same chemical structure as their fossil-based counterparts and do not biodegrade, and they contribute to plastic pollution if not properly managed. This fact holds true even for those bioplastics that are marketed ‘biodegradable’. In order to break down, these bioplastics require specific conditions, such as temperatures higher than ~60° C, oxygen, and a level of humidity that can be guaranteed only in a composting facility. In landfills such conditions are difficult to achieve. At the same time, depending on the feedstock used for production, bio-based plastics might cause deforestation, loss of biodiversity and/or lead to competition with food production. While some countries invest in and heavily rely on the production and use of bioplastic (which can also include fossil-based but degradable plastics), others, such as Australia, France and Taiwan have banned several types of bioplastics (ADB 2023). In its latest amendment to the existing plastic waste management rules (2024), India will aim to enforce stricter standards for biodegradable plastics (see the latest **Plastic Waste Management Amendment Rules 2024** under 2.2.2, below).

² See attempted differentiation between bioplastics and biopolymers here: <https://biobiz.in/s/opp/bioplastics-biopolymers-indian-market-scenario>

2. Policy landscape

2.1. Overview: basic legislation and institutions

The waste management policy landscape in India has a long, rich history of binding laws, regulations, and procedures that have addressed waste management in general, and more recently the specific issues linked to plastic pollution. Table 1 gives an overview of the relevant policies and roadmaps that aim at preventing plastic pollution, including command-and-control measures, provisions for market-based measures, and information requirements.

The following **nationwide policies** are established in India and will be described in more detail in section 2.2:

1. 'Umbrella' Law: Environment (Protection) Act 1986
2. Environment Protection Rules 1986 and Environment (Protection) 115 Amendment Rules 2021
3. Municipal Solid Wastes (Management and Handling) Rules 2000 and Solid Waste Management Rules 2016
4. Plastic Waste Management Rules (2016) & Amendments (2018, 2021 1 & 2, 2022 1 & 2, 2024), based on:
 - a. Recycled Plastics Usage Rules 1988
 - b. Plastics Manufacture, Sale and Usage Rules 1999 & Amendment 2003
 - c. Plastic Waste Management and Handling Rules 2011

There are also numerous roadmaps, handbooks, and plans in India that support existing policies and in particular their implementation at the regional and local levels, guide the country's progress towards a circular economy, and improve waste management.

Table 1. Overview of plastic-related policies in India

Source: Authors' own representation

	Production (primary polymers)	Manufacturing (plastic products)	Consumption	Waste management/ End-of-life	Trade
COMMAND AND CONTROL					
Mandatory performance/outcome standards (incl. targets)	Plastic Waste Management Rules 2016 & their Amendments in 2018	Plastic Waste Management Rules 2016 & their Amendments in 2018	Plastic Waste Management Rules 2016 & their Amendments in 2021		
Mandatory process standards (incl. targets)		Plastic Waste Management Rules 2016 & their Amendments in 2022 and 2024	Plastic Waste Management Rules 2016 & their Amendments in 2022 and 2024	<ul style="list-style-type: none"> • Plastic Waste Management Rules 2016 • Municipal Solid Wastes (Management and Handling) Rules 2000 • SWM Rules 2016 	
Technological standards (incl. targets)					
Prohibitions/bans (incl. phaseout)		Plastic Waste Management Rules 2016 & their Amendments in 2021 and 2024	Plastic Waste Management Rules 2016 & their Amendments in 2018, 2021, and 2024		
MARKET-BASED					
Taxes/levies			Plastic Waste Management Rules 2016	Plastic Waste Management Rules 2016	
Subsidies/grants/tax reductions					
Public procurement					
EPR/deposit refund schemes		Plastic Waste Management Rules 2016 & their Amendments in 2022	Plastic Waste Management Rules 2016 & their Amendments in 2022	<ul style="list-style-type: none"> • Plastic Waste Management Rules 2016 & their Amendments in 2022 and 2024 • SWM Rules 2016 	
Liability schemes				SWM Rules 2016	

	Production (primary polymers)	Manufacturing (plastic products)	Consumption	Waste management/ End-of-life	Trade
INFORMATION					
Taxonomies					
Data collection, reporting and disclosure				Plastic Waste Management Rules 2016 & their Amendments in 2024	
Labels		Plastic Waste Management Rules 2016	Plastic Waste Management Rules 2016	<ul style="list-style-type: none"> Plastic Waste Management Rules 2016 SWM Rules 2016 	
Awareness raising/ capacity development					
GOVERNANCE/COORDINATION					
Roadmaps, plans and strategies					
Inter-ministerial coordination	<ul style="list-style-type: none"> India's institutional framework for plastic waste management involves a division of responsibilities between two key ministries: the Ministry of Environment, Forests & Climate Change is responsible for developing rules, regulations, and guidelines for waste management; and the Ministry of Housing and Urban Affairs oversees on-the-ground implementation, working closely with state governments and urban local bodies (ULBs) to support programmatic initiatives and waste management projects (World Economic Forum 2023). Beyond these governmental bodies, various stakeholders play crucial roles across the plastic waste value chain, including recyclers, manufacturers, brand owners, and both formal and informal waste pickers. Additionally, innovators, civil society organisations, producer responsibility organisations, and consumers contribute to this system, creating essential interdependencies that support the overall management and reduction of plastic waste (World Economic Forum 2023). 				
Public-Private partnerships	<ul style="list-style-type: none"> Under Swachh Bharat (Clean India Mission), public-private partnerships have been established. One example is the collaboration between the Government of India and private sector players such as Unilever, HSBC, and the JSW Foundation to establish Suvidha centres for hygiene, sanitation and health services in Mumbai's slums (Prakash & Baker 2024). The India Plastics Pact brings together a wide range of stakeholders, including businesses, governments, non-governmental organisations (NGOs), and the public, to work collaboratively towards four key targets (see below under 3.1). The National Circular Economy Roadmap (2023) a strategic initiative that emerged from a three-year research collaboration between Indian research partners, providing a comprehensive approach to tackling plastic waste by addressing the entire plastics value chain. Plastindia Foundation is an apex body in India that promotes the development and global sourcing of plastic products, with support from the Ministry of Chemicals and Fertilisers (see below under 3.2). The Defence Research and Development Organisation (DRDO) has developed a technology for producing compostable plastics in collaboration with Ecolastic Products Pvt Ltd (Hyderabad) (see below under 3.3). 				

	Production (primary polymers)	Manufacturing (plastic products)	Consumption	Waste management/ End-of-life	Trade
SPECIAL FOCUS SECTOR: CONSTRUCTION					
	<p>The building and construction sector is the second largest user of plastic in India (Hossain et al. 2022). There is only one specific policy that addresses plastics in this sector. The Plastic Waste Management Rules, 2016 encourage local bodies to use non-recyclable plastic waste for road construction (see section 2.2.2).</p> <p>Increasing the use of secondary plastics in construction is also a central theme In the National Circular Economy Roadmap for Reducing Plastic Waste in India (2023), which is a strategic initiative that emerged from a three-year research collaboration between Indian research partners (see section 3.2).</p>				

2.2. Legally binding policies

India has adopted several legally binding policies that directly or indirectly affect plastic pollution, including basic environmental framework laws, general waste management laws and regulations that specifically address plastic pollution.

Often referred to as 'umbrella legislation', the **Environment Protection Act of 1986**, with the 1991 amendments, establishes a framework for regulating environmental protection in India through command-and-control mechanisms and deterrents for non-compliance, such as fines and imprisonment. While it does not specifically address plastic waste, this comprehensive law empowers the central government to set environmental standards and manage pollutants, including plastics, through provisions on handling and disposal.

The **Environment Protection Rules of 1986**, established under the Environment Protection Act, mandate the central government to enforce regulations on polluting emissions and industrial operations. Amendments, including the 2021 and 2023 updates, have introduced stricter waste management requirements and increased the penalties for violations. Notably, the **2021 amendment** added regulations for managing plastic waste from water purification systems, aligning with the **Plastic Waste Management (PWM) Rules of 2016** (see section 2.2.3 below).

2.2.1. General Waste Management Policies

The **Municipal Solid Wastes (Management and Handling) Rules 2000** provide a comprehensive framework for managing municipal solid waste (MSW) in India. While plastic waste is not explicitly mentioned, these Rules laid the foundation for later plastic-specific policies, and they are frequently referenced in the **Plastic Waste Management (PWM) Rules of 2016** (see section 2.2.2 below). The Rules outline detailed guidelines for the management of municipal waste, including specifications for collection, segregation, storage, transportation, processing, disposal, and minimisation of waste as laid out in Schedule II (Government of India 2000).

The **SWM Rules 2016** build on and update the Municipal Solid Wastes (Management and Handling) Rules from 2000, developing a more comprehensive approach to waste management with an increased focus on plastic waste. These amendments incorporate various Rules to improve and enhance waste management practices across the country (Government of India 2016a), central to which are **command-and-control** mechanisms with a particular focus on plastic waste. In areas with specific challenges, such as hilly regions, local bodies must enforce regulations against littering and provide adequate waste disposal facilities at tourist destinations, ensuring responsible management of waste, particularly plastic waste, in areas where waste management is difficult. A notable provision in the Rules is the phase-out of incineration of chlorinated plastics, which are harmful when burned because of their toxic emissions. The Rules require that incineration of these plastics cease within two years, in order to promote safer and environmentally more coherent waste management practices. The 2016 Rules also emphasise converting non-recyclable waste with high calorific value into energy, rather than being dumped in landfills. This waste should be used either for refuse-derived fuel (RDF) or as feedstock for energy generation, thereby reducing landfill use and harnessing waste for energy.

Such waste-to-energy approaches are, moreover, contested by experts. While the process of using the energy that is created during plastic incineration is preferable to dumping, landfilling, open burning and regular incineration, this practice nonetheless constitutes a loss of resources for the economy while increasing pollution. Additionally, costs for creating energy recovery plants are high and they lock investments into an ultimately less sustainable practice: namely, incinerating (plastic) waste for many years to come in order to recover investment costs. At the same time, this might create competition for feedstock between more sustainable mechanical recycling facilities and the energy recovery plants. Governments in the negotiation process of the Global Plastics Treaty therefore strongly disagree about whether or not energy recovery should be viewed as a sustainable measure in the waste hierarchy.

In addition to command-and-control mechanisms, the Rules also introduce **market-based mechanisms**,

including fines to encourage compliance, user fees, and measures that relate to extended producer responsibility (EPR). Fines are imposed for non-segregation of waste as well as for littering; user fees are levied for waste collection. The EPR-related measures affect manufacturers and brand owners, who become responsible for their disposable products and their resulting waste, including plastic packaging. Those who produce the waste are required to provide financial assistance to local authorities and large organisations like hotels, restaurants, and residential communities for establishing and maintaining effective waste management systems. This contribution thus ensures that those whose products end up as waste are also involved in managing it. Local authorities and Panchayats are mandated to set up material recovery facilities and secondary storage spaces to aid in waste sorting and recycling, including plastics. Furthermore, they must implement a color-coded bin system to improve waste segregation at the source: green for biodegradable waste, white for recyclables, and black for other waste, a system designed to enhance waste separation efficiency and recycling processes.

Information and education mechanisms are also a key component of the Rules. Producers of sanitary products, such as diapers, must educate consumers on proper disposal practices. The Rules encourage the use of recyclable materials in the manufacturing of disposable products to promote more sustainable consumption practices.

2.2.2. Plastic-specific Policies

The framework for managing plastic waste in India has evolved gradually over the past few decades, with different legislations culminating in the **Plastic Waste Management (PWM) Rules in 2016** and consecutive amendments of the same. Building upon the **Environment Protection Act 1986 (EPA 1986)**, the management of plastic waste formally commenced in 1998 when the **Recycled Plastics Usage Rules** were introduced, marking the initial step towards addressing the challenges posed by plastic waste. This initiative gained further momentum with the Ministry of Environment and Forests notifying the **Plastics Manufacture, Sale and Usage Rules in 1999**, which were amended in 2023. Initially, these regulations were primarily concerned with the manufacture and sale of plastic bags and containers, leaving the critical issues of other types of plastic packaging as well as the disposal of plastic waste largely unaddressed.

The introduction of the **Plastic Waste (Management and Handling) Rules** in 2011 marked a shift in policy focus and emphasised the need to manage plastic waste beyond just bags and containers, and to address the broader issues of plastic packaging and recycling. The new Rules expanded the regulatory framework by incorporating the concept of EPR, which places the onus of responsibility on producers and manufacturers for the environmentally coherent disposal of plastic products at the end of their life cycle. In 2016, **PWM Rules** further broadened the scope of plastic waste management and to a comprehensive overhaul of the existing regulations. The Rules are designed to address plastic waste across various sectors in order to ensure effective management of plastic waste throughout the country, and they apply to all waste generators including individuals, local administrations, manufacturers, importers, and producers while targeting a broad spectrum of stakeholders, including municipal authorities, industries, residential communities, and commercial entities. The enforcement of these Rules is overseen by the State Pollution Control Boards and Pollution Control Committees for Union territories, covering activities such as the registration, production, processing, and disposal of plastic products. Building on earlier laws and frameworks, the 2016 Rules and their amendments laid the foundation for a more inclusive and robust approach to managing plastic waste throughout the country.

Table 2 offers an overview of the interplay of the relevant measures from the PWM Rules and their consecutive amendments from 2018, 2021 [1] and [2], 2022 [1] and [2] and 2024.

Table 2. Measures in the Plastic Waste Management Rules 2016 and Amendments

Source: Authors' work

Concrete Measures	Law/Amendment
Command and Control Mechanisms	
<ul style="list-style-type: none"> • Ban on Plastic Bags: The manufacture, storage, distribution, sale, and use of plastic bags less than 120 microns thick is banned across the country. • Carry bags or commodities made from compostable plastic or biodegradable plastics are excluded from the thickness provision. 	<ul style="list-style-type: none"> • Amendment Rules 2021 • Amendment Rules 2024
<p>Certification: Manufacturers can produce carry bags and items from compostable or biodegradable plastics, but they must first obtain certification from the Central Pollution Control Board (CPCB) before the products may be marketed or sold. The products must meet Indian Standard IS 17088:2008.</p>	PWM Rules 2016
<p>Regulation of Recycled Plastic Bags: Recycled plastic bags or products can be used for storing, carrying, dispensing, or packaging ready-to-eat or drink food items, provided they meet the standards and regulations set by the Food Safety and Standards Authority of India under the Food Safety and Standards Act 2006 (34 of 2006).</p>	Second Amendment Rules 2021
<p>Pigments and Colorants Standards: Plastic packaging must either be in natural shade or use pigments and colorants that comply with Indian Standard IS 9833:1981, which ensures the safety of plastics that come into contact with food, pharmaceuticals, and drinking water.</p>	PWM Rules 2016
<p>Restrictions on Plastic Raw Material Supply: Manufacturers are not allowed to sell or provide plastic raw materials to producers who are not registered with State Pollution Control Boards or Pollution Control Committees.</p>	PWM Rules 2016
<p>Phasing Out of Non-Recyclable Multilayered Plastic (MLP): The phasing out of MLP is applicable to MLP, which are 'non-recyclable, or non-energy recoverable, or with no alternate use.'³</p>	Amendment Rules 2018
<ul style="list-style-type: none"> • Central Registration System: Producers, importers, brand-owners (including manufacturers) and waste processors (e.g. recyclers) must register at a central online registration system of the Central Pollution Control Board. • Anyone involved in selling plastic raw materials or intermediate materials for plastic packaging production must apply for registration with the relevant State Pollution Control Board or Pollution Control Committee. • Producers, importers, brand owners, and manufacturers of products made from compostable or biodegradable plastics are required to register via the centralised online portal. 	<ul style="list-style-type: none"> • Amendment Rules 2022 • Amendment Rules 2024
<p>Responsibility of Waste Generators: Individuals and bulk waste generators, such as offices, hotels, and hospitals, are responsible for minimising plastic waste and ensuring its proper disposal.</p>	PWM Rules 2016

³ The addition 'non-energy recoverable' weakens the approach as energy-recovery is possible for almost every MLP product (Gayathri Devi 2020, T'avora de Mello Soares et al. 2022).

Concrete Measures	Law/Amendment
<p>Plastic Waste Management by Local Bodies:</p> <ul style="list-style-type: none"> Urban Local Bodies (ULBs) must implement plastic waste management rules, ensuring segregation, collection, transportation, processing, and disposal of plastic waste in an environmentally sound manner. Local bodies are encouraged to use non-recyclable plastic waste for road construction, energy recovery, or waste-to-oil conversion as per Indian Road Congress guidelines. 	PWM Rules 2016
<p>Responsibilities of Retailers and Street Vendors: Retailers and street vendors must sell items only in plastic carry bags, sheets, or packaging that comply with the rules. Non-compliance will result in fines as per local by-laws.</p>	PWM Rules 2016
<p>Recycling Requirements: Recycling of plastic waste must conform to Indian Standard IS 14534:1998, ensuring proper recycling practices and standards.</p>	PWM Rules 2016
<p>Prohibition of Specific Plastics: Certain plastic materials, including Vinyl Acetate - Maleic Acid – and Vinyl Chloride Copolymer, are banned in the packaging of gutkha (type of chewing tobacco), pan masala, and tobacco to further limit plastic waste from these products.</p>	PWM Rules 2016
<p>Single-Use Plastics Ban: The production, import, storage, distribution, sale, and use of single-use plastic items, including polystyrene and expanded polystyrene products, are banned. Items covered by this prohibition are:</p> <ul style="list-style-type: none"> earbuds with plastic sticks plastic sticks for balloons plastic flags candy sticks ice-cream sticks PS (thermocool, also called polystyrene) for decoration crockery such as plates, cups, or glasses cutlery such as forks, spoons, knives, or straws trays wrapping or packing films around sweets boxes invitation cards cigarette packets plastic or PVC banners less than 100 microns thick stirrers 	Amendment Rules 2021
Information Mechanisms	
<p>Labelling of Plastic Carry Bags: Plastic carry bags must be labelled with information regarding their recycling status, manufacturer, and thickness.</p>	PWM Rules 2016
<p>Protocols for compostable plastics: degradability and disintegration must be evaluated according to specified Indian Standards (IS).</p>	Amendment Rules 2018
<p>Reporting for Biodegradable and Compostable Plastics: Manufacturers of products made from compostable or biodegradable plastics must report the quantity of these products introduced onto the market, along with any pre-consumer waste generated, to the Central Pollution Control Board.</p>	Amendment Rules 2024

Concrete Measures	Law/Amendment
<ul style="list-style-type: none"> • Annual Reports: Stakeholders must submit annual reports related to their plastic waste management activities and compliance. • Annual reports must include data on the plastic waste generated during the year, including the plastic waste present at dump sites (by Panchayat a district level and local bodies). 	<ul style="list-style-type: none"> • Introduced in PWM Rules 2016 • Amendment Rules 2024
<p>PR Data Collection: A centralised online portal managed by the Central Pollution Control Board (CPCB) is established for the registration and annual reporting of producers, importers, brand owners, and plastic waste processors. This portal acts as a comprehensive data repository for EPR implementation and provides annual reports to ensure transparency and effective information management.</p>	Amendment Rules 2022

A key **market-based mechanism** introduced through the Plastic Waste Management (PWM) Amendment Rules 2022 is 'Extended producer responsibility' (EPR). Initially mentioned in the PWM Rules of 2016 as a polluter-pays principle, the 2022 amendment offers more comprehensive guidelines, particularly for plastic packaging. These guidelines mandate specific targets for recycling plastic waste, reusing rigid plastic packaging, and incorporating recycled plastic content into new products. If companies fail to meet these targets a levy is imposed as compensation, according to the principle of the 'polluter pays'. The EPR framework applies to various types of plastic packaging and places the responsibility on producers to manage the entire life cycle of their products. Additionally, the system allows the trading of surplus EPR certificates, further promoting compliance and effective waste management.

The latest **Plastic Waste Management Amendment Rules 2024** (Amendment Rules 2024) strengthen efforts to combat plastic pollution in India by focusing on microplastics and enforcing stricter standards for biodegradable plastics. In the rules, the term 'biodegradable plastics' refers to plastics, excluding compostable plastics, that break down through biological processes in environments like soil, landfills, sewage sludge, freshwater, or marine settings, without leaving microplastics, visible remnants, or harmful toxic residues that negatively impact the environment behind. Since the 2024 Amendment, producers, importers, brand owners, and manufacturers of products made from compostable or biodegradable plastics can implement programmes like deposit refund systems, buy-back schemes, or other models to create a dedicated waste stream for collecting plastic packaging waste. These programmes help them meet their EPR obligations and prevent mixing plastic packaging waste with general solid waste.

2.2.3. Additional Plastic-Related Policies

The Bureau of Indian Standards (BIS) has established several guidelines over the years to regulate plastic waste recovery and recycling. For example, IS 14534:1998 outlines guidelines for plastic waste recovery, while IS 14535:1998 governs the use of recycled plastics in manufacturing. Recent standards, such as IS/ISO 17088:2021 for compostable plastics and IS 17899 T:2022 for biodegradable plastics, further promote environmentally sound practices in managing end-of-life plastic products. These standards are referenced in laws such as the PWM Rules 2016 and their amendments.

2.2.4. Waste management at state or city level

The SWM Rules 2016 and PWM Rules 2016 have placed a significant responsibility on urban local bodies (ULBs) to manage MSW and plastic waste at the city level in India. The implementation of these rules varies across different states and cities. For example, many ULBs have implemented bans on **single-use plastic products (SUPs)** and plastic bags, but the specifics of these bans vary widely by region. Some regions have imposed partial bans on certain plastic items, while others have enforced complete bans on plastic bags, with restrictions varying based on the thickness of the material (CPCB 2021). These differences reflect the diverse approaches to plastic waste management at the state and city levels, despite alignment with the national **PWM Rules 2016** and subsequent amendments.

State and city-level regulations are designed to complement the national framework, addressing local socio-

economic and environmental challenges. To assist in implementing these measures effectively, the Indian government's think tank **NITI Aayog**, in collaboration with the **United Nations Development Programme (UNDP)**, released the **Handbook on Sustainable Urban Plastic Waste Management** in 2021 (NITI Aayog 2021). This publication provides **practical and replicable solutions** for ULBs across India, aiming to streamline plastic waste management practices in urban areas. These strategies are rooted in the **Swachh Bharat (Clean India) Mission** principles in effect in India (Government of India 2016b). The handbook is intended to be a resource tool for ULBs to contribute toward India's goal of achieving a cleaner and more sustainable environment.

2.3. Roadmaps, Plans and Strategies

The **Swachh Bharat (Clean India) Mission (SBM)** (full title: Swachh Bharat Mission (SBM): Municipal Solid Waste (MSW) Management Manual, Part II: The Manual 2016), launched by the Indian government in 2014, aims to enhance sanitation facilities across the country and manage MSW through scientifically-driven methods. One of its primary objectives is to ensure that every household has access to basic sanitation infrastructure, such as toilets, while also adopting effective strategies for waste collection, processing, and disposal. Solid waste Management is explicitly addressed in Part II: The Manual of the Municipal Solid Waste Management Manual (Government of India 2016c).

A critical responsibility under the mission has been given to **ULBs**, which must meticulously plan, implement, and monitor urban service delivery, particularly regarding MSW management. This includes the **segregation of waste at the source**, collection, transportation, and eventual processing or disposal of the waste. The mission emphasises sustainability and quality in service provision, urging community engagement and inter-departmental coordination.

Moreover, the SBM encourages the **financial and environmental sustainability** of waste management systems through partnerships with the **private sector** and **public-private partnerships**. Technical aspects, such as **waste segregation**, collection, and transportation, follow the guidelines set by the **SWM Rules 2016**, which promote waste minimisation, material recovery, and recycling.

The mission also places significant focus on community awareness regarding waste reduction and encourages the use of alternative waste management technologies, such as composting and waste-to-energy projects. It must be noted that these latter projects are increasingly being contested as an environmentally friendly technology (see 2.2.1, above).

Overall, as Dhodapkar et al. (2023) have highlighted, there are several areas in the Indian plastic policy landscape that would benefit from improvements:

- There is room for improvement regarding the integration between formal and informal sector activities.
- Opportunities exist for capacity building to enhance implementation and monitoring.
- There is potential to create incentives that expand markets for plastic alternatives.
- Improved monitoring and greater data transparency would support more effective management.
- Standards and certifications are needed to encourage better product design.
- Multi-stakeholder consultation and cross-sector collaboration could be further strengthened.
- EPR regulations could benefit from greater focus on design and production improvements.

3. Good practices of the private sector

The private sector in India is actively engaged in various innovative efforts to reduce plastic pollution, covering mostly downstream measures (e.g. waste sorting, waste management or recycling), re-use and reduction activities. This section describes some of the most prominent examples for good practices in such innovative efforts.

In general, alongside the large organisations, smaller start-ups are also making significant contributions to addressing plastic pollution in India. The most prominent and widespread activities that can be cited among the efforts to reduce fossil-based primary plastic production are those mentioned with respect to bioplastic production, the limitations of which were outlined in Chapter 2.

3.1. India Plastics Pact

The India Plastics Pact, launched in September 2021, aims to establish a circular economy for plastic packaging in India, and it represents the first initiative of its kind in Asia. Member of a broader global network of 13 Plastics Pacts, the India pact brings together a wide range of stakeholders, including businesses, governments, non-governmental organisations (NGOs), and the public, to work collaboratively towards four key targets. Aligned with the global Plastics Pact network facilitated by WRAP and the Ellen MacArthur Foundation, a charity committed to circular economy, the India Plastics Pact is managed by the Confederation of Indian Industry (CII) with strategic and technical support from WRAP, a UK-based global environmental action NGO aimed at circular living.

The Pact focuses on four ambitious targets:

1. identifying and addressing unnecessary or problematic plastic packaging through redesign and innovation
2. ensuring that 100% of plastic packaging is reusable, recyclable, or compostable
3. achieving a 50% effective recycling rate for plastic packaging
4. reaching an average of 25% recycled content across all plastic packaging.

The Pact operates on the principles of **Eliminate, Innovate, and Circulate**, which primarily follow a command-and-control approach but also include information mechanisms. At its launch, 27 major businesses, including fast-moving consumer goods (FMCG) brands, manufacturers, retailers, and recyclers, committed to the Pact. Founding members include well-known corporations such as Amazon, Coca-Cola India, and Mondelez India.

3.2. National Circular Economy Roadmap for Reducing Plastic Waste in India (2023)

This strategic initiative emerged from a three-year research collaboration between Indian research partners, including CSIR NEERI (National Environmental Engineering Research Institute), Development Alternatives, and TERI (The Energy and Resources Institute), and their Australian counterparts, CSIRO (Commonwealth Scientific and Industrial Research Organisation), UNSW (University of New South Wales), and UTS (University of Technology Sydney). This collaboration is part of the Australia-India Comprehensive Strategic Partnership, focusing on developing innovative plastic waste recycling technologies (Dhodapkar et al. 2023).

The Roadmap presents a comprehensive approach to tackling plastic waste by addressing the entire plastics value chain. Key elements of the Roadmap include data transparency across the value chain, encompassing production, consumption, and the end-of-life management of various polymers. The Roadmap also emphasises the importance of establishing policy frameworks to support a circular economy for plastics in India, promoting circular business models, and advancing plastic recycling technologies. Another central

theme is the creation of secondary markets for used plastics, e.g. in construction and manufacturing, as well as primary markets for alternative eco-friendly products (Dhodapkar et al. 2023).

The roadmap proposes that by 2035 the disposal of plastic-waste in landfills is reduced by 30%, the phasing-out of single-use plastics is completed, recycling rates are increased to 67%, and over 80% of plastic-waste streams are digitally tracked and managed. These proposals are supported by practical guidance for government bodies, municipalities, and communities, integrating efforts across both formal and informal economies, and involving public, household, private, and non-profit stakeholders. Proposed measures include all kinds, including command-and-control, market based and informational instruments.

3.3. Plastindia

The Plastindia Foundation is a collective organisation that brings together diverse players in the Indian plastics industry (Plastindia Foundation 2024). On the one hand, the development and global sourcing of plastic products receives support from the Ministry of Chemicals and Fertilisers. The Foundation's goal of driving plastic production and export-led growth has contributed to the expansion of the industry. On the other hand, Plastindia also raises and addresses environmental concerns that arise from the increasing generation of plastic waste; notable efforts toward sustainability have been carried out. It should be noted that the foundation's sustainability goals must be critically contrasted with their prominent role in promoting the growth of the plastics industry.

A key environmental initiative of the foundation is the Plastindia International University, which integrates sustainability into its curriculum, emphasising biodegradable polymers, recycling technologies, and life cycle assessments. The university aims to prepare future industry professionals to meet the challenges of a circular economy and sustainable use of plastic (Plastindia International University 2024). Plastindia also promotes sustainability through initiatives mentioned on its website (<https://www.plastindia.org/>), advocating for innovative recycling technologies, resource conservation, and collaboration among organisations to foster environmental awareness. The foundation envisions transforming plastic from a problem into a potential for progress through eco-conscious practices.

3.4. Plastic Alternatives

Dharaksha Ecosolutions is a sustainability-focused start-up based in Delhi, with its roots in the Regional Centre for Biotechnology (RCB) incubator. The company is dedicated to addressing two critical environmental issues: plastic pollution and stubble burning. By developing biodegradable packaging solutions, Dharaksha transforms agricultural stubble waste, which is often burned and contributes to atmospheric pollution, into environmentally-friendly packaging materials. Using mycelium (fungi) in their production process, they offer an innovative alternative to plastic packaging that decomposes within 60 days, although specific conditions for degradation are not mentioned on their website. The company's research-driven approach, led by experienced scientists and entrepreneurs, aims to create sustainable solutions while providing farmers with an additional income stream through the utilisation of stubble waste.

Another Indian company specialising in developing alternatives to conventional plastics is SKYi Innovations. In partnership with the German firm FKUR Kunststoff GmbH, SKYi Innovations has established a joint venture, SKYi FKUR Biopolymers Pvt Ltd. This venture focuses on the production and distribution of biodegradable, compostable, and bio-based polymers within India and in adjacent regions. The collaboration aims to enhance the efficiency and speed of delivering potentially more sustainable plastic solutions to local markets. The flagship product line of the joint venture, Bio-Flex®, is a series of bio-based and compostable plastic granulates designed primarily for use in flexible packaging applications. These materials offer a viable alternative to single-use plastic (SUP), providing options that are compostable in both industrial and home composting environments. In addition to Bio-Flex®, the product portfolio includes other bio-based and biodegradable resins such as Terralene, Fibrolon, and Biograde. The production facility located in Pune, India, marks an advancement in the development of an alternative market to the SUP market.

The Defence Research and Development Organisation (DRDO) lab, DFRL, has developed a biodegradable cutlery technology, which incorporates natural fibres such as agricultural waste into a polymer matrix

derived from renewable resources (NITI Aayog 2022). DFRL produces cutlery through either compression or injection moulding processes. Items such as spoons, forks, sporks, bowls, plates, and teacups can replace traditional plastic tableware, offering advantages such as biodegradability, biocompatibility, and enhanced environmental safety. Unlike conventional plastics, which pose long-term environmental risks, this cutlery breaks down within 180 days and can fully compost within 90 days under natural conditions. The products are suitable for both hot and cold meals.

DRDO, in collaboration with Ecolastic Products Pvt Ltd (Hyderabad), has developed a technology for producing compostable plastics from a starch-based compostable material, which is being commercialised and is competitive, meeting performance standards for most short-term applications. The technology, which can be used to manufacture items such as bags, cups, plates, moulded cutlery, toothbrushes, and thermoformed boxes, is already in commercial use. One example is its application in Prasadam bags by Tirumala Tirupati Devasthanams (TTD), which manages the Sri Venkateswara Swamy temple in Andhra Pradesh. Prasadam is a religious offering of mostly vegetarian food in Hinduism. As has already been mentioned, composting plastics such as these requires dedicated facilities with specific environmental conditions, since municipal landfills do not provide the necessary conditions for proper decomposition. Therefore, while compostable plastic packaging is not a universal solution, it is suitable for targeted applications (European Commission 2024).

Nevertheless, and as has already been discussed above, bio-based, biodegradable, and compostable plastics will necessitate thorough evaluation. Although bio-based plastics are produced from biological resources instead of fossil fuels, they are not inherently biodegradable or compostable. It is crucial to assess their entire life cycle to confirm that they provide real environmental benefits, not just a reduction in fossil fuel use, and to understand their potential effects on land use. Biodegradable plastics are intended to break down under specific conditions at their end of life; however, to break down effectively they often require specialised environments, such as industrial composting facilities. Compostable plastics, which are a type of biodegradable plastic, need to be collected and processed in these facilities to decompose properly. Such infrastructure is often inadequate or missing, which can lead to consumer misconceptions about the environmental benefits of biodegradable plastic. Without proper disposal systems, the vocabulary used may give a misleading impression of the real sustainability of these new plastics (EPA 2024, European Commission 2024).

3.5. Technological Innovations

Ricron Panels is an innovative company that converts low-value multilayer plastics (MLPs), which are typically non-recyclable, into high-quality, fully recyclable products like panels and roofing sheets. Ricron Panel technology recycles plastic waste into sustainable solutions used in various sectors, such as roofing, furniture, flooring, and construction. Their innovation helps divert plastic waste from landfills and oceans, reducing carbon emissions and minimising water use in the timber industry. Ricron's products offer cost savings of 25%–35% in various projects. In 2022, they collaborated with Nestlé India to recycle KitKat wrappers into campus benches, and their technology has even been applied in building schools. Ricron Panels was featured in Marico Innovation Foundation's 2023 report, 'Innovation in Plastics – The Potential and Possibilities.'

Ishitva Robotic Systems is transforming India's waste management sector by leveraging cutting-edge Industry 4.0 technologies, such as artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT). Ishitva aims to improve recycling processes through automation, offering a more scalable and cost-efficient alternative to traditional manual sorting methods. Ishitva has developed AI-powered air-based sorting solutions capable of full-colour range sorting, including brand recognition and the ability to detect the colour black. Among their standout innovations are YUTA, an AI-powered industrial sorting robot, NETRA, a machine vision system that identifies recyclables from mixed waste on conveyor belts, and SUKA, an air sorter which enhances waste sorting accuracy by combining the NETRA AI vision systems with high-speed pneumatic valves to sort materials based on polymers, colours, and brands.

4. Challenges

India's plastic pollution crisis is a multifaceted issue shaped by a complex interplay of factors, including its vast and diverse geography, varied climate, industrial landscape, and governance structures. The country's annual plastic waste generation of approximately 10.8 million metric tonnes reflects the scale of the challenge, but also underscores the potential for significant positive impact through targeted interventions.

Geographical and climatic conditions play a crucial role in both exacerbating and potentially mitigating plastic pollution in India. The country's extensive coastline, numerous rivers, and varied topography contribute to the spread and accumulation of plastic waste across diverse ecosystems. For instance, the mighty Ganges River, which flows through densely populated regions, has become a significant carrier of plastic pollution (Das 2021). The monsoon season, while vital for agriculture, also leads to increased plastic waste dispersion through flooding and runoff. However, these same geographical features also present opportunities. India's river systems could be transformed into models of plastic waste interception and management, while the country's diverse climate zones allow for the testing and implementation of a range of solutions adaptable to different environmental conditions, potentially making India a laboratory for global plastic pollution mitigation strategies.

Industrial activities significantly contribute to plastic pollution but also hold the key to potential solutions. India's robust manufacturing sector, particularly in plastics, presents a two-edged sword. While the sector contributes to employment and the economy, it also increases plastic production and waste. The projected increase in plastic consumption underscores this challenge. This industrial capacity also offers an opportunity for transformation. There is potential for industries to lead in developing biodegradable alternatives, implementing extended producer responsibility, and pioneering circular economy models (Singh and Alam 2024).

Policy enforcement capabilities vary significantly across India's diverse states and territories, affecting the efficacy of plastic pollution control measures. For example, while some regions have successfully implemented plastic bans, others struggle with enforcement due to limited resources, competing priorities, or lack of alternatives (Noklebe et al. 2023). This inconsistency poses challenges but also provides valuable lessons for refining future policies. The variation in enforcement capabilities across India offers an opportunity to identify best practices and tailor approaches to local contexts. Successful models from one region can be adapted and scaled to others, while taking into consideration the local geographical, climatic, and socio-economic factors. This could lead to the development of a more nuanced and effective national strategy for plastic waste management.

India's diverse sociodemographic landscape adds another layer of complexity to policy implementation and enforcement. Cultural practices, economic disparities, and varying levels of environmental awareness across regions influence plastic use and disposal behaviours, which can complicate uniform policy implementation (Kannankai et al. 2024). In this regard, it is noteworthy that at least 40% of the plastic waste generated by India is managed by the informal sector, which goes beyond mere waste collection. The informal sector plays a vital role in resource recovery, especially in developing and emerging economies like India (WWF-India 2023). Despite its crucial role, this sector faces numerous challenges. These include lack of recognition, poor working conditions, health hazards, and limited access to social security benefits. Informal workers often operate on the fringes of the formal waste management system, leading to inefficiencies and missed opportunities for better integration (Velis et al. 2022). For India, a just recognition of these informal workers presents a significant opportunity to support the transition to a circular economy while improving the livelihoods of tens of thousands of India's poorest citizens.

Generally, the country's waste management infrastructure and technological capabilities present both challenges and opportunities. Many areas, particularly rural and peri-urban regions, lack adequate waste

collection and processing facilities (Hossain 2022). This gap also presents an opportunity to leapfrog outdated systems and implement cutting-edge technologies in waste management and recycling.

Public awareness and education remain critical factors in addressing the plastic crisis. While changing behaviours across a diverse population is a challenge, there are encouraging signs of increased environmental consciousness. Initiatives such as introducing plastic pollution-based content in school curricula (suggested by 21.2% of respondents in a study) offer promising avenues for long-term change (Kannankai et al. 2024).

In conclusion, India's journey to address the national plastic pollution crisis is characterised by a complex interplay of challenges and opportunities stemming from the country's unique geographical, climatic, industrial, and governance landscapes. While the task ahead is formidable, India is also being given the chance to develop innovative, context-specific solutions that could serve as models for other nations grappling with similar issues. By leveraging the country's diverse geography, industrial capacity, and varied enforcement experiences, India could forge a path towards more effective plastic pollution management. The road ahead will require a balanced approach that acknowledges the hurdles while the numerous opportunities for positive change are actively pursued, with the potential to position India as a global leader in sustainable plastics and environmental practices.

5. Way forward

India has made significant strides in addressing plastic pollution through various policy measures and initiatives. Meanwhile, given the size of the problem and the continued growth trajectory of plastics and plastic pollution, these are insufficient, and there is room for further improvement and further action.

First, while the Plastic Waste Management (PWM) Amendment Rules 2022 introduced a comprehensive EPR framework, this framework could be strengthened and improved. It is recommended that the scope of EPR be expanded to include more types of plastic products and to gradually increase the targets for recycling and reuse. A global plastics treaty could support this by establishing some minimum international standards for EPR that guide implementation and by facilitating knowledge-sharing on best practices between countries.

Second, while the PWM Amendment Rules 2024 introduced stricter standards for biodegradable plastics, it is crucial to continue updating these standards as appropriate and necessary, i.e. when new technologies make new standards possible, and to ensure effective implementation by enhancing regulatory enforcement, informing the public, promoting transparency, and fostering collaboration among government, industry, and communities at state and local levels, all of which would help prevent greenwashing and ensure that biodegradable alternatives are genuinely environmentally friendly. Without appropriate standards, the risk of greenwashing increases, because plastic products might be labelled biodegradable even though they will not fully break down and decompose in the environment in the absence of specific conditions, because biodegradable plastics break down only into smaller particles rather than completely decomposing into non-polluting substances.

Third, in order to improve waste management practices and infrastructure, it is recommended that infrastructure investments be expanded to ensure the widespread adoption of proper waste collection, segregation, and recycling practices, e.g. by enabling source segregation at household level and by establishing recycling facilities with advanced sorting and processing technologies to handle diverse types of plastics. In this regard, India could learn from best practices in other countries where source segregation is widespread and advanced, such as in Japan, and where recycling rates are comparatively high, such as in Germany.

Fourth, recognising that at least 40% of plastic waste in India is managed by the informal sector, it is crucial to develop policies that integrate these workers into the formal waste management system, such as including social security benefits, improving working conditions, and offering training programmes to ensure fair treatment and integration for informal waste workers, thus promoting a just transition to a circular economy.

Fifth, further improving and expanding the existing data collection and monitoring system would enable more customised and more effective policy-making and enforcement.

Sixth, while India has implemented bans on certain single-use plastics, alternatives need to be further promoted and incentivised. Policies could include tax incentives for companies producing sustainable alternatives and public procurement policies favouring environmentally-friendly products. Along these lines, encouraging the development of innovative, sustainable packaging solutions through research grants and public-private partnerships could help reduce plastic pollution. The example of Dharaksha Ecosolutions, which transforms agricultural stubble waste into biodegradable packaging materials, demonstrates the potential for such innovations, as does the India's focus on biodegradable plastics.

Seventh, it is recommended that, when implementing and improving plastic-related policies, the Indian government take into account the circular economy by incentivising circular business models and by promoting the use of recycled content in new products.

In conclusion, the complex challenges of plastic pollution in India can be addressed by targeting the various aspects of the plastic life cycle, from production to disposal. An ambitious global plastics treaty could provide crucial support by establishing international standards, facilitating knowledge sharing, and promoting global cooperation in addressing this urgent environmental issue. By implementing these policies and leveraging the support of a global treaty, India can make significant progress in reducing plastic pollution and moving towards a more sustainable, circular economy for plastics.

How could the Global Plastics Treaty help?

- By strengthening the EPR framework with the establishment of international standards for EPR implementation and by facilitating knowledge sharing between countries on best practices
- By providing a harmonised definition and certification system for truly biodegradable plastics
- By providing funds for investments in waste management, leveraging financial resources through the financial mechanism in the Treaty
- By fostering information exchange and technology transfer as well as international collaboration through the Treaty provisions on international cooperation
- By enabling global cooperation for a just transition in the informal waste sector
- By establishing standardised methodologies for data collection and reporting, facilitating international comparisons and knowledge sharing
- By facilitating research to develop plastic alternatives and more sustainable plastic materials, then promoting their adoption through international standards and guidelines
- By establishing international standards for recycled content and facilitating the development of global markets for recycled materials
- By stimulating awareness-raising, education and research through its provisions on these issues.
- The financial mechanism in the Treaty could also provide resources and expertise for capacity-building efforts for government and municipal actors

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