THE ILLUSION OF CIRCULARITY: RETHINKING EXTENDED PRODUCER RESPONSIBILITY IN INDIA'S E-WASTE GOVERNANCE

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ABSTRACT

Extended Producer Responsibility (EPR) has become the foundation of India's e-waste management and is often depicted as a crucial tool for promoting circular economy goals. India has implemented a digitally centralized, target-oriented, and certificate-based Extended Producer Responsibility (EPR) framework through consecutive legislative reforms, including the E-Waste (Management) Rules, 2022, aimed at improving producer accountability and resource recovery. This article critically examines whether India's Extended Producer Responsibility (EPR) framework functions as a revolutionary mechanism for a circular economy or primarily as a compliance-driven system focused on downstream waste management.

This paper assesses the development, implementation, and institutional framework of Extended Producer Responsibility (EPR) in India through a doctrinal legal analysis and a governance-oriented evaluation of the country's e-waste regulatory structure. It contends that although India's Extended Producer Responsibility framework has excelled in agenda-setting, formalization, and regulatory monitoring, these accomplishments are predominantly normative rather than substantive. Ongoing deficiencies in enforcement, insufficient upstream engagement in product design, inadequate incorporation of the informal sector, and disjointed institutional coordination indicate a more profound governance issue. The objectives of the circular economy are formally integrated into the legislative framework; yet, operational practices still prioritize target achievement, documentation, and certificate trading over systemic reform.

The paper defines this disjunction as an "illusion of circularity," in which legal frameworks and language imply circular progress, while actual material

flows and industrial systems are inherently linear. By reconceptualizing Extended Producer Responsibility (EPR) as a governance mechanism rather than a mere compliance instrument, the study enhances discussions on environmental regulation in the Global South. It highlights the inherent limitations of target-oriented regulatory frameworks in achieving substantial outcomes in the circular economy.

Keywords: Extended Producer Responsibility; E-Waste Governance; Circular Economy; Environmental Regulation; Producer Accountability; India.

1. Introduction

1.1 Background and Context

In 2022, the global production of Electronic and Electrical waste (E-waste) reached 62 billion kg, averaging 7.8 kg per capita; however, only 22.3% (13.8 billion kg) was collected and recycled in an environmentally responsible manner. Approximately 80% of the world's discarded electronics are mismanaged or disposed of informally, resulting in significant environmental contamination from hazardous materials, including 58,000 kg of mercury and 45 million kg of polymers containing brominated flame retardants annually. These numbers underscore that e-waste is not merely a byproduct of technology, but a critical global environmental justice concern that affects human health and resource security.[1] E-waste is the fastest-growing waste stream in the world, escalating at an unprecedented rate due to the continual advancement of new electronics, which result in abbreviated product life cycles, prompting regular upgrades and replacements, particularly for smartphones, computers, and televisions.[2] Today, devices like computers and cell phones have significantly reduced lifespans—decreasing from 6 years to as few as 2 years—attributable to intentional obsolescence and customer behaviors.[3] Moreover, the heightened consumption of electronics, driven by economic expansion, digitalization, and affordability, substantially increases the

[1] Cornelis P. Baldé et al., The Global E-Waste Monitor 2024 (2024), https://www.globalewaste.org.
[2] Sunil Herat, *Sustainable Management of Electronic Waste (e-Waste)*, 35 CLEAN Soil Air Water 305 (2007), https://onlinelibrary.wiley.com/doi/10.1002/clen.200700022; Riya Singh, Shadman Ahmed Khan & Shadab Siddiqui, *Fastest Growing Waste: E-Waste*, AJARR 20 (2020), https://journalajarr.com/index.php/AJARR/article/view/219.
[3] Jurgita Malinauskaite & Fatih Buğra Erdem, *Planned Obsolescence in the Context of a Holistic Legal Sphere and the Circular Economy*, 41 Oxford Journal of Legal Studies 719 (2021), https://academic.oup.com/ojls/article/41/3/719/6130120; Lieselot Bisschop, Yogi Hendlin & Jelle Jaspers, *Designed to Break: Planned Obsolescence as Corporate Environmental Crime*, 78 Crime Law Soc Change 271 (2022), https://link.springer.com/10.1007/s10611-022-10023-4.

volume of e-waste generated.[4] Additionally, the proliferation of e-waste is driven by consumer preferences and emotional connections to new products, rather than necessity, leading to the disposal of still-functional electronics.[5]

Table 1.1 below summarizes global e-waste statistics for 2010-2030 projections. It demonstrates how global e-waste has nearly doubled in just over a decade, while recycling efforts have not kept pace. The 2024 Monitor projects three possible scenarios for 2030: Business-as-Usual denotes the perpetuation of existing patterns with minimal innovation; Progressive signifies moderate reforms and enhanced policies that optimize recycling and stabilize results; and Aspirational embodies ambitious worldwide initiatives and significant reforms aimed at maximizing recycling, recovery, and economic benefits.

Table 0.1: Global E-Waste Generation and Recycling (2010–2030) Source[6]:

Year	EEE Placed on Market (billion kg)	E-Waste Generated (billion kg)	Formally Collected & Recycled (billion kg)	Global Recycling Rate (%)
2010	62	34	8.0	23.5%
2015	76	44	10	22.7%
2020	88	53	12	22.6%
2022	96	62	13.8	22.3%
2030 (BAU)	120	82	16	20%
2030 (Progressive)	120	82	31	38%

[4] Jonovan Van Yken et al., *E-Waste Recycling and Resource Recovery: A Review on Technologies, Barriers and Enablers with a Focus on Oceania*, Metals (2021), https://consensus.app/papers/ewaste-recycling-and-resource-recovery-a-review-on-boxall-nikoloski/3d798d36bc1d5384b43f1309f7c5d1f9/; Salma Taqi Ghulam & Hatem Abushammala, *Challenges and Opportunities in the Management of Electronic Waste and Its Impact on Human Health and Environment*, Sustainability (2023), https://consensus.app/papers/challenges-and-opportunities-in-the-management-of-ghulam-abushammala/720844b2dec55bb78080a2fab93eb065/.

[5] Xavier Pierron, *E-Waste and Sustainability in a Changing Environment*, *in* Sustainable Economy and Emerging Markets 212 (Stefania Paladini & Suresh George eds., 1 ed. 2019), https://www.taylorfrancis.com/books/9781000708677/chapters/10.4324/9780429325144-14.

[6] Baldé et al., *Supra* note 4.

2030 (Aspirational)	120	82	49	60%

E-waste presents considerable environmental and human health hazards due to its composition of numerous harmful substances, including lead, cadmium, mercury, and persistent organic pollutants. Improper disposal or informal recycling of e-waste can lead to the leaching of hazardous compounds into soil, contaminating water sources, polluting the air, and impacting ecological systems and surrounding communities.[7] Prolonged exposure may lead to significant health complications, including respiratory ailments, neurological abnormalities, and potentially cancer.[8] Moreover, Informal recycling endangers workers and surrounding communities—particularly children and pregnant women—by exposing them to harmful substances, resulting in respiratory ailments, neurological impairment, heightened cancer risk, and developmental disorders. Ingestion, inhalation, and skin contact are primary exposure pathways.[9] However, e-waste also represents significant economic value. The components—precious metals such as gold, silver, and copper, as well as rare-earth elements—can be removed and repurposed, often at higher concentrations than those obtained from conventional mining methods.[10] This potential categorizes e-waste as a profitable "urban mine," bolstering recycling enterprises, generating revenue, reducing the need for new mining, and promoting sustainable growth through effective resource recovery technologies, such as bioleaching.[11]

1.2 Establish the Rationale

Extended Producer Responsibility (EPR) is a pivotal regulatory mechanism for the global management of electronic waste and is integral to India's e-waste governance. By transferring post-consumer waste management obligations from the state to producers, the Extended Producer Responsibility (EPR) fosters lifecycle accountability in line with circular economy principles, including eco-design, reuse, and recycling. In India's swiftly growing electronics sector, Extended Producer Responsibility (EPR) serves as both a legislative framework and a

[7] Kang Liu et al., *A Global Perspective on E-Waste Recycling*, 2 Circular Economy 100028 (2023), https://linkinghub.elsevier.com/retrieve/pii/S2773167723000055.
[8] Taqi Ghulam and Abushammala., *Supra* note 7
[9] Michelle Heacock et al., *E-Waste and Harm to Vulnerable Populations: A Growing Global Problem*, 124 Environ Health Perspect 550 (2016), https://ehp.niehs.nih.gov/doi/10.1289/ehp.1509699.
[10] Sohani Vihanga Withanage & Komal Habib, *Life Cycle Assessment and Material Flow Analysis: Two Under-Utilized Tools for Informing E-Waste Management*, 13 Sustainability 7939 (2021), https://www.mdpi.com/2071-1050/13/14/7939.
[11] Minh-Hieu Le, Wen-Min Lu & Jui-Chen Chang, *Recycling E-Waste and the Sustainable Economy: A Bibliometric Exploration*, 15 Sustainability 16108 (2023), https://www.mdpi.com/2071-1050/15/22/16108.

sustainability strategy, specifically targeting the environmental and health hazards associated with the nation's significant dependence on perilous informal recycling methods.[12] Extended Producer Responsibility (EPR) is essential to compelling producers to assume accountability for creating secure, effective, and consistent collection and recycling systems that align with circular-economy goals.[13]

India's e-waste management framework is predicated on Extended Producer Responsibility (EPR), yet the system predominantly emphasizes compliance and recycling. Although legislation establishes collection and disposal objectives, it rarely assesses whether these initiatives effectively promote circular economy concepts, including waste prevention, repair, reuse, and material recovery efficiency.[14] Due to this discrepancy, producers choose convenient recycling pathways, PROs struggle to integrate informal operators, and regulators lack the means to analyze circular performance beyond EPR portal indicators. A comprehensive methodology incorporating legal, institutional, and operational data is needed to examine the compliance and regulatory impact of India's e-waste law on systemic circularity.[15] This alignment facilitates the synchronization of India's e-waste legislation with overarching sustainability objectives, climate-related necessities, and international norms for a circular economy.

Ultimately, India demonstrates the challenges of establishing a Circular Economy (CE) in the Global South. EPR adoption is complicated by the informal sector's 95% e-waste management, rapid consumer growth, and insufficient enforcement. Informal recyclers are economically significant, yet their poor technology and safety standards raise environmental concerns, creating a policy quandary between formalization and livelihood protection. India's growing EPR framework can help emerging economies that face legislative, economic, and societal constraints adopt CE concepts.[16]

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[12] Terje Andersen & Bjørn Jæger, *Circularity for Electric and Electronic Equipment (EEE), the Edge and Distributed Ledger (Edge&DL) Model*, 13 Sustainability 9924 (2021), https://www.mdpi.com/2071-1050/13/17/9924.

[13] Xiong Zheng, Fangchao Xu & Lipan Feng, *Analysis of Driving Factors for Extended Producer Responsibility by Using Interpretative Structure Modelling (ISM) and Analytic Network Process (ANP)*, 9 Sustainability 540 (2017), https://www.mdpi.com/2071-1050/9/4/540.

[14] Kalyan Bhaskar and Rama Mohana Rao Turaga, "India's E-Waste Rules and Their Impact on E-Waste Management Practices: A Case Study," 22 Journal of Industrial Ecology 930–42 (2018).

[15] Joseph Fiksel, Praveena Sanjay & Kavya Raman, *Steps toward a Resilient Circular Economy in India*, 23 Clean Techn Environ Policy 203 (2021), https://link.springer.com/10.1007/s10098-020-01982-0.

[16] Lynda Andeobu, Santoso Wibowo and Srimannarayana Grandhi, "A Systematic Review of E-Waste Generation and Environmental Management of Asia Pacific Countries," 18 International Journal of

1.3 Research Objectives

This paper rigorously analyzes Extended Producer Responsibility (EPR) as a legal and governance mechanism for advancing circular-economy goals within India's e-waste regulatory framework. It assesses whether India's Extended Producer Responsibility (EPR) framework operates as a transformative mechanism or primarily as a compliance-driven system focused on downstream waste management.

The study specifically aims to: (i) analyze the evolution and institutional design of India's Extended Producer Responsibility (EPR) framework; (ii) assess the prioritization of compliance targets over upstream circular economy interventions; and (iii) identify governance and structural constraints that hinder substantial circularity.

The study enhances discussions on environmental governance by redefining Extended Producer Responsibility (EPR) as a potentially underutilized tool for structural reform in environmental regulation within the Global South.

1.4 Research Questions:

In India, Extended Producer Responsibility (EPR) is the primary legislative framework for e-waste disposal; however, its benefits for a circular economy remain under scrutiny. Digitized objectives, reporting, and certificate-based processes have improved procedural compliance, but their ability to drive upstream transformation and material circularity remains uncertain. The following research questions guide this study:

1- Is India's e-waste EPR framework a compliance-oriented regulatory framework or a transformative circular-economy tool?

2- How does India's legal, institutional, and enforcement system prioritize targets above eco-design, product durability, and waste reduction?

3- What governance and institutional constraints in India's EPR framework prevent the adoption of circular economy principles, thereby maintaining linear material flows?

4- How can India's environmental governance system rethink EPR to promote circularity,

Environmental Research and Public Health 9051 (2021).

ecological justice, and producer accountability beyond procedural compliance?

2. Conceptual Framework: EPR and Circular Economy

2.1 Extended Producer Responsibility in the E-waste management realm

Thomas Lindhqvist's seminal work in formulating the Extended Producer Responsibility (EPR) concept has led to its widespread adoption as a policy strategy that focuses on environmental improvements across product life cycles.[17] Stemming from an analysis of global recycling and waste management initiatives, EPR shifts responsibility from consumers and waste authorities to product producers. Economic Responsibility: Producers cover the costs of managing end-of-life waste, either directly or through fees. The Packaging Decision 2014 mandates producers to finance separate collection or packaging separation in the Netherlands. Liability: Producers are accountable for environmental damage caused by their products throughout their life cycles, including use and disposal. Informative Responsibility: Producers provide information on the product's environmental impact throughout its life cycle, including details on waste pollution and other environmental impacts.[18] Naoko Tojo[19] noted the integration of EPR into the ecological policies of many governments since the 1990s, positioning it as a guiding principle for sustainable production and consumption. The Organization for Economic Co-operation and Development (OECD) has played a crucial role in promoting EPR globally through research and policy guidance, emphasizing sustained producer participation in post-consumer product management. EPR encourages designers to prioritize easily reusable and recyclable materials, aligning with modern pollution-prevention policies that focus on product design.[20] P. Manomaivibool traced the practical implementation of EPR to the 1991 German Ordinance on Packaging Waste, inspiring similar recycling programs worldwide. Yet, challenges remain, as producers often view EPR as a social duty rather than a business imperative, hindering collaboration with for-profit entities and informal recyclers.[21] Y Gupt et al. 's study across 27

[17] Thomas Lindhqvist, 'Extended Producer Responsibility in Cleaner Production: Policy Principle to Promote Environmental Improvements of Product Systems' (PhD thesis, Lund University 2000).
[18] Katrien Steenmans, "Extended Producer Responsibility: An Assessment of Recent Amendments to the European Union Waste Framework Directive," 15 Law, environment and development journal (2019).
[19] Naoko Tojo, Extended Producer Responsibility as a Driver for Design Change - Utopia or Reality? (2004) (Lund University).
[20] OECD, Extended Producer Responsibility: A Guidance Manual for Governments (2001), https://www.oecd.org/en/publications/extended-producer-responsibility_9789264189867-en.html.
[21] Panate Manomaivibool & Jong Ho Hong, *Two Decades, Three WEEE Systems: How Far Did EPR Evolve in Korea's Resource Circulation Policy?*, 83 Resources, Conservation and Recycling 202 (2014), https://linkinghub.elsevier.com/retrieve/pii/S0921344913002188.

countries underscores the importance of effective regulatory frameworks and upstream management for successful EPR implementation, particularly in developing countries, where robust regulations are essential for controlling informal sectors.[22] In e-waste management, Extended Producer Responsibility (EPR) systems can diminish electronic pollutants by allocating responsibility to relevant stakeholders.[23] Moreover, DS Khetriwal et al. noted that EPR policies vary by waste type, explaining why some waste types are better suited to EPR and why countries implement EPR laws differently.[24]

2.2 EPR and Circular Economy Integration Framework in India

There is a nexus between EPR and Circular Economy (CE), focusing on upstream improvement through the promotion of Ecological Design, also known as Eco-design. This review examines the evolving landscape of environmental governance, highlighting the challenges and opportunities of aligning E-waste management mandates with broader circular-economy goals through EPR tools. The Ellen MacArthur Foundation defines the circular economy (CE) as an industrial system that aims to be restorative or regenerative by design, replacing the 'end-of-life' concept with restoration and focusing on renewable energy use, elimination of toxic chemicals, and waste elimination through superior material, product, and system design, including innovative business models.[25]. M. Geissdoerfer et al. elaborate on CE as a regenerative system that minimizes resource input and waste, emissions, and energy leakage through practices such as long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling. S. Mondal et al highlight CE's goal of maximizing product lifespan to optimize utility, particularly emphasizing its significance for waste management in efficiently addressing environmental issues like resource depletion, pollution, and climate change.[26] J. Kirchherr et al.'s analysis of 114 definitions underscores CE's multifaceted nature,

[22] Yamini Gupt & Samraj Sahay, *Review of Extended Producer Responsibility: A Case Study Approach*, 33 Waste Manag Res 595 (2015), https://journals.sagepub.com/doi/10.1177/0734242X15592275.
[23] Li Jian & Zhang Shanshan, *Study E-Waste Management Based on EPR System*, *in* 2010 International Conference on E-Business and E-Government 820 (2010), http://ieeexplore.ieee.org/document/5591725/.
[24] Deepali Sinha Khetriwal, Philipp Kraeuchi & Rolf Widmer, *Producer Responsibility for E-Waste Management: Key Issues for Consideration – Learning from the Swiss Experience*, 90 Journal of Environmental Management 153 (2009), https://linkinghub.elsevier.com/retrieve/pii/S030147970700312X.
[25] Ellen MacArthur Foundation, *Towards the Circular Economy Vol. 1: An Economic and Business Rationale for an Accelerated Transition*, (Jan. 1, 2013), https://www.ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an.
[26] Sourav Mondal, Saumya Singh & Himanshu Gupta, *Green Entrepreneurship and Digitalization Enabling the Circular Economy through Sustainable Waste Management - An Exploratory Study of Emerging Economy*, 422 Journal of Cleaner Production 138433 (2023), https://linkinghub.elsevier.com/retrieve/pii/S095965262302591X.

focusing on minimizing waste through reduction, reuse, recycling, and material recovery across all production, distribution, and consumption stages to achieve sustainable development at various levels[27]. Compagnoni's study assesses the influence of EPR on circularity within the Electrical and Electronic Equipment (EEE) value chain, providing policy recommendations and highlighting the role of WEEE as both a challenge and a potential asset in CE.[28]

2.3 Indian Circular Economy in E-waste Management: Opportunities and Challenges.

A global shift towards sustainable resource utilization is driving a 7.8% annual growth in the circular economy sector, with an expected value of exceeding $650 billion by 2028. This transition could unlock $4.5 trillion in GDP growth by 2030, with 68% of that progress stemming from replacing non-renewable energy sources and recycling waste. Focusing on India, the circular economy is expected to reach a value exceeding $45 billion by 2030.[29] The Indian Cellular and Electronics Association (ICEA) released a report on 'Pathways to Circular Economy in E-waste ' that identifies six circular business models: Circular Design, Product-as-a-Service, Repair, Resell, Refurbishment, and Recycle. Based on existing commitments, these models could reach a market size of $13 billion by 2035. Still, with the right actions, the market could expand to $20 billion.[30] S. Arya et al. confirmed that Eco-product design, circular resource management, extended producer responsibility, the polluter-pays principle, life-cycle assessment, the 4R principle, and bioleaching are crucial strategies for sustainable E-waste management in India.[31] Manu Sharma et al. emphasize the global imperative of effective electronic waste (e-waste) management in transitioning nations like India, within the context of the Circular Economy (CE), highlighting the importance of waste minimization and recycling. Underscores 'Environmental Management Systems' (EMS) as pivotal, influencing other factors such as eco-friendly product design, stringent regulations, and support for CE practices by producers.[32] R. Panchal et al. validate the Extended Producer Responsibility's

[27] Julian Kirchherr et al., "Conceptualizing the Circular Economy (Revisited): An Analysis of 221 Definitions," 194 Resources, Conservation and Recycling 107001 (2023).
[28] Marco Compagnoni, "Is Extended Producer Responsibility living up to expectations? A systematic literature review focusing on electronic waste," 367 Journal of Cleaner Production 133101 (2022).
[29] Mukherjee, Anirban, & Banerjee, Tania. "Zoomed Out | Why circular economy is imperative for businesses in India." CNBC TV18, Oct 3, 2023, https://www.cnbctv18.com/economy/why-circular-economy-is-imperative-for-businesses-in-india-anirban-mukherjee-bcg-17929111.htm
[30] ICEA (India Cellular & Electronics Association), Accenture, Pathways to Circular Economy in Indian Electronics Sector (2022), https://icea.org.in/wp-content/uploads/2024/10/3.-Pathways-to-Circular-Economy-in-Indian-Electronics-Sector.pdf.
[31] Shashi Arya and Sunil Kumar, "E-waste in India at a glance: Current trends, regulations, challenges and management strategies," 271 Journal of Cleaner Production 122707 (2020).
[32] Sharma, M., Joshi, S., & Kumar, A, Assessing enablers of e-waste management in circular economy using

(EPR) role in utilizing secondary raw materials in waste electrical and electronic equipment (WEEE), thereby reducing reliance on critical imported materials, such as antimony, and the significant economic potential of urban mining for WEEE in India, estimated at USD 36 billion for common materials such as glass, copper, and tin.[33]

2.4 Concept of Extended Producer Responsibility (EPR) in E-Waste Management

EPR was initially conceptualized and advanced by Lindhqvist and Lidgren in a 1990 report to the Swedish Ministry of Environment.[34] In 2000, Lindhqvist categorized EPR into four types: Financial, Informative, Liability, and Physical. Table 2 identifies each EPR type.

Table 2: Overview of the different forms of EPR according to Lindhqvist.[35]

EPR type	**Short explanation**
Financial	where a producer covers all or part of the costs (directly or by a special fee to a Producer Responsibility Organization) for managing the wastes at the product's end-of-life, for example, for the collection, processing, and disposal
Informative	where the producer is required to provide information on the product and its environmental effects at various life-cycle stages, such as the polluting effects of waste produced by the product
Liability	where responsibility for environmental damages caused by a product is borne by its producer. This may encompass damages occurring at various stages of the life cycle, including use and final disposal.
Physical	where the producer is involved in physical end-of-life management of the products and/or their effects through the development of technology or the provision of services

Extended Producer Responsibility (EPR) is an environmental policy principle that broadens a

DEMATEL method: An Indian perspective, Environmental Science and Pollution Research International 27, no. 12 (2020): 13325-13338.

[33] Panchal, Rohit & Singh, Anju & Diwan, Hema, Economic potential of recycling e-waste in India and its impact on import of materials, Resour. Policy 74 (2021): 102264.

[34] 17T Lindhqvist and K Lidgren, 'Modeller för Förlängt Producentansvar' in Ministry of the Environment (ed), Fraan Vaggan till Graven – Sex Studier av Varors Miljöpaaverkan (Allmänna förl 1990); Lindhqvist, Thomas Lindhqvist, 'Extended Producer Responsibility in Cleaner Production: Policy Principle to Promote Environmental Improvements of Product Systems' (PhD thesis, Lund University 2000).Thomas Lindhqvist, Extended Producer Responsibility in Cleaner Production Policy Principle to Promote Environmental Improvements of Product Systems (2000) (Doctoral Dissertation dissertation, Lund University), https://linkinghub.elsevier.com/retrieve/pii/0959652694900108.

[35] Thomas Lindhqvist, 'Extended Producer Responsibility in Cleaner Production: Policy Principle to Promote Environmental Improvements of Product Systems' (PhD thesis, Lund University 2000).*Id.*

producer's accountability for a product to encompass the post-consumer phase of its life cycle, including take-back, recycling, and ultimate disposal. EPR aims to shift responsibility for waste management from local governments and taxpayers to producers, thereby incentivizing manufacturers to create more recyclable, environmentally benign goods.[36] The objective is to internalize the environmental costs of products and motivate producers to account for ecological consequences across the entire product life cycle, encompassing design, production, and end-of-life management.[37] EPR was introduced in Europe during the 1990s and has since been implemented in various versions globally. The European Union's Waste Electrical and Electronic Equipment (WEEE) Directive sets significant collection and recycling objectives and mandates that producers fund the treatment of e-waste.[38] It is a policy approach that serves as a mechanism to advance circular economy goals, reduce landfill use, and mitigate the environmental and health hazards of informal e-waste recycling, particularly in low-income nations[39]. EPR is grounded in the "polluter pays" principle, which seeks to internalize the environmental costs associated with products by holding producers accountable for managing post-consumer waste[40]. The policy is justified by the need to address market failures, including externalities associated with improper e-waste disposal, and to encourage producers to design products that facilitate recycling and minimize toxicity[41]. EPR is also considered a tool for maintaining a circular economy and maximizing resource efficiency.[42]

2.5 Criticisms and limitations of EPR

Extended Producer Responsibility (EPR) is recognized for enhancing waste collection and end-of-life management; however, its effectiveness is constrained by numerous significant limitations. A primary critique is its limited upstream influence, as companies often meet

[36] Mohammad Abdullatif Bukhari, Ruth Carrasco-Gallego & Eva Ponce-Cueto, *Developing a National Programme for Textiles and Clothing Recovery*, 36 Waste Manag Res 321 (2018), https://journals.sagepub.com/doi/10.1177/0734242X18759190.
[37] Ya-Jun Cai & Tsan-Ming Choi, *Extended Producer Responsibility: A Systematic Review and Innovative Proposals for Improving Sustainability*, 68 IEEE Trans. Eng. Manage. 272 (2021), https://ieeexplore.ieee.org/document/8731754/.
[38] Kleoniki Pouikli, *Concretising the Role of Extended Producer Responsibility in European Union Waste Law and Policy through the Lens of the Circular Economy*, 20 ERA Forum 491 (2020), http://link.springer.com/10.1007/s12027-020-00596-9.
[39] Venkatesha Murthy and Seeram Ramakrishna, "A Review on Global E-Waste Management: Urban Mining towards a Sustainable Future and Circular Economy," 14 Sustainability 647 (2022).
[40] Ya-Jun Cai and Tsan-Ming Choi, "Extended Producer Responsibility: A Systematic Review and Innovative Proposals for Improving Sustainability," 68 IEEE Transactions on Engineering Management 272–88 (2021).
[41] C. Kieren Mayers, "Strategic, Financial, and Design Implications of Extended Producer Responsibility in Europe: A Producer Case Study," 11 Journal of Industrial Ecology 113–31 (2007).
[42] Kunz et al., *Supra* note 339.

compliance standards without sufficient motivation to innovate products for durability, reparability, or recyclability. Consequently, EPR primarily emphasizes downstream waste management rather than fostering systemic improvements in product design and manufacturing. This shortcoming highlights a broader issue: whereas Extended Producer Responsibility (EPR) enhances collection and recycling systems, it fails to effectively alter production methods to minimize waste generation at the source, thus not fully realizing its potential as a driver for circular economy transitions.[43] A significant obstacle is the intricate coordination among stakeholders, as successful implementation requires collaboration among producers, governments, recyclers, and consumers. In fact, achieving this coordination is frequently challenging, leading to fragmented rules, inconsistent enforcement, and variable outcomes that undermine the overall effectiveness of Extended Producer Responsibility as a catalyst for circular economy transformations.[44]

3. Evolution of EPR in India's E-Waste Governance

Evolution of India's E-Waste Rules (2011, 2016, 2022, Amendments)

The evolution of e-waste management regulation in India has progressed markedly over the past decade, shifting from a basic framework in 2011 to a more organized and digital system by 2022.

3.1 The 2011 E-Waste (Management and Handling) Rules: A Basic Foundation

The E-Waste (Management and Handling) Rules, 2011, were notified under the Environment (Protection) Act, 1986.[45] This signifies the initial formal regulatory measure concentrating on extended producer responsibility (EPR). These rules took effect in May 2012 and established a foundational framework by introducing Extended Producer Responsibility (EPR) for

[43] Ximin Huang, Atalay Atasu & L. Beril Toktay, *Design Implications of Extended Producer Responsibility for Durable Products*, SSRN Journal (2017), https://www.ssrn.com/abstract=3043985; Fu Gu et al., *An Integrated Architecture for Implementing Extended Producer Responsibility in the Context of Industry 4.0*, 57 International Journal of Production Research 1458 (2019), https://www.tandfonline.com/doi/full/10.1080/00207543.2018.1489161; Marco Compagnoni, *Is Extended Producer Responsibility Living up to Expectations? A Systematic Literature Review Focusing on Electronic Waste*, 367 Journal of Cleaner Production 133101 (2022), https://linkinghub.elsevier.com/retrieve/pii/S0959652622026907. Compagnoni, *Supra* note 30.

[44] Nathan Kunz, Kieren Mayers and Luk N. Van Wassenhove, "Stakeholder Views on Extended Producer Responsibility and the Circular Economy," 60 California Management Review 45–70 (2018).

[45] Central Pollution Control Board (CPCB), "Environment (Protection) Act, 1986 — CPCB" (Central Pollution Control Board (CPCB))available at: https://cpcb.nic.in/env-protection-act/ (last visited October 7, 2025).

producers of electrical and electronic equipment (EEE). EPR was defined as a legal obligation for producers to reclaim end-of-life products and channel them to authorized dismantlers and recyclers.[46]

The E-Waste (Management and Handling) Rules, 2011, introduced several foundational provisions to establish a basic regulatory structure for managing end-of-life electrical and electronic equipment in India. One of the key regulatory features was the requirement for dismantlers and recyclers to obtain authorization from the respective State Pollution Control Boards (SPCBs). This measure aimed to ensure that only formally recognized and environmentally compliant entities could dismantle and recycle e-waste, thereby promoting safer handling of hazardous components embedded in it.[47]

3.2 The 2016 E-Waste (Management) Rules: Introducing Quantitative Targets and PROs

The E-Waste (Management) Rules, 2016 marked a significant regulatory advancement over the 2011 framework, introducing a more robust, target-driven, and institutionally inclusive approach to the governance of electronic waste in India. One of the most significant changes was the establishment of explicit, phase-wise collection targets under the Extended Producer Responsibility (EPR) mechanism. These targets were calculated based on the average lifespan of electrical and electronic equipment and were designed to progressively increase from 30% in the initial year to 70% by 2023. By moving away from the qualitative obligations of the 2011 regime, the 2016 Rules aimed to introduce quantifiable accountability into e-waste collection practices and encourage producers to achieve measurable compliance.[48]

Another critical innovation introduced in the 2016 Rules was the formal recognition of Producer Responsibility Organizations (PROs). These entities were authorized to act on behalf of producers to fulfill their obligations for collection and recycling. The institutionalization of PROs aimed to create specialized intermediaries that could bridge the gap between producers and recyclers, coordinate reverse logistics, and ensure compliance with regulatory targets.

The 2016 Rules also expanded the list of obligated stakeholders beyond producers and recyclers. For the first time, manufacturers, bulk consumers, dealers, e-retailers, and

[46] Central Pollution Control Board, Implementation of E-Waste (Management and Handling) Rules, 2011
[47] E-Waste (Management and Handling) Rules, 2011 of 2011, S.O. 1035(E).
[48] Ministry of Environment, Forest and Climate Change, Government of India, E- Waste Management Rules, 2016 (Government of India, New Delhi, March 2016)

refurbishers were explicitly brought within the regulatory fold. Each actor was assigned specific responsibilities for collecting, storing, or reporting e-waste. For example, bulk consumers were required to maintain records of e-waste generated and ensure its delivery to authorized dismantlers or recyclers. At the same time, refurbishers had to register and comply with environmentally sound refurbishment standards. This expanded stakeholder inclusion reflected a broader understanding of the e-waste lifecycle and the need for system-wide participation.[49]

3.3 The 2022 E-Waste (Management) Rules: Digitalization, Certification, and Circular Economy Orientation

The E-Waste (Management) Rules, 2022, notified in November 2022 and brought into effect from April 1, 2023, represent a paradigmatic shift in India's approach to regulating electronic waste. Replacing the 2016 framework, these rules are designed around technology-driven compliance systems, market-based accountability, and explicit alignment with the principles of a circular economy.[50] By integrating digital infrastructure, certificate-based trading, and refined monitoring mechanisms, the 2022 Rules constitute India's most comprehensive and systemic intervention in the e-waste regulatory landscape to date.[51]

Schedule III of the E-Waste (Management) Rules, 2022 establishes incremental, obligatory recycling targets for companies, correlating compliance with the average lifespan of electrical and electronic equipment (EEE) introduced to the market. The objectives are delineated as a percentage (by weight) of items reaching end-of-life within a specified year, starting at 60% for 2023–24 and 2024–25, increasing to 70% for 2025–26 and 2026–27, and culminating at 80% from 2027–28 onwards. This incremental escalation seeks to progressively enhance producer accountability while enabling the sector to develop sufficient collection and recycling capabilities. The framework establishes realistic recovery expectations by linking obligations to product lifespan, thereby encouraging design for recycling and long-term resource efficiency. Schedule III serves as a vital compliance standard, directly affecting producer responsibility organizations (PROs), the advancement of recycling infrastructure, and the

[49] Ministry of Environment, Forest and Climate Change, Government of India, E- Waste Management Rules, 2016 (Government of India, New Delhi, March 2016)
[50] Ministry of Environment, Forest and Climate Change (MoEFCC), "E-Waste (Management) Rules, 2022" (Government of India, 2022)
[51] Monika Sheoran & Devashish Das Gupta, *International Best Practices for E-Waste Take Back and Policy Interventions for India*, 42 F 376 (2024), http://www.emerald.com/f/article/42/3-4/376-404/1213079.

overall efficacy of India's Extended Producer Responsibility (EPR) framework.[52]

At the core of the 2022 Rules is the establishment of a centralized digital portal, maintained by the Central Pollution Control Board (CPCB). This portal is the single interface through which all stakeholders—producers, recyclers, dismantlers, refurbishers, and regulators—must interact. Registration on this portal is mandatory, and it acts as the backbone of the compliance system by facilitating the submission of returns and uploading documents, reconciling Extended Producer Responsibility (EPR) targets, and generating transaction histories. The digitalization of compliance aims to enhance transparency, traceability, and real-time monitoring, thereby addressing longstanding enforcement challenges inherent in previous regulatory regimes.[53]

A major innovation of the 2022 Rules is the EPR certificate method. A registered recycler can generate EPR certificates based on the amount of e-waste they treat sustainably. Electronic goods manufacturers must buy these certificates as traded instruments. To prove compliance, upload the certificate to the CPCB portal. Each certificate lasts two years and is priced within a CPCB-regulated band. Market-linked recycling encourages recycling, discourages paper compliance, and holds businesses accountable for internalizing waste costs or improving product design and lifecycles.[54]

3.4 Amendments to the 2022 E-Waste Rules: Analytical Overview

The E-Waste (Management) Rules, 2022, established a centralized, digital, and certificate-based system to promote circular economy objectives. Initial implementation difficulties led to three changes from January 2023 to March 2024, designed to enhance legal clarity, technical viability, and institutional responsiveness, while maintaining the fundamental objectives of the Rules.

3.4.1 First Amendment Rules, 2023 (Notified January 30, 2023 – Effective April 1, 2023)

The First Amendment to the E-Waste (Management) Rules, 2022, officially promulgated on

[52] Central Pollution Control Board, *E-Waste Management System*, https://eprewaste.cpcb.gov.in/#/target (last visited Sept. 16, 2025).
[53] Central Pollution Control Board, SOP for Registration of Stakeholder s on E Waste Management Portal under E Waste M Anagement Rules, 2022 (Central Pollution Control Board (CPCB), Ministry of Environment, Forest and Climate Change, October 2024).
[54] *Id.*

January 30, 2023, instituted two primary alterations. Rule 16(5), which once required producers to incorporate RoHS (Restriction of Hazardous Substances) compliance information in all product user manuals, has been amended.[55] The revised rule permits a more adaptable requirement, stating that such paperwork must be supplied "as and when required by the Central Pollution Control Board (CPCB)." This transition from a universal duty to a demand-driven approach reflects a deliberate effort to alleviate administrative burdens, particularly for small and medium enterprises (SMEs), while preserving the CPCB's capacity to enforce compliance where necessary.

The amendment extended Schedule II of the Rules by including two exemptions from RoHS substance limitations. These exemptions relate to (i) cadmium and lead utilized in solar panels, solar photovoltaic (PV) modules, and solar cells, and (ii) lead employed in medical equipment, excluding those that are implanted or diseased. These enhancements emphasize a pragmatic regulatory perspective that aligns India's standards with international practices.[56]

3.4.2 Second Amendment Rules, 2023 (Notified July 2023)

The Second Amendment to the E-Waste (Management) Rules, 2022, promulgated in July 2023, implemented specific modifications to Schedule II, chiefly augmenting the enumeration of exempted applications under the RoHS (Restriction of Hazardous Substances) regulations. It clarified specific entries by providing technical rationales or aligning them with recognized industry standards.[57] The amendment, however limited in scope, expanded upon the exemptions established in the First Amendment, providing enhanced clarity and flexibility for industries such as solar energy and medical equipment, where RoHS compliance presents practical difficulties.[58] Furthermore, it prioritizes secure and sustainable e-waste management, with a specific focus on refrigerants. Approved destruction technologies must now be adopted for managing refrigerants, overseen by the Central Pollution Control Board through guidelines with immediate enforceability.[59]

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[55] E-Waste (Management) Amendment Rules, 2023 of 2023, GSR 61(E).
[56] S. S. Rana and Co-Apalka Bareja, "Amendment of E-Waste (Management) Rules, 2022" Lexology, 2023available at: https://www.lexology.com/library/detail.aspx?g=74e4efc9-7b3b-4d22-a97c-a0fcce027ec1 (last visited August 8, 2025).
[57] Ministry of Environment, Forest and Climate Change, E-Waste (Management) Second Amendment Rules, 2023 G.S.R. 534(E), 2023.
[58] E-Waste (Management) Second Amendment Rules, 2023 of 2023, CG-DL-E-24072023-246285 G.S.R. 534(E).
[59] Legality Simplified, "E-Waste (Management) Second Amendment Rules, 2023 - Legality Simplified,"

3.4.3 Third Amendment Rules, 2024 (Notified March 2024)

The Third Amendment to the E-Waste (Management) Rules, 2022, announced in March 2024, initially redefined the term "dismantler" to differentiate it from recyclers and refurbishers, minimizing misunderstandings in stakeholder registration and job delineation. The deadline for completing yearly returns on the CPCB site has been extended by up to 9 months, giving producers and recyclers extra time to address issues and submit delayed filings without incurring immediate penalties.[60]

The amendment effectively implemented the long-awaited EPR certificate trading mechanism. It empowered the CPCB to establish a centralized digital platform for certificate exchange, including pricing regulation, stakeholder eligibility verification, and transparency protocols. This market-oriented concept integrates India's Extended Producer Responsibility approach with global best practices, including carbon trading, to ensure cost efficiency, the internalization of environmental costs, and a reduced risk of price manipulation.[61]

4. The Compliance-Centric Design of India's EPR Regime

In India's Extended Producer Responsibility (EPR) framework for e-waste, "challenges" include normative expectations and structural barriers. Besides policy design and stakeholder alignment, structural impediments, including enforcement gaps, logistical difficulties, insufficient awareness, and exclusion of the informal sector, directly affect implementation. Given their interconnection, this analysis uses "challenges" as an umbrella term to identify distinct concerns that impede EPR enforcement.

4.1 Administrative and Monitoring Gaps

A central administrative challenge in India's Extended Producer Responsibility (EPR) framework is the lack of reliable, comprehensive data systems. Official estimates produced by the CPCB heavily depend on producer disclosures, registered recyclers, and limited state-level reporting, thereby excluding the considerable volumes handled by the informal sector. In contrast, global assessments like the Global E-Waste Monitor employ standardized

2023available at: https://www.legalitysimplified.com/e-waste-management-second-amendment-rules-2023/ (last visited August 8, 2025).

[60] E-Waste (Management) Amendment Rules, 2024 of 2024, CG-DL-E-09032024-252788 G.S.R. 164(E).

[61] *Id.*

international models based on sales data, product lifespans, and material flow estimates, resulting in much higher estimates. The inconsistencies are worsened by inconsistent definitions of electrical and electronic equipment categories, varying treatment of components, and unreported cross-border transactions. The consequent statistical disparity highlights India's inadequate oversight. It reveals significant governance shortcomings, notably the lack of a unified, transparent system to monitor the generation and distribution of e-waste.[62] Furthermore, the lack of comprehensive data inventory systems and inadequate oversight by regulatory authorities pose significant challenges for overseeing producers' compliance with e-waste obligations. This gap hinders timely submissions, undermines transparency, reduces regulatory oversight, and undermines the overall effectiveness of India's Extended Producer Responsibility (EPR) framework.[63]

4.2 Low Infrastructure Capacity

Extended Producer Responsibility requires manufacturers to implement methods for the collection, recycling, and environmentally responsible disposal of products at the end of their life cycle. The effectiveness of this responsibility is significantly constrained by deficiencies in the institutional infrastructure required to facilitate these operations. Data on installed recycling capacity indicate that numerous states lack sufficient facilities, compelling producers to rely on the informal sector or leaving certain regions underserved. This architectural deficiency compromises the consistent implementation of EPR and diminishes its capacity to establish closed-loop, circular systems.

A key indicator of this disparity is the incongruence between India's total e-waste production and the existing recycling capacity quantified in metric tons per annum (MTA). In numerous states, installed capacity significantly lags behind generation, resulting in substantial amounts of e-waste that are either untreated or managed in environmentally hazardous ways.[64] This circumstance not only constrains adherence but also diminishes the environmental and resource recovery advantages that Extended Producer Responsibility (EPR) aims to provide. Regional disparities exacerbate this difficulty. Others, such as Haryana, Gujarat, and Tamil Nadu, exhibit

[62] Shailender Singh, Mani Sankar Dasgupta and Srikanta Routroy, "Analysis of Critical Success Factors to Design E-waste Collection Policy in India: A Fuzzy DEMATEL Approach," 29 Environmental Science and Pollution Research 10585–604 (2022).
[63] Bhaskar and Turaga, *Supra* note 16.
[64] Deblina Dutta and Sudha Goel, "Understanding the gap between formal and informal e-waste recycling facilities in India," 125 Waste Management 163–71 (2021).

comparatively high processing capacities and a more robust presence of licensed recyclers. In contrast, others, including Assam, Jammu & Kashmir, and Jharkhand, are significantly under-resourced. These disparities result in a disjointed system in which producers face inconsistent compliance obligations depending on their market presence across multiple jurisdictions. In the absence of localized, accessible infrastructure, producers are unable to fulfill their obligations under Extended Producer Responsibility (EPR), resulting in inconsistent implementation outcomes that undermine the policy's national effectiveness.

4.3 Dominance of the Informal Sector

In India, the informal sector is responsible for processing between 70% and 95% of the country's electronic waste, according to multiple studies. Recent estimates suggest that informal workers, often referred to as "kabadiwalas" or scrap merchants, manage more than 90 percent of electronic waste. These individuals gather, dismantle, and recycle electronic waste using rudimentary and often hazardous methods.[65] Despite recent expansion, the formal sector accounts for only a small share of the electronic waste generated, typically less than 10 percent.[66]

The prevailing informal sector underpins EPR goals as it operates outside regulatory control and reporting systems. This sector accounts for a significant percentage of the process. Producers struggle to meet mandated collection and recycling quotas under EPR rules.[67] This dominance implies that producers cannot precisely quantify the e-waste processed informally, leading to substantial underreporting and complicating the achievement of Extended Producer Responsibility (EPR) objectives.[68] Moreover, the lack of reliable data from the informal sector leads to inadequate inventory management and undermines the traceability required for efficient EPR compliance.[69]

Beyond the health and environmental damage, the informal sector incurs significant economic expenses. India forgoes approximately $10 billion per year due to environmental degradation,

[65] Diyasha Sengupta et al., "Circular economy and household e-waste management in India. Part II: A case study on informal e-waste collectors (Kabadiwalas) in India," 200 Minerals Engineering 108154 (2023); Yuvaraj Krishnamoorthy et al., "Emerging public health threat of e-waste management: global and Indian perspective," 33 Reviews on Environmental Health 321–9 (2018).
[66] Bhaskar and Turaga, *Supra* note 16.
[67] Deblina Dutta et al., *Supra* note 68.
[68] Anwesha Borthakur, "Design, adoption and implementation of electronic waste policies in India," 30 Environmental Science and Pollution Research 8672–81 (2022).
[69] Murthy and Ramakrishna, *Supra* note 42.

incurs more than $20 billion in social losses associated with reduced worker life expectancy, and loses nearly ₹80,000 crore in the value of essential metals that are unrecovered due to crude extraction techniques. Furthermore, the tax system incurs an annual deficit exceeding $20 billion due to the predominantly cash-based, unrecorded nature of informal recycling. These statistics highlight that informal dominance constitutes not only an environmental and governance crisis but also a significant depletion of national economic potential.[70]

4.4 Stakeholder Coordination Failure

A significant coordination challenge stems from the hierarchical division of responsibilities between the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs). The CPCB oversees the national digital compliance platform, whilst SPCBs are tasked with on-site enforcement, encompassing inspections and authorizations. The limited compatibility between centralized digital systems and state-level procedures has led to reporting discrepancies, inconsistent enforcement, and regulatory ambiguity for manufacturers and recyclers, thereby undermining the effectiveness of EPR duties.[71]

Horizontal coordination deficiencies further exacerbate these vulnerabilities, especially in the context of Producer Responsibility Organizations (PROs). The E-Waste Rules, intended as compliance intermediaries, offer scant direction on the mandates, performance requirements, or accountability procedures for Producer Responsibility Organizations (PROs). Consequently, PRO procedures exhibit significant variability, facilitating compliance arrangements centered on certification that emphasize documentation rather than authentic gathering and transparency, thereby compromising the integrity of the regulatory framework.[72]

4.5 Appropriate Economic EPR Instruments:

India's e-waste governance is complicated by the need to determine the most effective Extended Producer Responsibility (EPR) approach. Mandatory take-back mandates and exchange rules dominate policy frameworks, studies have shown, hindering efficient collection. Since take-back initiatives have not improved collection and recovery rates, recycling markets require

[70] Dhanendra Kumar, "India's rising e-waste, the need to recast its management" The Hindu, 12 May 2025, section Comment.
[71] Zikun Hu et al., "An evolutionary game study on the collaborative governance of environmental pollution: from the perspective of regulatory capture," 11 Frontiers in Public Health 1320072 (2024).
[72] Borthakur, *Supra* note 72.

more effective economic mechanisms. These techniques overlook the informal sector, which handles the majority of e-waste flows in India without regulatory oversight.[73] Numerous researchers have called for a rethink of India's Extended Producer Responsibility (EPR) plan, recommending economic measures to encourage compliance and secure sustainable funding. A comprehensive Extended Producer Responsibility (EPR) system, which includes Advanced Recycling Fees (ARF) or Advanced Disposal Fees (ADF), is gaining support. These fees are charged at the point of sale to consumers or producers to fund recycling programs.[74] The effectiveness of deposit–refund systems enhances take-back obligations, product returns, and eco-friendly product design. These approaches could strengthen India's e-waste management framework and increase producer responsibility for sustainable recycling by internalizing end-of-life costs into market prices.[75]

India's dependency on floor-level Extended Producer Responsibility certificate prices is another economic weakness. Worldwide, OEMs pay EPR fees well above the minimum required under India's regulations. Global Evidence demonstrates that these contributions maintain formal recycling networks and mitigate externalities from informal processing while slightly increasing consumer product costs and yielding significant environmental and social benefits. However, India's artificially low floor pricing undermines the trade in certificates and fails to fund authentic collection, treatment, and resource recovery.[76]

4.6 Upstream Gaps in E-Waste Regulation

India adopted Extended Producer Responsibility EPR at the core of the legal framework. EPR is a transformative policy approach that aims to make structural changes to waste management by shifting responsibility for waste generation from producers to governments or other parties. And enhance the sound environment in the industrial design, particularly on Electronic Waste.[77] Extended producer responsibility is initially suggested to maintain the ecological and environmental integrity of production. Thomas Linquvist, considered the father of EPR, developed his policy approach in his Ph.D. thesis, "Extended Producer Responsibility in Cleaner Production: Policy Principle to Promote Environmental Improvements of Product

[73] Priyanka Porwal and S. Chatterjee, "Extended Producer Responsibility on E-waste Management in India: Challenges and Prospects," 2019.
[74] Rama Mohana R. Turaga et al., "E-Waste Management in India: Issues and Strategies," 44 Vikalpa: The Journal for Decision Makers 127–62 (2019).
[75] Bhaskar and Turaga, *Supra* note 16.
[76] Dhanendra Kumar, *The Hindu*, *Supra* note 74.
[77] Compagnoni, *Supra* note 30.

Systems."[78] To give double attention to the environmental aspects of production rather than recycling and ecological disposal of waste.

Ecological Design (Eco design) is a central pillar of EPR. The United Nations Environment Program supports the Eco-design approach, which integrates environmental considerations into product development. Achieving Eco-design involves incorporating sustainable waste-management principles into product design, thereby enhancing its effectiveness and reducing waste. Empirical studies reinforce this view. Scholars such as Kieren Mayers et al. have demonstrated that EPR has proven successful in driving a closed-loop resource cycle by holding producers accountable for their products at the end of their lifespan, leading to the creation of easily disassembled, recyclable, and reusable products.[79] EPR, through its implementation across various countries and distinct circumstances, modifies both upstream and downstream stages of the product lifecycle, underscoring the need for strategies that address production activities, such as raw material extraction, as well as post-production activities.[80]

5. Governance Failure and the Limits of Target-Based Regulation

5.1 Achievements as Normative Openings Rather Than Outcomes

Simultaneously, it would be excessively simplistic to characterize India's EPR framework as a simple tale of failure. Although the digital compliance portal and EPR certificate system are still maturing, they are genuine innovations that offer new opportunities for transparency and accountability. These mechanisms should not be interpreted solely as technical fixes, but rather as normative openings that restructure the relationship among the state, producers, and recyclers. India has made strides toward implementing the polluter-pays principle by incorporating financial accountability into its compliance framework. Similarly, implementing refurbisher credits signifies a conceptual shift from linear waste management to a life-cycle approach.[81] Thereby, institutionalizing reuse as a valid compliance pathway. However, the genuine evaluation is not in the presence of these innovations, but rather in their capacity to

[78] Lindhqvist, *Supra* note 19.
[79] Kieren Mayers et al., "Redesigning the Camel: The European WEEE Directive," 15 Journal of Industrial Ecology 4–8 (2011).
[80] Gupt and Sahay, *Supra* note 24.
[81] Ayush Gautam, Ravi Shankar and Prem Vrat, "Managing end-of-life solar photovoltaic e-waste in India: A circular economy approach," 142 Journal of Business Research 287–300 (2022).

transform producer incentives and modify deeply ingrained practices.[82] If strict enforcement is not implemented, the risk is that these instruments will revert to a "certificate economy," resulting in paper compliance rather than tangible environmental improvements.[83]

National political leadership has articulated a normative vision that connects India's digital and economic revolutions with enhanced e-waste governance. This perspective has granted e-waste policy legitimacy and propelled the development of regulatory frameworks and collection objectives over the last decade.[84] Nonetheless, despite the effectiveness of agenda-setting, notable implementation deficiencies remain, particularly in incorporating the informal sector and its existing collection networks. The primary accomplishment lies in establishing a political and normative framework, rather than in achieving significant governance results.

5.2 Institutional Weaknesses and Structural Contradictions

The continual delays in compliance deadlines under the 2022 Rules indicate that accomplishments remain aspirational commitments rather than actual results. The framework anticipates a verifiable, market-driven Extended Producer Responsibility (EPR) ecosystem; yet, unfiled returns and underutilized certificate markets hinder the Central Pollution Control Board (CPCB) from accurately evaluating producer accountability or recycling effectiveness. This postponement undermines environmental accountability and diminishes the legal certainty needed to foster early investment in infrastructure and digital networks.[85] The government's adaptability demonstrates a pragmatic acknowledgment of the limitations encountered by small producers, emerging recyclers, and overburdened state bodies. Such extensions do not revoke the Rules, but instead defer their enforceability, delaying substantial progress toward a high-integrity circular e-waste system. Addressing this gap necessitates technical enhancements, improved coordination, and ongoing capacity-building to convert normative aspirations into tangible compliance.

As of September 2025, there are 9,560 producers registered on the CPCB's E-Waste

[82] Kumar et al., *Supra* note 425.
[83] Daan Hulshof, Catrinus Jepma and Machiel Mulder, "Performance of markets for European renewable energy certificates," 128 Energy Policy 697–710 (2019).
[84] Natasha Deshwal, "India's E-Waste Management: Analysis and Opportunities for a Sustainable Future" (unpublished Master's thesis, Queen Mary University of London, School of Geography, London, 2024).
[85] Ramachandran Rajesh, Dharmaraj Kanakadhurga and Natarajan Prabaharan, "Electronic waste: A critical assessment on the unimaginable growing pollutant, legislations and environmental impacts," 7 Environmental Challenges 100507 (2022

Management System portal.[86] This is a significant increase over the 2,061 authorized producers recorded in July 2022.[87] This nearly fivefold increase in just over three years signifies the expedited formalization of producer compliance under the E-Waste (Management) Rules, 2022. The expansion fortifies regulatory monitoring, enhances the traceability of e-waste movements, and expands the scope for achieving targets and enforcing compliance through the EPR framework. This rapid rise increases the pressure on CPCB's monitoring capabilities. It highlights the need for effective digital reporting, prompt filing of returns, and regular follow-up to ensure that registration leads to genuine compliance rather than mere ceremonial adherence.

5.3 Extended Producer Responsibility as Policy Innovation

The global proliferation of EPR exemplifies the strengths and weaknesses of policy transfer. Its conceptual clarity—the extension of the polluter pays principle throughout the lifecycle of a product—makes it appealing on a global scale. However, the inconsistent way it is implemented demonstrates the extent to which local circumstances shape governance instruments.[88] Germany's integration of municipalities guaranteed accountability, whereas China's centralized control expanded recycling but diminished individual incentives. These discrepancies indicate more profound institutional logics: federal decentralization and centralized industrial governance.[89]

The reflective question for India is whether EPR will serve as a transformative instrument or a bureaucratic ritual. Global models significantly influence the 2022 Rules but are still rooted in a governance culture that prioritizes symbolic over substantive compliance. This reveals a broader paradox of environmental regulation in the Global South: policies are often implemented to signal compliance with global norms, yet structural constraints limit their transformative potential. Therefore, EPR should not be interpreted solely as a technical instrument but as a test of India's ability to reconcile global aspirations with domestic

[86] CPCB, Authorized Producers — E-Waste EPR Portal, *Supra* note 506.
[87] Ministry of Environment, Forest and Climate Change, "Extended Producer Responsibility" (Press Information Bureau (PIB),Government of India, 2022) *available at*: https://www.pib.gov.in/PressReleasePage.aspx?PRID=1842627 (last visited September 19, 2025).
[88] E. (Ellen) Minkman, M. W. (Arwin) Van Buuren and V. J. J. M. (Victor) Bekkers, "Policy transfer routes: an evidence-based conceptual model to explain policy adoption," 39 Policy Studies 222–50 (2018).
[89] Elizaveta Kuznetsova et al., "Integrated decision-support methodology for combined centralized-decentralized waste-to-energy management systems design," 103 Renewable and Sustainable Energy Reviews 477–500 (2019).

institutional realities.[90]

5.4 Indian Challenges, Limitations, and Successes

Policy discourse often exaggerates EPR's collection rate gains and municipal burden reductions. EPR may be more effective at waste management than production system transformation due to enforcement issues, limited eco-design innovation, and widespread free riding. EPR can be implemented; however, the regulatory framework prioritizes downstream management over upstream responsibility, addressing symptoms of waste rather than its systemic causes.

Indian institutional governance limits exacerbate these shortcomings. Enforcement issues stem from institutional diseases such as fragmented jurisdictional authority, limited regulatory capacity, and political reluctance to oppose prominent industrial actors. Implementing international regulatory models, such as the EU's WEEE framework, without contextual adaptation has exacerbated these issues, particularly by marginalizing India's vast informal recycling sector.[91]

Paradoxically, India's most effective participants in the e-waste ecosystem are excluded from official governance structures. The EPR regime risks damaging collection systems by imposing exclusionary compliance requirements rather than integrating informal recyclers into its regulatory design. This highlights a fundamental governance question: does India's EPR framework prioritize environmental protection or market formalization for select actors? In this context, EPR's shortcomings are inherently rooted in the political economy of environmental regulation.

6. Conclusion

This study aims to critically assess Extended Producer Responsibility as the fundamental component of India's e-waste governance and its claimed contribution to furthering circular economy goals. The analysis indicates that India’s Extended Producer Responsibility (EPR) framework has made significant advancements in regulatory formalization, digitalization, and the political acknowledgment of e-waste as a policy priority. Instruments such as the

[90] Saroj Kumar Pani and Atul Arun Pathak, “Managing plastic packaging waste in emerging economies: The case of EPR in India,” 288 Journal of Environmental Management 112405 (2021).
[91] Borthakur, *Supra* note 72.

centralized compliance portal, EPR certificates, and quantified recycling targets signify genuine institutional progress and demonstrate a progressive commitment to producer accountability.

Nonetheless, the results suggest that these accomplishments primarily operate at a normative and procedural level. The Indian EPR framework is focused mainly on verifiable compliance rather than meaningful circular transformation. Deficiencies in enforcement, inadequate upstream requirements for eco-design and product durability, fragmented jurisdictional authority, and the marginalization of the informal sector all constrain the regime's transformative capacity. EPR primarily serves as a downstream waste-management strategy that alleviates symptoms of e-waste generation without tackling the underlying systemic causes, hence leaving production systems largely unaltered.

The enduring presence of informal recycling networks, which handle the majority of e-waste processing, underscores a fundamental governance contradiction. The most efficient material recovery entities in India are often excluded from official regulatory frameworks, while compliance processes may prioritize documentation and certificate trade over genuine environmental outcomes. The dynamics indicate that the deficiencies of EPR stem not solely from administrative inadequacy, but are ingrained in the political economics of environmental regulation and the selective application of global policy frameworks.

This research highlights the constraints of target-based regulation in achieving significant environmental change by framing these processes as an "illusion of circularity." For Extended Producer Responsibility (EPR) to serve as an authentic circular-economy tool, it must be reconceptualized as a governance framework that emphasizes upstream accountability, incorporates informal participants, and aligns enforcement strategies with material outcomes rather than procedural indicators. The Indian experience offers significant insights for the Global South, demonstrating that transitions to a circular economy require not only legal ambition but also institutional coherence, local adaptability, and political resolve to address persistent structural impediments.