

Extended Producer Responsibility And Municipal Solid Waste Management In Delhi: A Legal And Comparative Analysis

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Abstract

Municipal Solid Waste (MSW) management in Indian cities is at a crossroads. Urbanization, population growth, and changing consumption patterns have overwhelmed traditional waste management systems, resulting in severe environmental degradation. In response, Extended Producer Responsibility has emerged as a regulatory innovation that shifts the onus of post-consumer waste management onto producers, thereby internalising the environmental costs of production and promoting circularity. This paper investigates the implementation of EPR within the framework of MSW management in Delhi. It evaluates the legal architecture governing EPR in India, the operational challenges in its local implementation, and the institutional dynamics that shape compliance. The paper further engages in comparative analysis, studying Indore's waste governance model, China's EPR framework, and elements of best practice that Delhi could adopt. This paper proposes legal and administrative reforms through doctrinal analysis and policy critique to strengthen EPR as a core pillar of sustainable urban waste governance in India.

Keywords: Municipal Solid Waste, Extended Producer Responsibility, Delhi, Environmental Degradation, Sustainable Development, Waste Governance Model, Urban Waste Governance, India, Indore, China, Germany

INTRODUCTION

Municipal solid waste (MSW) has become a defining environmental and governance challenge in the 21st-century urban landscape. Indian cities, as nodes of rapid urbanisation, are grappling with an exponential rise in waste generation, exacerbated by increasing population densities, evolving lifestyles, and unsustainable consumption patterns. According to recent estimates by the Central Pollution Control Board (CPCB), Urban India generates about 160,038.9 tonnes per day (TPD) of solid waste from which about 152,749.5 TPD is collected which means that collection efficiency is around 95% for the aggregated data. Out of the collected waste, 79,956.3 TPD, which is about 50% of the total generated waste, undergoes some form of treatment or processing. Meanwhile, 29,427.2 TPD (\approx 18.4% of total generated) is disposed of in landfills. Another significant portion of 31.7% remains unaccounted for in terms of treatment or disposal pathways [1].

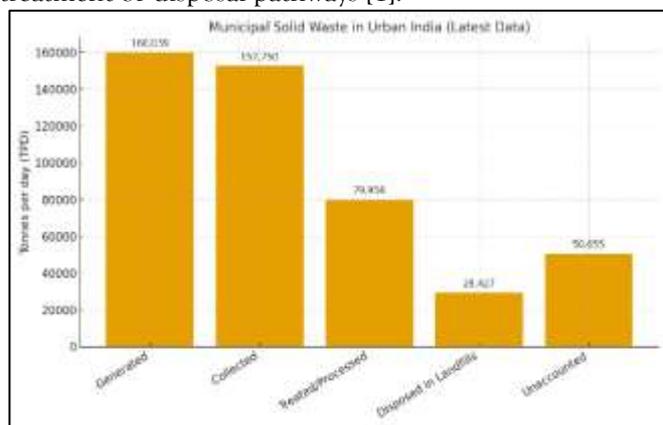


Figure 1- Graphical depiction of municipal solid waste in urban India

Overflowing landfills, contaminated rivers, deteriorated air quality, and increased dangers to public health are all signs of this systemic failure. Delhi, India's capital and one of its largest megacities, is emblematic of this crisis. Generating more than 11,000 metric tonnes of MSW daily, Delhi's waste management system is under extreme stress, burdened by inadequate infrastructure, weak enforcement, and fragmented institutional responsibility [2]. The three major landfill sites in the city Ghazipur, Bhalswa, and Okhla have far exceeded their saturation limits, contributing to methane emissions, groundwater contamination, and frequent fires. Despite multiple judicial interventions and policy initiatives, sustainable and decentralised waste management in Delhi remains largely aspirational. In recent years, the concept of Extended Producer Responsibility (EPR) has gained traction as a regulatory innovation that seeks to reconfigure responsibility for post-consumer waste management. EPR, based on the 'Polluter Pays Principle' and life cycle thinking, assigns producers the financial and physical responsibility for the collection, recycling, and environmentally sound disposal of products once they are discarded by consumers. First institutionalised in the environmental policy regimes of OECD countries in the early 1990s, EPR has since become a global best practice to promote sustainable product design, circular economy goals, and shared responsibility mechanisms [3].

This paper aims to address a significant gap in the legal and policy discourse on EPR in India. The introduction situates the problem within India's rapid urbanisation and growing plastic consumption, while also outlining key models of extended producer responsibility (EPR). The section on the legal framework examines the evolution of Indian EPR law, particularly the Plastic Waste Management Rules, 2016 and their amendments, highlighting gaps in enforcement. The discussion on the state of waste management in Delhi provides an empirical overview of waste generation, landfill dependence, and the role of informal waste workers. A comparative analysis then draws lessons from Indore's decentralised governance, China's digitalised EPR enforcement, and Germany's Green Dot system. Building on this, the critical analysis identifies structural weaknesses in Delhi's current EPR regime, including weak municipal integration and superficial producer compliance. The recommendations and way forward section sets out practical policy steps, such as legal amendments, digital traceability, and civic participation. Finally, the conclusion underscores the need for political will, multi-stakeholder trust, and systemic reforms to transform Delhi's waste management into a sustainable and equitable model.



Figure 2- Ghazipur landfill site [4]

LEGAL AND POLICY FRAMEWORK OF EXTENDED PRODUCER LIABILITY AND MUNICIPAL SOLID WASTE MANAGEMENT INDIA

The legal foundation for waste management and environmental protection in India emanates from both constitutional mandates and statutory enactments. The Constitution of India, through Article 48-A (Directive Principles of State Policy), obliges the State to "endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country [5]." Article 51(A) (g) [6] further casts a fundamental duty on every citizen to protect and improve the natural environment. Judicial interpretation by the SC has progressively integrated under Article 21, the right to a healthy and clean environment, so that a person can have a fulfilling life. The Municipal Solid Waste (Management and Handling) Rules, 2000, which were the first comprehensive attempt to codify urban waste management, placed the onus of collection, segregation, and disposal on municipal authorities. However, they were silent on the role of producers and lacked provisions for minimising waste at source. This changed with the introduction of revised waste management rules in 2016, which significantly broadened the scope and incorporated EPR obligations:

1. **Plastic waste management rules, 2016:** These rules mark the first formal codification of EPR obligations in India. They require producers, importers, and brand owners (PIBOs) to establish waste

collection systems, either individually or through Producer Responsibility Organisations (PROs) [7]. The 2022 amendment established measurable objectives grounded in Extended Producer Responsibility Certificates and permitted credit trading systems, inspired by European frameworks.

2. **E-waste (management) rules, 2016 (now revised in 2022):** These regulations give manufacturers of electrical and electronic equipment access to the EPR framework. Producers are subject to yearly compliance requirements and are required to direct e-waste to approved dismantlers and recyclers [8].

3. **Batteries waste management rules, 2022:** Established under the "Battery Waste Management" initiative, these regulations construct a circular economy framework for batteries. For accountability, they incorporate traceability technologies like QR code-based tracking systems into EPR duties [9].

The implementation landscape of these rules are nevertheless fragmented, especially when it comes to incorporating EPR into the MSW regime, even if these regulations represent a progressive trajectory in waste administration. MSW, in contrast to plastic or e-waste, is still subject to the Solid Waste Management Rules, 2016, which emphasise local body accountability without imposing EPR requirements on manufacturers of packaging or non-durable consumer items that make up a sizable portion of urban solid waste.

The regulatory landscape for EPR and MSW management in India is marked by institutional multiplicity. The nodal organisation for the nationwide implementation, oversight, and enforcement of EPR targets is the CPCB. Additionally, it provides compliance reports and allows PIBOs and PROs to register. However, there are frequently jurisdictional overlaps because implementation is shared by SPCBs and ULBs. Under the 74th Constitutional Amendment Act, which gives municipalities the authority to regulate urban planning and sanitation, ULBs are principally in charge of municipal waste management. However, these bodies often lack the capacity, resources, or expertise to enforce EPR norms on producers operating nationally or across multiple jurisdictions. The difficulties in monitoring are made worse by the lack of a centralised digital compliance infrastructure. Even though the CPCB created the EPR Portal for Plastic Waste, many smaller manufacturers are still outside of its purview because they have not registered or have provided incorrect information, and its interaction with local enforcement mechanisms is still lacking [10].

The Indian judiciary has been instrumental in establishing the framework for waste management regulations. In *Almitra H. Patel v. Union of India* [11], the SC issued a few guidelines like collecting waste from door to door, segregation of waste should be done at the source, and scientific landfilling, to enhance municipal solid waste management. The ruling called for capacity-building and monitoring systems and emphasized the municipal organizations' noncompliance with their statutory duties. *Municipal Council, Ratlam v. Vardhichand* [12]. In this landmark case, the court held that statutory authorities couldn't plead financial incapacity as a defence to non-compliance with environmental duties. Although the case pre-dates EPR frameworks, its doctrinal value remains critical in enforcing producer and government accountability. Recent orders from the National Green Tribunal (NGT) have also sought to enforce EPR obligations. In *Aryavart Foundation v. Union of India*, [13] the NGT directed the CPCB and SPCBs to ensure strict compliance with EPR targets and maintain real-time data on producer registration and PRO operations. The Tribunal has also issued suo motu directions for integrating the informal sector into formal waste streams, particularly in the plastic and e-waste sectors. However, enforcement remains weak in the absence of penal consequences for false compliance declarations, and judicial orders are often complied with in form rather than in substance. A significant policy disconnect exists between the EPR framework and India's MSW management.

While EPR rules are now reasonably robust on paper, for e-waste and plastic, they operate in silos disconnected from the broader municipal waste management ecosystem. Packaging materials, which form a major component of urban MSW, fall under the Plastic Waste Management Rules, yet municipal bodies continue to treat them as undifferentiated waste, thereby diluting the effectiveness of source segregation and traceability [14]. Moreover, many of the waste streams regulated under EPR (such as batteries, electronics, or multilayered plastics) ultimately enter the municipal waste stream. Without coordination between ULBs and producer systems, this leads to duplication, leakage, or outright loss of recyclable materials. An integrated model of governance that links EPR mandates to the logistical capabilities of ULBs is urgently needed. Efforts at convergence, such as the National Action Plan for EPE and Swachh Bharat Mission 2.0, are welcome developments, but they remain limited in scope and rely heavily on voluntary compliance. The inclusion of digital traceability tools, geo-tagging of collection points, and

decentralised Material Recovery Facilities (MRFs) would go a long way in harmonising producer obligations with municipal capacities.

CASE STUDY - DELHI'S MUNICIPAL SOLID WASTE CRISIS AND THE ROLE OF PRODUCERS

Delhi, with a population exceeding 20 million, is one of the largest urban agglomerations in the world. Unsurprisingly, it also ranks among the highest in terms of generation of MSW. As of June 2025 according to the data from the Delhi Pollution Control Committee (DPCC), the city generates solid waste per day of around 11,342 metric tonnes, a figure projected to rise significantly with urban expansion and rising consumption levels. This waste comprises biodegradable matter (approximately 50–55%), non-biodegradable dry waste such as plastic and paper (30–35%), and inert materials (10–15%). Delhi operates several Waste to Energy (WtE) plants with the following capacities: Ghazipur: 1,300 TPD (12 MW), Narela-Bawana: 2,400 TPD (24 MW), Tehkhand: 2,000 TPD (25 MW) and Okhla: 2,000 TPD (21 MW). Approximately 622.4 TPD of waste is processed at composters, biogas plants, organic waste converters, and compost pits. Material Recovery Facilities (MRFs): Around 271 TPD of waste is recycled through 170 material recovery facilities and approximately 4,360 TPD of waste is disposed of at dumpsites, contributing to the growing legacy waste at sites like Ghazipur, Okhla, and Bhalswa [15].

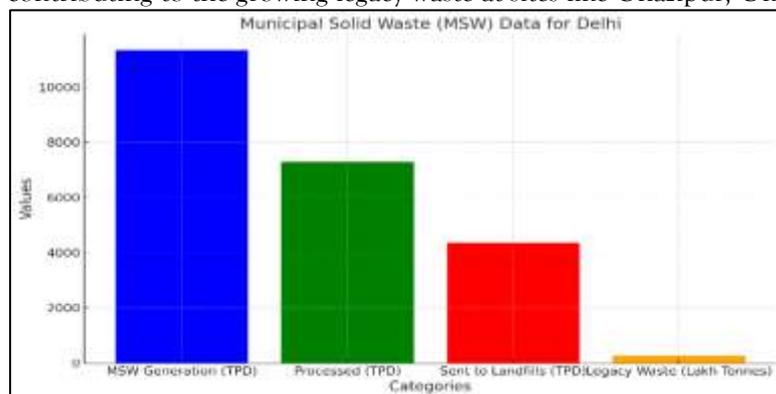


Figure 3. Graphical depiction of solid waste generation and management in Delhi

Despite several policy efforts, Delhi continues to grapple with severe inefficiencies in waste segregation, collection, and disposal. A major share of waste ends up in the city's overburdened landfills at Ghazipur, Bhalswa, and Okhla sites that have long exceeded their intended capacities and now pose significant environmental and public health risks. In Delhi, management of solid waste falls under the purview of MCD and NDMC. These urban local bodies are tasked with waste collection, transportation, processing, and disposal. However, their operational effectiveness is hampered by resource limitations, inconsistent administrative restructuring, and a lack of coordination between departments. Even with the Solid Waste Management Rules, 2016, which mandate segregation at source and scientific processing, compliance remains sporadic. On the EPR front, Delhi does not have a distinct city-level framework that integrates producer obligations into its MSW system. While producers are required to register with the CPCB under national-level plastic and e-waste rules, there exists no effective enforcement or monitoring mechanism to ensure that the waste generated by such producers is being scientifically managed within the city. In essence, the disjuncture between national EPR obligations and local solid waste responsibilities has created a compliance vacuum.

A significant proportion of Delhi's solid waste burden stems from plastic packaging and disposable items, categories directly regulated under EPR provisions. Multilayered packaging, which is often used in food, beverage, and consumer goods, is non-recyclable and constitutes a growing component of Delhi's dry waste stream. Despite the existence of multiple Producer Responsibility Organisations operating in Delhi, ground-level compliance is largely confined to token collection drives or partnerships with private recyclers with limited geographical coverage[16]. Many major fast-moving consumer goods (FMCG) companies claim to be meeting EPR obligations through PROs. However, evidence from audits and NGT orders suggests that these claims are often inflated, and traceability of the collected waste remains minimal [17]. This failure has a direct impact on Delhi's municipal system, which ends up handling a large proportion of this producer-generated waste without receiving any financial or infrastructural support from the producers responsible.

Furthermore, informal waste pickers, who play a vital role in material recovery in Delhi, are not integrated into official PRO operations. This exclusion not only undermines the effectiveness of recycling but also erodes livelihoods and reduces transparency in material flow. The National Green Tribunal (NGT) has issued multiple orders with respect to waste management in Delhi. In *Almitra H. Patel v. Union of India*, the Supreme Court lamented Delhi's "waste mountains" landfills and directed the authorities to adopt scientific waste processing techniques and ensure accountability for non-compliance. More recently, the NGT, in *Suo Motu v. Govt. of NCT of Delhi*, took cognisance of the growing plastic waste burden and directed the Delhi government and CPCB to furnish status reports on EPR enforcement in the region [18]. Despite such directives, tangible outcomes remain limited. While the Delhi government has introduced measures such as plastic bags, material recovery facilities (MRFs), and door-to-door waste collection, these have not been adequately supported by producer participation or robust monitoring. Delhi's informal recycling sector is a complex and decentralised network of ragpickers, scrap dealers, and middlemen who collectively recover an estimated 20–25% of the city's recyclable waste [19]. These actors perform essential services that are often invisible in formal waste management systems. Ironically, their labour contributes significantly to achieving recycling targets, yet their efforts are neither recorded in official EPR compliance reports nor remunerated by producer organisations. Studies have shown that integration of informal workers into formal PRO operations through co-operative models or public-private partnerships can increase collection efficiency, ensure fair compensation, and improve waste traceability. However, such integration remains ad hoc and limited to isolated pilot projects, largely driven by non-governmental organisations (NGOs) rather than the producers themselves. The Delhi experience demonstrates a broader implementation deficit in India's EPR framework. Key gaps include:

1. **Lack of localised planning:** There is no city-specific EPR roadmap that maps producer obligations to municipal waste flows or sets quantifiable local targets.
2. **Weak data and reporting systems:** Delhi's waste data infrastructure is fragmented, with discrepancies between producer declarations, PRO operations, and municipal records.
3. **Poor coordination between CPCB AND ULBS:** EPR enforcement remains centralised, while actual waste management is localised, creating a structural disconnect from execution.
4. **Inadequate incentives for eco-design or waste minimisation:** The current system does not reward producers for reducing packaging waste or innovating biodegradable alternatives.
5. **Limited use of digital tools:** While CPCB has initiated EPR portals, Delhi lacks a real-time monitoring platform that integrates municipal and producer data to ensure transparency. In sum, Delhi's MSW crisis is not merely a municipal failure but also a consequence of non performing producer responsibility systems, which remain poorly institutionalised at the city level.

COMPARATIVE PERSPECTIVES- LESSONS FROM INDORE, CHINA AND GERMANY

International and domestic best practices in waste management offer valuable insights for improving Delhi's Extended Producer Responsibility implementation and overall waste governance systems. Examining successful models from cities like Indore, countries such as China, and other advanced jurisdictions reveals innovative approaches to stakeholder coordination, technology integration, and policy enforcement that could be adapted to Delhi's unique urban context.

A. Indore: Model of Decentralised Waste Governance and Civic Engagement

Indore, consistently ranked India's cleanest city under the Swachh Survekshan, provides a notable contrast to Delhi in terms of MSW management. With a population of over 2 million, Indore generates nearly 1,200 metric tonnes of waste daily approximately one-tenth of Delhi's but manages to process nearly 100% of its waste scientifically through a decentralised, well-monitored system [20]. Key to Indore's success has been its integrated approach involving source segregation, door-to-door collection, and real-time GPS tracking of waste vehicles. The Indore Municipal Corporation (IMC) has institutionalised daily segregation into six categories, with strong community mobilisation and penal action for non-compliance. While the city does not yet operate a robust formal Extended Producer Responsibility (EPR) mechanism, its model offers three vital lessons.

1. **Localised monitoring infrastructure:** By employing QR codes, RFID tags, and control rooms, Indore has ensured high visibility and traceability in waste collection, an essential prerequisite for EPR traceability.

2. **Formalisation of the informal sector:** Indore has successfully integrated thousands of ragpickers into the formal system through SHGs and registered cooperatives, a model Delhi has struggled to replicate.

3. **Public-private partnerships (PPPS):** The IMC has engaged private players through performance-based contracts, ensuring accountability in secondary waste processing.

If such a model were to incorporate a producer-municipality contract framework, wherein FMCG and packaging companies co-finance infrastructure or logistics, it could provide a replicable EPR-MSW convergence model.

B. China: Regulatory Rigour and Digital Governance in EPR

China offers a sharply contrasting model of centralised regulatory enforcement backed by digital governance. The country implemented its EPR framework through its Circular Economy Promotion Law (2009) and the subsequent EPR Implementation Plan for Waste Electrical and Electronic Products (2016) [21]. The government mandates producers to contribute to a special EPR fund, used for subsidising certified recyclers.

Significantly, China's success in EPR is underpinned by three critical mechanisms:

1. **Digital product tracking:** Every electrical or plastic product unit is given a unique identification number, which makes it possible to follow its lifecycle from manufacturing to recycling.

2. **Mandatory producer contribution:** Businesses have a significant financial incentive to reduce packaging waste since they contribute to an EPR fund based on sales volume.

3. **Audit-driven enforcement:** Regulatory compliance is validated via third-party audits, diminishing dependence on self-reported returns. The Green Points concept fosters public participation in the implementation of Extended Producer Responsibility (EPR) by incentivizing customers to return recyclables for digital credits. China's model emphasizes the efficacy of compulsory contributions and data-driven regulation, in contrast to India's Extended Producer Responsibility (EPR) framework, which is predominantly voluntary and reliant on self-reporting.

C. Germany: Originator of EPR and The Dual System

Germany is acknowledged as the origin of Extended Producer Responsibility (EPR), having implemented the Packaging Ordinance of 1991, which established the inaugural dual collection system, Der Grüne Punkt (The Green Dot). Producers must either return their packaging trash or engage external Producer Responsibility Organizations, such as DSD GmbH, to collect and recycle the materials on their behalf [22]. The success of Germany rests on:

1. **Clear cost internalisation:** EPR prices are directly related to the type, size, and ability to recycle of the package. Wasteful design is not encouraged because packaging that can't be recycled costs more.

2. **Consumer-producer cooperation:** Residents must put their trash in the right colored bins; if they don't, they could get fined or have their service cut off. India has tried to copy some parts of this system, like EPR certificates and goals for recycling, but the results are still not consistent because there aren't enough ways to see what's going on.

COMPARATIVE ANALYSIS AND LESSONS FOR DELHI

Different yet complementary models are revealed by the comparative overview:

Aspect	Indore (India)	China	Germany
Governance structure	Decentralized	Centralized	Hybrid (federal-local integration)
Role of producers	Minimal	Primarily financial	Financial and operational
Integration of informal sector	Strong	Limited	Minimal (largely mechanized)
Data and monitoring infrastructure	Basic, locally managed	Advanced, centrally coordinated	Advanced, nationally standardized

Enforcement mechanism	Civic led (community engagement)	State-led	Regulator-led (compliance-driven)
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The operational synergy and regulatory coherence present in these models are absent in Delhi. Several lessons are still relevant despite its greater population and more intricate administrative structure. Add manufacturers to ward-level planning with the help of local EPR mapping, like the kind that can be found in Indore. Set up centralized traceability systems like the ones used in China to keep track of how plastic trash gets from the person who makes it to the person who recycles it. Set up a third-party register like Germany's Central Packaging register to make sure that customers know about compliance data and that it is clear.

Also, India's future EPR reforms need to fix the problem of uneven enforcement between local laws and national rules. This problem can be solved by setting up urban EPR teams within city governments and giving them the job of integrating producer logistics into the flow of waste in cities. Since Delhi's MSW problem is getting worse, we need a comprehensive plan that includes producer responsibility in the management of urban trash, not a bunch of separate steps. Due to the current gap between national EPR rules and municipal implementation, producer duties are mostly just for show. Delhi needs an Integrated Extended Producer Responsibility Framework that makes producers part of the city's trash ecosystem by giving them clear legal, financial, and logistical duties and making sure that national laws are followed by local police.

WAY FORWARD AND RECOMMENDATIONS

The analysis of Delhi's municipal solid waste management within the context of extended producer liability (EPL) underscores the pressing need for comprehensive reforms that transcend disjointed regulations and superficial adherence. Currently, although the Plastic Waste Management Rules, 2016 establish a national mandate for producers, their responsibilities are frequently undermined at the municipal level due to insufficient institutional clarity, inadequate enforcement capabilities, and the lack of financial mechanisms that compel producers to co-finance waste recovery.

A clear way forward is the adoption of an integrated EPL model tailored to Delhi's specific governance and demographic context. Such a model would require legislative amendments to the Delhi Municipal Corporation Act, 1957 to explicitly authorise municipal authorities to demand producer compliance, establish a dedicated Urban EPR Cell within the municipal structure to verify targets and coordinate recovery systems, and design financial instruments such as EPR bonds or municipal surcharges that ensure producers contribute proportionately to the costs of waste management. Only when producers are structurally embedded in the financial and operational aspects of waste governance will the principle of extended liability move from paper to practice.

Equally important is the recognition that effective EPL cannot function in isolation from the social and institutional realities of Delhi's waste economy. The city's estimated 1.5 lakh informal waste pickers contribute substantially to material recovery yet remain excluded from producer-led recovery frameworks. A forward-looking model must therefore formalise their role by mandating registration with producer responsibility organisations, providing social protections such as health insurance and safety equipment, and integrating them into reverse logistics chains financed by producers. At the same time, governance must shift from a centralised, opaque structure to a decentralised and transparent system of accountability, where each municipal ward is treated as a unit of producer responsibility and waste flows are digitally tracked through GPS-enabled collection vehicles, QR-coded bins, and real-time dashboards accessible to the public. Comparative lessons reinforce these imperatives: Indore's decentralised civic monitoring shows the power of localised systems, China demonstrates the effectiveness of mandatory producer contributions and digital tracking, and Germany illustrates how transparent registries and cost-internalisation can reshape packaging design itself. If Delhi is to move forward, it must hybridise these models into a governance framework that is locally grounded but globally informed. There should be a life cycle approach according to which EPR introduces environmental thinking at the product design stage, compelling manufacturers to reduce waste generation, use recyclable materials, and extend product lifespans.

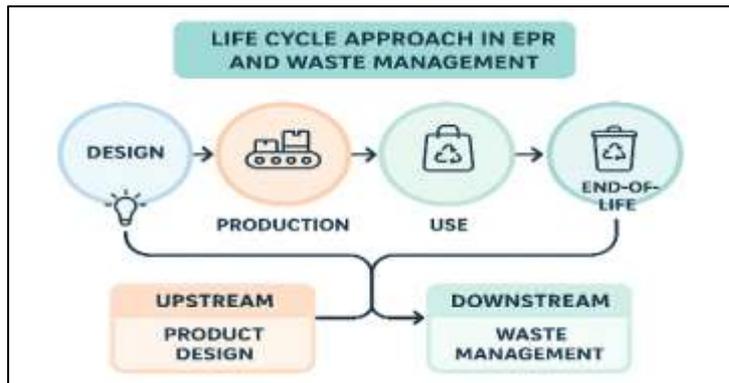


Figure 4- Life cycle approach and waste management

Finally, the success of such reforms depends not merely on regulatory innovation but also on political will and civic participation. Delhi's waste crisis is compounded by overlapping jurisdictions between municipal authorities, state government, and central regulators, which has historically led to inertia and blame-shifting. The way forward lies in creating multi-level coordination platforms involving regulators, producers, municipalities, informal workers, and civil society, monitored through quarterly disclosures and judicial oversight. Public participation is equally vital, both through behavioural change campaigns on segregation and through mechanisms such as deposit-return incentives that encourage citizen involvement in producer-led recovery. In this sense, the future of EPL in Delhi is not simply a legal or technical question, but a question of governance ethics—whether producers, regulators, and citizens can together construct a system where responsibility for waste is fairly distributed and environmental sustainability becomes integral to urban living. If pursued seriously, an integrated EPL model could transform Delhi from a symbol of waste mismanagement into a replicable model of sustainable, inclusive, and accountable waste governance in India.

CONCLUSION

The incorporation of Extended Producer Responsibility (EPR) into municipal solid waste management is both an environmental need and a governance imperative in response to Delhi's severe urban difficulties. The current framework, based on the Plastic Waste Management Rules, 2016, is undermined by structural deficiencies, including the disparity between national directives and municipal capabilities, the marginalization of informal sector workers, and the absence of accountability measures for manufacturers. A restructured framework for Extended Producer Responsibility (EPR) in Delhi must consequently rectify these shortcomings while conforming to the overarching obligations of the United Nations Sustainable Development Goals (SDGs).

The study contextualizes EPR within the aims of Agenda 2030, specifically relating to SDG 11 concerning sustainable cities and communities. Integrating EPR into local government frameworks and decentralizing planning to the ward level can yield waste management systems that are participatory, transparent, and efficient. The incorporation of producer accountability across the lifecycle of packaging and consumer goods promotes SDG 12 regarding responsible consumption and production. Proposals such as the establishment of local EPR bonds, collaborative partnerships between producers and municipalities, and design-oriented waste reduction directly confront the unsustainable linear economy and promote the shift towards circularity.

Moreover, EPR significantly influences climate initiatives pertaining to SDG 13. Methane emissions from landfills, improper plastic disposal, and inefficiencies in waste management substantially add to Delhi's carbon footprint. Digital monitoring and traceability systems can bolster climate resilience by assuring adherence to regulations and diminishing emissions through enhanced waste management. The socio-economic integration of informal trash workers is crucial. Identifying their function via identity cards, minimum salaries, and social welfare benefits corresponds with SDG 8 about decent labor and economic growth. This rights-based approach rectifies a persistent neglect in waste governance and strengthens the ethical underpinnings of environmental labor.

The emergence of institutional synergy stands out as a vital aspect of reform. Collaborative efforts among local government entities, producer responsibility organizations, pollution control agencies, and community stakeholders play a crucial role in advancing SDG 17. Through the promotion of collaboration among public, private, and informal sectors, a robust governance framework can be

established. Nonetheless, a continuous normative gap in India's EPR framework is its lack of consideration for gender issues. Even though women play a crucial role in informal waste work, the lack of gender-sensitive strategies continues to reinforce marginalization and hazardous working environments. Integrating requirements for women's participation in PROs, guaranteeing workplace safety, and promoting leadership training would not only support SDG 5 on gender equality but also embed EPR within the foundations of environmental and social justice.

Corporate responsibility must also expand beyond compliance. The CSR obligations under Section 135 of the Companies Act provide a platform for corporations to co-fund gender equity initiatives within EPR, whether through self-help groups, skill development, or social protection measures. This integration of CSR and EPR would enhance the legitimacy of the circular economy and reinforce equity within Delhi's waste governance paradigm.

Comparative insights from Indore, China, and Germany underscore that Delhi requires a context-specific model. Lessons from decentralised civic engagement in Indore, data-driven enforcement in China, and rigorous compliance in Germany demonstrate that hybrid approaches combining local participation with strong central oversight are most effective. Accordingly, this study proposes an integrated EPR model for Delhi, comprising ward-level waste mapping, formalised producer-municipality cooperation, transparent financing through bonds, digital compliance tools, and structured inclusion of informal workers.

Resolving Delhi's waste crisis is therefore not merely a matter of statutory reform or technological intervention but of political will, civic accountability, and institutional innovation. By embedding inclusivity, gender equity, and producer responsibility within its waste governance, Delhi can transform its solid waste challenge into an exemplar of sustainable, just, and regenerative urban management, and in doing so, lead India's transition toward a circular economy.

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