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Managing the Menace: A Critical Legal Analysis of E-Waste Pollution in India

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Abstract: ***In today's era of accelerated digital transformation, the widespread use of electronic devices ranging from mobile phones and laptops to televisions, refrigerators, and air conditioners has become integral to daily life. While these technologies enhance convenience and efficiency, their eventual obsolescence presents a significant environmental threat in the form of electronic waste (e-waste). E-waste is now among the fastest-growing waste streams globally, characterized by hazardous, non-biodegradable substances that pose serious risks to both human health and ecological systems. This paper offers a critical assessment of the escalating e-waste crisis in India, fuelled by increasing digital dependence and consumerism. It investigates the volume of e-waste generated, its toxic effects on public health and the environment, and the legal instruments established to regulate its management. Central to this legal framework are the Environment (Protection) Act, 1986 and the E-Waste (Management) Rules, 2022. However, despite these legislative measures, the study finds that implementation remains weak due to inadequate enforcement, minimal deterrent penalties, and the absence of robust public engagement. The paper underscores the urgent need for more stringent legal mechanisms, formalization of the informal recycling sector, and adoption of environmentally sustainable waste management practices to effectively address the growing e-waste burden in India.***

Keywords: Electronic Waste, E-Waste Regulation, Environmental Law in India, Environment (Protection) Act 1986, E-Waste (Management) Rules 2022, Toxic Waste, Informal Sector, Public Health Hazards, Legal Reform, Sustainable Waste Management

1. Introduction

The escalating generation of electronic waste, commonly known as e-waste, has emerged as a critical environmental challenge on a global scale, recognized as one of the fastest-growing waste streams worldwide. [1] This surge is primarily driven by the rapid advancements in technology, the increasing consumption of electronic devices, and their ever-shortening lifespans. India, positioned as the third-largest e-waste generator globally, faces a particularly significant challenge in managing this growing volume of discarded electronics.4 Effective e-waste management is paramount for environmental protection due to the presence of numerous hazardous substances within these devices, which can contaminate air, water, and soil if not handled properly. [2] Furthermore, improper handling and disposal of e-waste pose significant risks to public health, particularly for those involved in informal recycling activities. [3] This research article aims to provide a comprehensive analysis of the e-waste management laws in India, exploring their historical evolution, examining the current legal framework, identifying the challenges in their implementation and enforcement, evaluating their impact on recycling rates and environmental outcomes, discussing current issues and debates, and proposing suggestions and recommendations for improvement.

The Problem Profile

Quantity of E-waste generated and the content of toxic and valuable materials, it has become an emerging problem throughout the world. The Indian information technology (IT) industry has been one of the major drivers of change in the economy in the last decade and has contributed significantly to the digital revolution being experienced by the world. [4] A 2016 study conducted by the Associated Chambers of Commerce and Industry of India (ASSOCHAM) and cKinetics ranked India among one of the top five countries in e-waste generation, with an estimated 52 lakh metric tonnes (MT) of E-Wastes likely to generate per annum by 2020. [5] Further, the same study revealed that computer equipments contribute up to 70% of the total E-waste generation in India. [6] Mobile phones are another significant source of e-waste in the country: of the more than

[1] Electronic waste (e-waste)-World Health Organization (WHO), accessed on April 29, 2025, https://www.who.int/news-room/fact-sheets/detail/electronic-waste-(e-waste).

[2] E-Waste Management: As a Challenge to Public Health in India-PMC-PubMed Central, accessed on April 20, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC2963874/

[3] Addressing India's Mounting E-Waste Crisis: Challenges and Solutions-ECS Environment, accessed on April 12, 2025, https://www.ecsenvironment.com/addressing-indias-mounting-e-waste-crisis-challenges-and-solutions/

[4] Santhanam Needhidasan, Melvin Samuel et. al., *"Electronic waste – an emerging threat to the environment of urban India"*, JEHSE (2014).

[5] India`s e-waste growing at 30% per annum: ASSOCHAM-cKinetics study, *available at:* https://www.assocham.org/newsdetail.php?id=5725, (Visited on June 8, 2024 at 7.30 PM)

[6] Anwesha Borthakur and Madhav Govind, "How well are we managing E-waste in India: evidences from the city of Bangalore" 2(4) *Energ. Ecol. Environ.* 225–235 (2017), (Visited on June 14, 2024 at 6.15 PM), https://link.springer.com/content/pdf/10.1007/s40974-017-0060-0.pdf.

one billion mobile phones in circulation, 25 per cent end up as e-waste. [7]

India, together with China and the United States, accounts for 38% of this volume generated worldwide. E-waste generation in India increased by 43 per cent in just three years, according to a written statement presented in the Lok Sabha (September 23, 2020) by the Union Minister of State in the Ministry of Environment, Forest and Climate Change. [8] According to the study conducted by United Nations Environment Program (UNEP) about 62 million tonnes of e-waste has been generated globally in 2014. Out of which India generates 8 lakhs tonnes of e-waste annually. [9] This report considers only three equipment namely Television, Cellular phone and Personal computer. [10]

As such the volume of e-waste is already a serious problem in India and is escalating at a rapid rate. All these large and increasing quantities of e-waste need a clear policy, institutions and legislative infrastructure for effective management and control.

Impact of E-Waste Pollution

There are numerous health effects also of these crude methods of disposal of E-waste. For instance, reports have shown that continued contact and exposure to these hazardous materials of E-wastes ends in negative birth consequences, cancer, long-term and permanent neurologic damage, and end-organ disease of the thyroid, lungs, liver, and kidneys. [11] The toxic chemical compounds and persistent organic pollutants (POP) affect the environment through the ecological food chain and adversely affect human health and ecosystems. Bioaccumulation (i. e., accumulation of several chemical elements) in the food chain affects human health, especially in pregnant and breastfeeding women. [12] In addition, they cause endocrine disruption and this, in turn, affects the nervous system, pre- and postnatal development. Furthermore, they also change the serum levels of mothers and newborns and are a potential hazard to maternal health and child development as well as thyroid-disrupting effects in developmental life stages. [13]

In addition to the human, the ecological health is also abruptly disturbed by the E-waste. The dangerous metals and toxic chemicals that electronic waste contains do not organically break down and can, over time, seep into the environment around landfills, contaminating local groundwater or get absorbed into the atmosphere, thus seriously endangering the health of nearby communities and animal populations. [14] Burning to recover metal from wires and cables leads to emissions of brominated and chlorinated dioxins, causing air pollution. [15] During the recycling process in the informal sector, toxic chemicals that have no economic value are simply dumped. The toxic industrial effluent is poured into underground aquifers and seriously affects the local groundwater quality, thereby making the water unfit for human consumption or for agricultural purposes. [16] Atmospheric pollution is caused by dismantling activities as dust particles loaded with heavy metals and flame retardants enter the atmosphere. Soils become toxic when substances such as lead, mercury, cadmium, arsenic, and polychlorinated biphenyls (PCBs) are deposited in landfills. [17]

Therefore, the need of the hour is proper handling of electronic wastes to avert human suffering and in the foreseeable future, the long-term degradation of our environment and ecosystem is averted as well.

Environment Protection Act 1986:

The parent legislation directly dealing with electronic waste is the Environment (Protection) Act, 1986. It has a total of four chapters comprising of 26 sections. E waste (Management) Rule of 2022 is the product of The Environment (Protection) Act, 1986 only since EPA is an umbrella Act for protection of environment in India. This implies that the penal provisions incorporated in EPA are applied directly to the E-Waste rules. This is emphasized by section 15 of EPA which provides for penalties for the contravention of the provisions related to the Act, rules, orders and even directions passed under EPA.

The relevant penal provisions which can be related to prevent the E-Waste pollution under the EPA are given in Section 15, 16 and 17. Section 15 provides penal provision to the extent of imprisonment for a term which extends to 5 years or with fine which may extend to one lakh rupees, or with both. Additional penalty is imposed in case of failure. [18]

[7]Working Paper No. 323, "From Waste to Jobs Decent work challenges and opportunities in the management of e-waste in India" *International Labour Organization* (2019), (Visited on June 8, 2024 at 9.30 AM), https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/--sector/documents/publication/wcms_732426.pdf,

[8]Anwesha Borthakur, *"International E-waste day: The tsunami is here"*, Down to Earth, (Visited on June 11, 2024 at 10.15 PM), https://www.downtoearth.org.in/blog/waste/international-e-waste-day-the-tsunami-is-here-73774?fbclid=IwAR3abq-i9yKYK4gGxlufZurlE778u7os1PDRo3HP1JQ9IrOQeNNEJ1ZBW28

[9]J. Senophiyah Mary and T. Meenambal, *"Inventorisation of E-Waste and Developing a Policy – Bulk Consumer Perspective"* (35) Procedia Environmental Sciences 643–655 (2016), (Visited on June 10, 2024 at 9.45 PM), https://www.sciencedirect.com/science/article/pii/S1878029616301475.

[10]*Ibid.*

[11] Xijin Xu, Yulin Zhou, *et.al.*, *"Birth outcomes related to informal e-waste recycling in Guiyu, China"* Reproduction Toxicology (33) 94-98 (2012).

[12] Md. Sahadat Hossain, Sulala M.Z.F. Al-Hamadani et. al., *"E-waste: A Challenge for Sustainable Development",* Journal of Health and Pollution,(5) pp. 3–11 (2015)

[13] *Ibid.*

[14] Kirsten Zeller, *"E-Waste: A Burden on Human Health and our Ecosystem Alike"*, Reset (2013), (Visited on June 13, 2024 at 2.10 PM), https://en.reset.org/blog/e-waste-burden-human-health-and-our-ecosystem-alike.

[15] Gitanjali Nain Gill, "Electronic waste", (Visited on June 15, 2024 at 7.30 PM), https://www.britannica.com/technology/electronic-waste.

[16] *Ibid.*

[17] *Ibid.*

[18] Section 15 of Environment Protection Act 1986 reads, "Penalty For Contravention of the Provisions of the Act and the Rules, Orders And Directions.- (1) Whoever fails to comply with or contravenes any of the provisions of this Act, or the rules made or orders or directions issued thereunder, shall, in respect of each such

Likewise section 16[19] created the liability of the companies and section 17[20] creates liabilities on government departments. Therefore, the electrical companies, who through their irresponsible conduct fuel in the E-waste generation, will be made liable under Section 16 of the EPA. Likewise the authorities responsible for handling and preventing E-Waste pollutions in India are to be made liable under section 17 of the EPA.

Analysis of the Current Legal Framework: The E-waste (Management) Rules, 2022

The E-waste (Management) Rules, 2022, establish a comprehensive framework for the environmentally sound management of electronic waste and apply to every manufacturer, producer, refurbisher, dismantler, and recycler involved in the lifecycle of electrical and electronic equipment (EEE) listed in Schedule I. This includes their components, consumables, parts, and spares that make the product operational. At the core of the 2022 rules lies the Extended Producer Responsibility (EPR) framework. [21] This framework mandates that producers of electrical or electronic equipment listed in Schedule I are responsible for meeting recycling targets as per Schedule III and Schedule IV, solely through registered recyclers of e-waste. A key requirement under the EPR framework is the mandatory registration of producers on the online portal developed by the Central Pollution Control Board (CPCB). The annual recycling targets for producers are specified in Schedules III and IV and are based on the quantity of EEE placed in the market in previous years and the average lifespan of the products. [22] Producers fulfill their EPR obligations by purchasing EPR certificates online from registered recyclers and submitting them quarterly. [23] The quantity of EPR certificates eligible for generation by recyclers is calculated based on the quantity of the end product and a conversion factor determined by the CPCB. The rules also incentivize refurbishing through the concept of refurbishing certificates, which allow producers to defer their EPR obligation for the extended life of the product.

In line with international efforts to restrict the use of hazardous substances in electronics manufacturing, the 2022 rules incorporate provisions for the reduction of hazardous substances (RoHS compliance). Producers of EEE listed in Schedule I must ensure that new equipment and their components do not contain Lead, Mercury, Cadmium, Hexavalent Chromium, polybrominated biphenyls, and polybrominated diphenyl ethers beyond specified maximum concentration values. Schedule II provides exemptions from these limits for certain applications or specifies particular limits.

The 2022 rules also lay down regulations for the entire process of e-waste management, including collection, storage, transportation, dismantling, and recycling. Manufacturers, producers, refurbishers, and recyclers are permitted to store e-waste for a period not exceeding one hundred and eighty days, with a possible extension up to three hundred and sixty-five days by the CPCB under specific circumstances. All entities involved in the handling of e-waste are required to obtain authorization from the relevant State Pollution Control Boards (SPCBs) or Pollution Control Committees (PCCs) and must adhere to the guidelines issued by the CPCB.

To ensure compliance and deter violations, the 2022 rules include provisions for environmental compensation to be imposed by the CPCB for non-compliance, non-fulfillment of EPR obligations, and the use of false EPR certificates. The funds collected as environmental compensation are to be kept in a separate Escrow account and utilized for various e-waste management initiatives. Additionally, the rules specify that providing incorrect information for obtaining EPR certificates, using false certificates, willfully violating directions, or failing to cooperate in verification and audit proceedings can lead to prosecution under Section 15 of the Environment (Protection) Act, 1986.

Impact of E-waste Management Laws on Recycling Rates and Environmental Outcomes in India

Government data indicates a positive trend in the proportion of e-waste being processed in India, rising from 22% in 2019-20 to 43% in 2023-24. [24] However, a substantial amount, approximately 57%, still remains unprocessed. [25]

failure or contravention, be punishable with imprisonment for a term which may extend to five years with fine which may extend to one lakh rupees, or with both, and in case the failure or contravention continues, with additional fine which may extend to five thousand rupees for every day during which such failure or contravention continues after the conviction for the first such failure or contravention. (2) If the failure or contravention referred to in sub-section (1) continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to seven years."

[19] Section 16 (1) of Environment Protection Act 1986 reads, "Where any offence under this Act has been committed by a company, every person who, at the time the offence was committed, was directly in charge of, and was responsible to, the company for the conduct of the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly."

[20] Section 17 (1) of Environment Protection Act 1986 reads, "Where an offence under this Act has been committed by any Department of Government, the Head of the Department shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly."

[21] E-Waste (Management) Rules, 2022 in force since 1st April, 2023 to manage e-waste in an environmentally sound manner with an improved Extended Producer Responsibility (EPR) regime in place for e-waste recycling-Press Release: Press Information Bureau.

[22] India's e-waste surges by 73% in 5 years-Down To Earth, https://www.downtoearth.org.in/waste/indias-e-waste-surges-by-73-in-5-years

[23] India's e-waste surges by 73% in 5 years-Down To Earth, https://www.downtoearth.org.in/waste/indias-e-waste-surges-by-73-in-5-years

[24] India's e-waste surges by 73% in 5 years-Down To Earth, accessed on April 29, 2025, https://www.downtoearth.org.in/waste/indias-e-waste-surges-by-73-in-5-years

[25] India's E-waste Crisis: Why We Must Act Now, accessed on April 18, 2025, https://www.councilonsustainabledevelopment.org/post/india-s-e-waste-crisis-why-we-must-act-now

Notably, some sources report significantly lower formal recycling rates, around 5% of the total e-waste generated. This discrepancy in reported figures suggests challenges in accurately quantifying e-waste recycling rates in India, potentially due to the significant role of the informal sector and variations in data collection methodologies.

Despite the regulatory framework, the environmental impact of e-waste management practices in India remains a serious concern. Improper handling and disposal, particularly within the dominant informal sector, continue to pose significant environmental risks. [26] The burning of e-waste and crude smelting processes release harmful pollutants into the air, including dioxins, furans, and particulate matter. The leaching of heavy metals and other toxic substances from landfills and unscientifically managed recycling sites contaminates water sources, including groundwater and rivers. Soil contamination from the dumping and improper processing of e-waste further degrades ecosystems and poses risks to human health through the food chain.

The effectiveness of the current e-waste management laws in mitigating these environmental and health hazards is limited by the persistent challenges in their implementation and enforcement. While the regulations aim to promote environmentally sound practices and increase recycling rates through the EPR framework and other provisions, the continued dominance of the informal sector, coupled with inadequate infrastructure, low public awareness, and weak regulatory oversight, hinders the achievement of the intended outcomes. Addressing these fundamental challenges is crucial to realizing the full potential of the legal framework in safeguarding the environment and public health from the adverse impacts of electronic waste.

2. Current Issues and Debates Related to E-waste Management in India

The effectiveness of the Extended Producer Responsibility (EPR) framework in India is a subject of ongoing discussion and concern. While the EPR mechanism aims to make producers responsible for the end-of-life management of their products, debates persist regarding the ambition of the recycling targets and the practical challenges faced by producers in achieving them. Legal clashes between the government and electronics manufacturers concerning recycling costs further underscore the complexities and tensions surrounding the implementation of the EPR framework. [27]

The role and integration of the informal sector in e-waste management are also subjects of significant debate. [28] While some argue for leveraging the informal sector's extensive network and expertise in collection, others raise concerns about their unsafe and environmentally damaging recycling practices and lack of regulatory compliance. Finding effective ways to formalize and regulate the informal sector while ensuring environmental protection and worker safety remains a critical challenge.

The increasing volume and complexity of e-waste generation, driven by rapid technological advancements and shorter product lifecycles, also pose significant issues for e-waste management in India. This rapid obsolescence leads to a continuous increase in the amount of e-waste generated, while the increasing complexity of electronic devices, with their diverse materials and intricate designs, makes recycling processes more challenging and necessitates continuous updates to the regulatory framework.

Finally, the illegal import and transboundary movement of e-waste into India, often disguised as donations or reusable equipment, further complicate the e-waste management efforts in the country. [29] This influx of e-waste from other countries adds to the domestic burden and can undermine national management strategies, as the imported waste may not always be accounted for or treated under the existing regulatory framework.

3. Suggestions and Recommendations for Improving the E-waste Management Framework in India

To enhance the effectiveness of e-waste management in India, several key areas require focused attention and strategic interventions. Strengthening the enforcement and monitoring mechanisms for the existing e-waste management laws is paramount. This involves increasing the capacity of regulatory bodies to conduct regular inspections, track compliance by all stakeholders, and take stringent action against violations, particularly within the informal sector.

Promoting greater investment in research and development (R&D) of environmentally sound and cost-effective recycling technologies is crucial for improving material recovery rates and reducing the reliance on hazardous recycling methods. Encouraging innovation in recycling processes can lead to more efficient extraction of valuable materials and minimize the environmental footprint of e-waste management.

Developing effective strategies for the formalization and integration of the informal e-waste sector is essential. This can be achieved by providing training and capacity building to informal workers on safe and environmentally sound recycling practices, facilitating their access to better technologies, and ensuring their integration into the formal system with proper regulations and safeguards.

Enhancing public awareness and education campaigns is vital to inform consumers and bulk consumers about the

[26] E-Waste Management: As a Challenge to Public Health in India- PMC-PubMed Central, accessed on April 29, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC2963874/
[27] India's E-Waste Rules Trigger Legal Clash With Companies- StratNews Global, accessed on April 29, 2025, https://stratnewsglobal.com/asia/indias-e-waste-rules-trigger-legal-clash-with-companies/
[28] E-Waste Management: As a Challenge to Public Health in India- PMC-PubMed Central, accessed on April 29, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC2963874/
[29] E-Waste Management: As a Challenge to Public Health in India- PMC-PubMed Central, accessed on April 29, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC2963874/

hazards of improper disposal and the importance of utilizing formal collection channels. Effective awareness programs can motivate behavioral change towards responsible e-waste disposal practices.

Exploring the implementation of economic incentives, such as deposit-refund schemes and tax benefits for recycling, as well as disincentives like penalties for improper disposal, can further promote formal recycling and discourage environmentally harmful practices.

Finally, continuous policy revisions and updates are necessary, drawing upon international best practices, lessons learned from the implementation of the current rules, and the evolving challenges in the e-waste sector. The regulatory framework should be dynamic and adaptive to ensure its long-term effectiveness in managing the growing e-waste challenge in India.

4. Conclusion

The e-waste management laws in India have evolved significantly over the years, culminating in the comprehensive E-waste (Management) Rules, 2022, which incorporate key principles like Extended Producer Responsibility and aim to align with international standards. However, despite these advancements, the effective management of e-waste in India continues to be hampered by challenges such as the dominance of the informal sector, inadequate infrastructure, low public awareness, and weak enforcement mechanisms. While there has been some progress in increasing recycling rates, a substantial gap remains between the e-waste generated and the amount formally recycled, and improper practices persist, posing significant environmental and health risks. Addressing these challenges requires a concerted and multi-faceted approach involving stricter enforcement, greater investment in technology and infrastructure, the formalization of the informal sector, enhanced public awareness, and the implementation of effective economic incentives. Continuous learning from international best practices and regular updates to the regulatory framework are also essential to ensure a sustainable and environmentally sound future for e-waste management in India, ultimately protecting the environment, safeguarding public health, and promoting a circular economy for electronics.