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Need for a Circular Economy to Manage E-Waste: An Analysis of Indian Legal Regime

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Abstract

As per the Global E-waste Report 2020, approximately 53.6 million metric tonnes of E-waste were generated globally in 2019, which is expected to exceed 74 Mt by 2030. Asia ranks in first place for the quantity of e-waste generated in 2019, followed by the American, European, and African continents. At the global level, India has moved from fifth to third in generating e-waste. To address this issue India has launched various programs, including policy regulations for environmental protection. The Electronic Waste (Management and Handling) Rules, 2011 was one such great move to manage e-waste scientifically, and the E-Waste (Management) Rules, 2022 replaced the old Rules. In this context, this study tries to examine the importance of scientific e-waste management strategies, basic regulatory standards adopted by other countries, and a critical review of the laws existing in India. The study finds that, though India revised the E-waste Management Rules recently, it failed to incorporate various fundamental concepts like circular economy, reverse logistics, right to repair, and incentives for consumers and producers to properly manage e-waste. The paper also aims to give a comparative analysis of E-Waste (Management) Rules 2016 and 2022. On the basis of the research, the paper recommends adopting a more comprehensive approach where all stakeholders, including the informal sector dealers and dismantlers are identified and responsibilities are assigned to them. A regulatory shift towards upstream e-waste management is also recommended for developing ecologically sustainable EEE electrical or electronic equipment for the future.

Keywords: Consumer Awareness, Nanomaterials, Non-renewable energy, Producer Liability, Reverse logistics

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1. Introduction

E-waste or waste electrical or electronic equipment (WEEE) is a common threat to the world. Both developing and developed nations are striving hard to manage the e-waste. The excessive generation of e-waste contaminates the environment, affects all functions of the human body and accumulates in the food chain. Studies[1]have proved the presence of toxicants even in breast milk. The initiatives contemplated way back in the 1970s are still struggling to attain the promised objectives of environmental sustainability and intergenerational equity. The changing lifestyle and mass production rate of Electrical and Electronic Equipment (EEE) across the jurisdictions turned counterproductive to policy initiatives. In the beginning, countries focused mainly on three 'Rs' reducing, repairing and recycling e-waste and slowly, other 'Rs' evolved, such as refusing, rethinking, repairing, refurbishing, remanufacturing, repurposing and recovering to manage e-waste. Though waste recycling is a generally accepted way out, recycling also pollutes the environment due to improper handling and recycling methods adopted. E-wastes are gold mines, and it can be a source of income and a profitable business endeavour due to the presence of precious metals, rare earth elements and other valuable components. Thus, it is necessary to channel e-waste for dismantling, segregation, recycling and disposal through proper methods to extract the valuable components. Therefore, through legal instruments and business models, countries have devised various schemes and strategies, including extended producer responsibility, product deposit schemes, circular economy, reverse logistics, right to repair, etc. [2] For example, the European Union's Circular Economy Action Plan is to develop sustainable manufacturing standards and to increase recycling rates[3]. Similarly,

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[1] Asamoah, A., Nikbakht Fini, M., et. al., *PAHs contamination levels in the breast milk of Ghanaian women from an e-waste recycling site and a residential area,* 666 SCIENCE OF THE TOTAL ENVIRONMENT 347-354 (2019).
See, Li, X., Tian, Y., Zhang, Y., et. al., *Accumulation of polybrominated diphenyl ethers in breast milk of women from an e-waste recycling center in China*, 52 JOURNAL OF ENVIRONMENTAL SCIENCES 305 -313(2017).

[2] Sai Preetham Grandhi, Pranav Prashant Dagwar, et. al., Policy pathways to sustainable E-waste management: A global review, 16 JOURNAL OF HAZARDOUS MATERIALS ADVANCES 5-12 (2024).

[3] Circular Economy Action Plan (Dec.20, 2024, 11AM), https://environment.ec.europa.eu/strategy/cir cular economy action plan_en.

the China, Japan, Mexico, Germany etc have adopted their national circular economy policies to retain a product and complete its life cycle[4].

The study is doctrinal, and has reviewed primary and secondary resources, including The Global E-Waste Monitor 2020 & 2024 E-waste Statistics - Guidelines on Classification, Reporting and Indicators, Report by United Nations University, research articles elaborating the importance of circular economy, recycling and extended producer responsibility and the Indian legal regulations. On reviewing existing literature, the study finds that the Indian legal regulations are in their nascent stage, and hence the study scrutinised the E-waste (Management) Rules, 2022 and compared them with the E-waste (Management) Rules, 2016 in the backdrop of general strategies adopted at the global level. Furthermore, the study analysed the implementation challenges in India due to a lack of awareness, transboundary imports, and informal sectors in collecting and processing e-waste. Thus, the scope of the study is limited to explaining generally accepted e-waste management strategies at the international level, and an attempt is made to identify how far these strategies have been incorporated into the Indian regulatory regime by critically analysing the E-waste (Management) Rules, 2022. Though the management of E-waste needs an interdisciplinary approach, the study limits its scope to regulatory standards of E-waste management, and it does not dwell on the technological aspects of data analysis to prove the effectiveness of regulations existing in India.

2. Accumulation of E-Waste: Global Reflections

Mounting e-waste is a global issue that requires strategic approaches to reduce the generation and proper management of e-waste through initiatives that ensure environmental sustainability. Due to a multitude of factors, total global use and consumption of electrical or electronic equipment increases annually by 2.5 million metric tonnes[5].

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[4] Thibaut Wautelet, The Concept of Circular Economy: Its Origin and its Evolution (Feb. 15, 2024, 6AM), https://www.researchgate.net/publication/322555840. Katrien Steenmans & Vibe Ulfbeck, Fostering the circular economy through private law: Perspectives from the extended producer responsibility concept 195 RESOURCES, CONSERVATION & RECYCLING 1 (2023) .

[5] The Global E Waste Monitor 2020, the United Nations University/United Nations

The introduction of Cathode Ray Tube (CRT) Television in the mid-twentieth century initiated a boom in personal electronic devices[6]. With the changing lifestyle, markets are flooded with unique gadgets, household products, and industrial equipment offering cutting-edge technologies to make our lives easier. The digital revolution and post-COVID digital initiatives at the governmental level tremendously increased the use of digital devices. Due to the availability of sophisticated and advanced models in the market, the consumer trend of replacing old electronic and digital devices has become common[7]. Across the globe, life has become impossible without the support of electronic and telecommunication devices. The large-scale use of EEEs, regular replacement before expiration, lack of consumer awareness, and inefficient WEEE management pose environmental safety and sustainability issues.

E-waste is equipment or parts discarded by the owner as waste without intending to be reused[8]. Approximately 53.6 million metric tonnes of E-waste were generated globally in 2019, and it is expected to exceed 74 Mt by 2030[9]. The global rate of increase is at an alarming rate of 2 Mt yearly[10]. As per the Global E-waste Monitor, the highest quantity of e-waste was generated in Asian continent in 2019, followed by the American, European, and African continents[11].

Institute for Training and Research and the International Telecommunication Union (Feb. 15, 2024, 10.30 AM), https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_ju ly 1_low.pdf.

6 Christopher Smitty Smith, The Economics of E-Waste and the Cost to the Environment, *Natural Resources & Environmen*t (Feb. 10, 2024, 11 AM), https://www.jstor.org/stable/441 34 066.

7 Renske van den Berge, Lise Magnier, et.al., Too good to go? Consumers' replacement behaviour and potential strategies for stimulating product retention, *Current Opinion in Psychology* (Feb. 10, 2024, 11. 15 AM), https://www.sciencedirect.com/science/article/pii/ S2352250X20301226?via%3Dihub.

8 Forti V., Baldé C.P., et. al., E-waste Statistics - Guidelines on classification, reporting and indicators 12 (2nd ed., Report by United Nations University) (Feb. 12, 2024, 12.05 PM), https: //collections.unu.edu/eserv/UNU:6477/RZ_EWaste_Guidelines_LoRes.pdf.

9 Supra note 5, at 23.

10 The Global E-Waste Monitor 2020, the United Nations University/United Nations Institute for Training and Research and the International Telecommunication Union (Feb. 15, 2024, 10.30 AM), https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_ july 1_low.pdf.

11 Asia (24.9 Mt), America (13.1 Mt), Europe (12 Mt), Africa (2.9 Mt). See *Id.*

Data shows that Europe generates the highest per capita amount of E-waste[12]. At the international level, only around 22.3% % of the total waste generated was formally collected and recycled[13]. In Asia, the rate of e-waste formally collected and recycled in 2019 was only 12%[14]. More surprisingly, the recycling rate in India stands at 1 %, as per the Global Waste Statistics[15]. Also, it is worth noting that only 78 countries have policies or regulations for e-waste management[16]. Despite regulations in developed and developing countries, the UN report categorically states that around 77.7% of e-waste was not formally collected, recycled and disposed off correctly[17]. A good amount of such informally collected e-waste became part of municipal solid waste and ended up in landfills or disposed off along with other solid waste[18]. Furthermore, e-waste from developed countries is imported into developing countries, violating the basic norms of the transboundary e-waste movement[19]. The illegal dumping of e-waste is also a primary concern for developing countries like India.

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[12] Global E-Waste Monitor 2024, the United Nations University/United Nations Institute for Training and Research and the International Telecommunication Union (May 02, 2025, 10.30 AM), https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_ju ly1_low .pdf.

[13] Global E-Waste Monitor 2024, the United Nations University/United Nations Institute for Training and Research and the International Telecommunication Union (May 02, 2025, 10.30 AM), https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_ july1_low .pdf.

[14] E-waste Statistics in Asia, The Global Waste Statistics Partnership (Feb. 16, 2024, 10PM), https://globalewaste.org/statistics/continent/asia/2019/.

[15] E-waste Statistics in Asia, The Global Waste Statistics Partnership (Feb. 16, 2024, 10PM), https://globalewaste.org/statistics/continent/asia/2019/.

[16] Global Waster Monitor, supra note 12 .

[17] Global E-Waste Monitor 2024, the United Nations University/United Nations Institute for Training and Research and the International Telecommunication Union (May 02, 2025, 10.30 AM), https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_ july1_low.pdf.

[18] Deblina Dutta, Sudha Goel, *Understanding the gap between formal and informal e-waste recycling facilities in India,* 125 WASTE MANAGEMENT 163 -171 (2021).

[19] 5.1 Mt transboundary waste movement occurred, of which 3.3 Mt were uncontrolled transboundary movements. See, C.P. Baldé, E. D'Angelo, et. al., Global Transboundary E-Waste Flows Monitor 2022 (Report of the United Nations Institute of Training and Research) (Feb. 10, 2024, 11 AM) https://ewastemonitor.info/wp-content/uploads/2022/06/Global-TBM_webversion_ june_2_pages. pdf.

3. Health and Environmental Hazards of E-Waste

E-waste is complex in composition and varies in products that fall under different categories. It contains more than 1000 substances that fall under the hazardous and non-hazardous categories[20]. The presence of heavy metals (lead, mercury, cadmium, etc), flame retardants (polybrominated diphenyl ethers, pentabromophenol, etc) and other substances make e-waste generally hazardous for the environment and the health of people[21]. The use of nanomaterials in electrical and electronic devices is also common[22]. The impact of nanomaterials and other uncommon substances used in EEE still needs to be deciphered in order to evaluate the health and environmental consequences[23].

The improper handling and recycling of e-waste releases toxins into the environment, which pollutes the air, water and soil. Traditional practices like dumping on land or in water bodies, landfills along with regular waste, burning or heating, acid bath, shredding plastic coatings and manual disassembly of equipment are hazardous to the environment[24]. The e-waste contaminants can be grouped into three groups[25]. The primary group includes heavy metals and halogenated compounds of e-waste. The second category is the by-product of the recycling process, such as poly aromatic hydrocarbons (PAHs); the tertiary group is the compounds used for recycling. Citric acid, aquaregia, hydrochloric acid, bromide, etc., which are unsafe for the environment and human health if not used safely[26].

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[20] Guidelines for Environmentally Sound Management of E-Waste (Report of the Ministry of Environment and Forest) 9 (2008).

[21] Anwesha Borthakur, *Health and Environmental Hazards of Electronic Waste in India*,78 Journal Of Environmental Health 18 (April 2016).

[22] Chaudhery Mustansar Hussain (Ed.), Handbook Of Nanomaterials For Industrial Applications 324 -364 (2018).

[23] Anwesha Borthakur, supra note 24.

[24] Electronic Waste (E-Waste), WHO (Feb. 17, 2024, 11AM), https://www.who.int/news-room/fact-sheets/detail/electronic-waste-%28e-waste%29#:~:text=Ewaste%20is%20considered%20hazardous%20waste%20as%20it%20contains, public%20health%20concern%2C%20including%20dioxins%2C%20 lead%20 and% 20mercury.

[25] Shireen Ibrahim Mohammed, *E-Waste Management in Different Countries: Strategies, Impacts, and Determinants in Albert Sabban* (Feb. 17, 2024, 11.30 AM), https://www.intechopen.com/chapters/83011.

[26] *Id.*

The mismanagement of e-waste and improper recycling have proved harmful to the environment and local inhabitants near the recycling facilities. Studies conducted in Vietnam and China found that the burning and manual dismantling cause soil and river pollution. It was also found that burning in open spaces affects the groundwater quality[27]. The intoxicants and heavy metals are perilous to human health. It affects our immune system, reproductive functions, development in children, nervous system and can cause hormone imbalance etc[28]. Studies have also found that it can cause damage to DNA in workers who handle e-waste. Abortions and premature birth are also known impacts of e-waste[29]. Such wastes also contaminate the food and food chain. A study conducted in China established the accumulation of high concentrations of heavy metals in rice growing near recycling sites[30]. The Persistent Organic Pollutants (POPs) in e-waste are nonbiodegradable substances, and they tend to accumulate in the food chain and are transferred from one generation to the other through breastfeeding[31]. Studies have already proved the presence of e-waste contaminants in breast milk, [32] animal meat, eggs, and milk too[33]. Thus, it is imperative to address these issues through statutory regulations.

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27 Eva Ignatuschtschenko, *Electronic Waste in China, Japan, and Vietnam: A Comparative Analysis of Waste Management Strategies,* 9 VIENNA JOURNAL OF EAST ASIAN STUDIES 30 - 52 *(2017)*

28 Okunola A Alabi, Yetunde M Adeoluwa, Environmental contamination and public health effects of electronic waste: An overview, 19(1) JOURNAL OF ENVIRONMENTAL HEALTH SCIENCE AND ENGINEERING 1209-1227 (2021). See, Anwesha Borthakur, supra note 24, at 19.

29 Kristen Grant MIPH, Fiona C Goldizen BA, et. al., *Health consequences of exposure to e-waste: a systematic review*, 1 THE LANCET GLOBAL HEALTH 350 - 358 (2013). See, Shireen Ibrahim Mohammed, supra note 28.

30 Anwesha Borthakur *Supra* note 24, at 19

31 Arti Mishra, Moni Kumari, *Persistent organic pollutants in the environment: Risk assessment, hazards, and mitigation strategies*, 19 BIORESOURCE TECHNOLOGY REPORTS (2022).

32 Biplab Das, E-waste toxins in mum's milk, DOWN TO EARTH (May.02, 2024, 11 AM), https://www.downtoearth.org.in/environment/ewaste-toxins-in-mums-milk-37885.
See Asamoah, A., *Supra* note 1.

33 Anwesha Borthakur, supra note 24, at 19.

4. Regulatory Alternatives for E-Waste Management: A Review of General Practices Followed in Other Countries

We live today by using more than what the earth can provide by extracting more than 60% of the resources it can regenerate annually[34]. The linear system depends primarily on nonrenewable energy and rare natural resources, resulting in 53% of the world's carbon emissions and 80% of biodiversity loss[35]. It is estimated that around 50 million tonnes of EEEs costing more than 62 billion dollars, including rare earth minerals, are wasted yearly[36]. Thus, the current model of taking, wasting and emitting too much must be replaced by an environmentally sustainable model to ensure intergenerational equity. The general initiatives that emerged at the international, regional, and national levels include shifting from a linear economy to a circular economy, recycling e-waste to generate secondary sources, and bringing extended product liability to manage the mounting e-waste. These existing strategies are briefly discussed here to examine the effectiveness of the Indian regulatory regime.

4.1 Circular Economy and Right to Repair

For a long time, industries have been following a linear economy approach based on 'take-make and dispose'[37]. Industries following the linear economy model extract natural resources, use energy and human resources to manufacture the product, and sell it to consumers, who then throw it into nature after use[38]. This unsustainable practice

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[34] Jessica Long, 7 surprising facts to know about the circular economy for COP26, World Economic Forum (Feb.15, 2024, 10AM), https://www.weforum.org/stories/2021/10/7-surprising-facts-to-know-about-the-circular-economy-for-cop26/.

[35] Furkan Sariatli, *Linear Economy Versus Circular Economy: A Comparative and Analyzer Study for Optimization of Economy for Sustainability*, 1 VISEGRAD JOURNAL ON BIOECONOMY AND SUSTAINABLE DEVELOPMENT 31-34 (2017). See, id.

[36] Jessica Long, supra note 37.

[37] Otekenari David Elisha, *Moving Beyond Take-Make-Dispose to Take-MakeUse for Sustainable Economy*, 13(2) INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH IN EDUCATION 500 (2020).

[38] Apurva Goel, Application of Circular Economy in E-Waste Management – A Review with an Indian Perspective (Feb.12, 2024, 9PM), https://www.researchgate.net/publication/363769313_Application_of_circular_economy_in_Ewaste_management_a_review_with_an_Indian_perspective/

affects the environment in two ways; it leads to the exhaustion of resources and the escalation of e-waste. Industries and Governments across the globe have been focusing on developing alternative economy models that are environmentally sustainable. One such popular model is the Circular Economy (CE)[39].

The circular economy is a global initiative to circumvent the ill effects of the linear economy. The idea was initially mooted in 1940 and became part of the environmental movement in the 1960s and 1970s[40]. The concept of the circular economy came to the mainstream in 2013 through the reports published by the Ellen MacArthur Foundation (EMF)[41]. It defined CE as "… an industrial economy that is restorative by design, and which mirrors nature in actively enhancing and optimising the systems through which it operates[42]". The idea of a circular economy aims to develop strategies to reduce the use of resources and minimise the generation of waste and carbon emissions[43]. Initially, the circularity was confined to recycling, and then it expanded to the three R's reduce, reuse and recycle[44]. Now, ten R's have been identified as contributing towards the circularity of a product[45]. It includes

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link/632d5ff94cc5d63f0851195d/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UG FnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2 F0aW9uIn19.

39 *Id.*

40 Paul Ekins, Teresa Domenech, The Circular Economy: What, Why, How and Where, The OECD Centre for Entrepreneurship (May 02, 2025, 12.30 PM), https://www.researchgate.net/publication/374740327_The_circular_economy_What why how and where/link/652c4f5c06bdd619c493ba85/download?tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6Il9kaXJlY3QiLCJwYWdlIjoicHVibGljYXRpb24ifX0

41 Ellen MacArthur Foundation (EMF), in 2010, partnered with a number of large companies and the McKinsey consultancy, and produced three publications in 2013: 'Towards The Circular Economy'. See Ekins P., Domenech T., et.al., The Circular Economy: What, Why, How and Where (Feb. 14, 2024, 5AM), https://discovery.ucl.ac.uk/id/eprint/10093965/1/Ekins-2019-Circular-Economy-What-Why-How-Where.pdf.

42 Loiseau E., Saikku L., et.al., *Green economy and related concepts: An overview*, 139 Journal of Cleaner Production 9 (2016).

43 Victoria Masterson, Ian Shine, What is the circular economy, and why does it matter that it is shrinking?, World Economic Forum (Feb.12, 2024, 5AM), https://www.weforum.org/ agenda/2022/06/what-is-the-circular-economy/.

44 Ekins P., Domenech T., et.al, *Supra* note 44.

45 Stijn van Ewijk and Julia Stegemann, An Introduction to Waste Management and

a) Refusing to buy unsustainable products by using another product
b) Rethinking to enable product sharing
c) Reducing material usage and waste generation by adopting efficient production and product design
d) Reusing products before losing the appeal and functionality if the owner does not want them anymore
e) Repairing of defective products or improve functionality by regular maintenance
f) Refurbishing an older product by updating the critical aspects of its performance
g) Remanufacturing complex products by combining new and used or repaired or refurbished parts
h) Repurposing a product by finding an alternate use
i) Recycling the used materials by scientifically and building new products
j) Recovering the energy content of the materials through thermal treatment [46].

If appropriately implemented, CE can slow down the EEE consumption rate by retaining the waste within the system for the longest possible time, and sometimes materials can be subjected to any one of the R's repeatedly[47]. However, moving to CE will not happen in isolation. To implement it, strategies, business models, and government policies need to be adopted, which will have to work at the micro and macro levels[48]. The design of the products and materials used must facilitate activities described in the CE. Also, the business models must enable sharing, repairing, refurbishing, remanufacturing etc[49]. To put CE into action, reverse logistics must be embedded in the policies that ensure every single product sold or brought into the market is made available for repair, reuse, refurbishing, remanufacturing, recycling etc.

Circular Economy, 316 - 317 (2023).

[46] *Id.* at 316, 317.

[47] C. Baskar et al. (ed.), Handbook of Solid Waste Management 3 - 4 (2021).

[48] *Id.*

[49] Amanda McGrath, What is a circular economy? (May 02, 2025, 6PM), https://www.ibm.com/think/topics/circular economy

Transforming a linear economy into a circular one requires shared commitment among the stakeholders, which can be ensured through government policies and regulations. China is the first country to enact a law to implement CE. In 2008, China adopted the China Circular Economy Promotion Law[50]. In 2017, Uruguay enacted Circular Economy rules, France in 2020 adopted the Anti-Waste and Circular Economy Law, and Mexico in 2021 introduced General Circular Economy Law[51]. The enactment of the Waste Disposal Act in Germany in 1976 was a significant breakthrough among European countries, and the EU adopted the EU Waste Directive in 2008[52]. In 2020, an ambitious project was launched by the European Commission, the Circular Economy Action Plan (CEAP) to promote circular economy processes to achieve EU climate neutrality by 2050[53]. Towards this end, the Commission revised the Circular Economy Monitoring Framework in 2023[54].

In connection with implementing CE, countries have been enacting laws to facilitate the repair and reuse of products to ensure waste retention within the system. The right to repair has emerged as an independent legal right in many jurisdictions. The right-to-repair movement started way back in the 1960s[55]. The conceptual foundation of the right-to-repair movement was that an individual who purchases a product must own it completely[56]. It will enable the consumers to repair, modify or upgrade the equipment or devices in their way. However, companies worldwide have followed planned obsolescence

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50 Thibaut Wautelet, The Concept of Circular Economy: Its Origin and its Evolution (Feb. 15, 2024, 6AM), https://www.researchgate.net/publication/322555840.

51 Katrien Steenmans & Vibe Ulfbeck, *Fostering the circular economy through private law: Perspectives from the extended producer responsibility concept* 195 Resources, Conservation & Recycling 1 (2023).

52 DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, 19 November 2008 on waste and repealing certain Directives.

53 Circular Economy Action Plan (Dec.20, 2024, 11AM), https://environment.ec.europa.eu/ strategy/circular-economy-action-plan_en

54 *Id.*

55 Nicholas Gisonna, *Right to Repair* (Feb. 06, 2024, 10PM), https://www.britannica.com/ topic/right-to-repair.

56 Tanish Jain, Navigating the Right to Repair in India, NLIU LAW REVIEW (May 02, 2025, 1 PM), https://nliulawreview.nliu.ac.in/wp-content/uploads/2025/01/Volume XIV Issue I 101 134.pdf.

for many centuries to induce consumers to buy new products[57]. Also, with the new IP regime, encrypted software, sophisticated designs, etc., repairing or modifying electrical and electronic equipment has become more costly than buying a new one[58]. This became an accepted business model, resulting in new consumer behaviour of use and throw. Recently, the right-to-repair movement has been brought under the realm of circular economy to extend the life cycle of EEE in the UK[59] and US[60] by passing laws despite tech giants like Apple, Microsoft, etc resisting vehemently[61]. The new regulations were enacted to end the monopoly of corporations and make the owner repair or cost-effectively modify the product or equipment. This will help to retain a product, complete its life cycle, and successfully pass through different phases of R's.

4.2 Recycling and Restricted Use of Chemicals

Recycling is transforming used goods into valuable products to bring them back into the cycle and has been the popular E-waste management strategy across the globe for many decades. However, in a circular economy, recycling is not the primary option to eliminate waste, though it has been accepted for some reasons. Recycling of e-waste also demands energy usage, resulting in secondary and tertiary level environmental pollution due to the chemicals used for the recycling process, and it also produces toxic by-products[62]. However, e-waste recycling is much recommended because it is a secondary source for rare earth elements and precious metals[63]. E-waste contains

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57 ARFA JAVAID, What is the Right to Repair Movement and how are tech giants reacting to it?, (Feb.10, 2024, 10AM), https://www.jagranjosh.com/general-knowledge/right-to-repair-movement-and-how-are-tech-giants-reacting-to-it-1628261259-1.

58 Takara Small, *Your right to repair*, 17 CORPORATE KNIGHTS, 18-19 (2018).

59 The Ecodesign for Energy-Related Products and Energy Information Regulations 2021 (UK).

60 Lauren Goode, Joe Biden Wants You to Be Able to Fix Your Own Damn iPhones, WIRED (Feb. 15, 2024, 12PM), https://www.wired.com/story/biden-executive-order-right-to-repair/.

61 Rahel Philipose, Explained: What is the 'right to repair' movement?, The Indian Express (Feb.16, 2024, 11.30 AM), https://indianexpress.com/article/explained/explained-what-is-the-right-to-repair-movement-7400287/.

62 Shireen Ibrahim Mohammed, supra note 28.

63 Rare earth metals are a group of 17 chemical elements found in earth's crust and

non-precious metals, including iron, steel, copper, and aluminium, as well as precious metals, such as gold, silver, palladium, and platinum[64]. Recycling is recommended to reduce environmental pollution and solve the scarcity of rare earth elements (REEs) used in electronic device manufacturing[65]. The extraction and production of REEs also cause environmental pollution, and the processing is not economical[66]. Thus, recycling e-waste is a suitable policy option, both environmentally and economically, if done scientifically. Therefore, countries have generally adopted regulatory strategies for recycling e-waste.

However, the recycling sector is grappling with many issues such as unscientific recycling methods like burning, incineration, and acid striping and in most countries, informal recycling units are handling the majority of E-waste. Thus, around 27 countries in Europe have adopted regulations to maximise collection and recycling. The US has no federal laws. However, half of the states in the US have introduced their own rules for e-waste recycling[67]. Similarly, countries, like Canada, Brazil, Peru, Latin America, Columbia, Mexico, India, etc, have separate laws for recycling e-waste[68]. The recycling system

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most commonly used neodymium, dysprosium, europium, and terbium. The precious metals include silver, gold, platinum and palladium.
See, Purva Paranjape, Manishkumar D. Yadav, Recent advances in the approaches to recover rare earths and precious metals from E-waste: A mini-review, 101(2) THE CANADIAN JOURNAL OF CHEMICAL ENGINEERING 1043-1054(2022).
See, Rishabh Mohapatra, Rare Earth Metals in E-Waste: A Precious Resource to Recover (May 02. 2025, 2PM), https://medium.com/greenbyte-labs/rare-earth-metals-in-e-waste-a-precious-resource-to-recover-98f139fecd3d

64 Tackling Informality in E-waste Management, International Labour Organisation, 13 (2014) (Feb.15, 2024, 10 PM), https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/sector/documents/ publication/wc ms_315228.pdf.

65 Christopher Smitty Smith, supra note 6.

66 Petra Zapp, Andrea Schreiber, Environmental impacts of rare earth production, 47(3) MRS BULLETIN 267-275(2022).

67 The Global E-Waste Monitor 2020, the United Nations University/United Nations Institute for Training and Research and the International Telecommunication Union (Feb. 15, 2024, 10.30 AM), https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_ju ly1_low.pdf.

68 The Global E-Waste Monitor 2020, the United Nations University/United Nations Institute for Training and Research and the International Telecommunication Union (Feb. 15, 2024, 10.30 AM), https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_ju ly1_low.pdf.

implemented in Germany is the most successful model, which combines the best economic tools, business models and recycling practices. It integrates the activities of producers, consumers and recycling companies relying on extended producers' liability by providing incentives to consumers[69]. Germany maintains the highest recycling rate in the world, around 65%[70].

Along with recycling policies, countries have launched regulations to reduce the use of hazardous chemicals in electrical and electronic equipment manufacturing. The hazardous chemicals or the chemicals of concern (CoC) may be released into the environment during production, use, transport or end-of-life treatment[71]. Thus, the UN Environmental Programme (UNEP) mandates that the issue be addressed explicitly through specific regulatory norms. UNEP identified the presence of such regulations only in 45 countries. Therefore, most countries have no strict regulations to prohibit the use of harmful chemicals in EEE. Also, the range of chemicals prohibited is confined to selected heavy metals, brominated flame retardants and phthalates[72]. Thus, green manufacturing and recycling technologies should be adopted to manage e-waste in an environmentally sustainable manner in the long run.

4.3 Extended Producer Liability

Extended producer liability (EPR) is an internationally accepted environmental principle introduced by Thomas Lindhqvist in 1990[73]. It rests on the 'Polluter Pays Principle', a fundamental environmental norm which mandates that 'those who profit shall pay'[74]. The liability

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69 Anna Korostova, From the waste management to circular economy (Dec. 18, 2024, 5AM), https://www.jstor.org/stable/resrep52801.4.

70 *Id.*

71 Amelie Ritscher, Addressing Chemicals of Concern in Electrical and Electronic Equipment: Options for Action for Policymakers, UN Environment Programme 3 (2021).

72 *Id.*

73 Robert Reagan, *A Comparison of E-Waste Extended Producer Responsibility Laws in the European Union and China*, 16 Vermont Journal Of Environmental Law 668 (2015).

74 James Boyd and Daniel E. Ingberman, *The Search for Deep Pockets: Is "Extended Liability" Expensive Liability?*, 13 Journal of Law, Economics, & Organization 233 (April 1997).

will be extended to the producer for the risk it caused, though he is not in direct control of the product[75]. The idea was mooted as a "strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer responsible for the entire life-cycle of the product and especially for the take-back, recycling and final disposal of the product"[76]. Generally, it makes the producer responsible even in the post-consumer stage of the product life cycle. More specifically, EPR shifts the responsibility of managing waste from the customers and local bodies to manufacturers and producers by fixing responsibility in five levels[77].

1. Ownership – Manufacturer retains ownership at all product life cycles;
2. Liability – Manufacturer is responsible for all proven environmental damages;
    a) Physical Responsibility – Where the manufacturer is involved in the physical management of waste and needs to ensure the waste is recycled and disposed of in an environmentally sustainable manner;
    b) Economic Responsibility – Where the producer is not responsible for the physical management of waste, must bear the cost for the collection, recycling and disposal of the waste;
    c) Informative Responsibility – The producer must give information to the consumer about the environmental impact of the product.

Nowadays, EPR is considered as a measure to promote a circular economy (CE). Countries have adopted appropriate regulations to impose it as a statutory responsibility rather than a business model. It is a strategic approach that allows flexibility in its implementation. These regulatory approaches underscore three operative strategies

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[75] *Id.*

[76] Marco Compagnoni, *Is Extended Producer Responsibility living up to expectations? A systematic literature review focusing on electronic waste*, 367 Journal of Cleaner Production (2022).

[77] Utsav Bhadra and Prajna Paramita Mishra, *Extended Producer Responsibility in India: Evidence from Recykal, Hyderabad*, 10 Journal of Urban Management 430 - 431 (2021).

for the effective implementation of EPR. It works through Producer Responsibility Organisation (PRO), Advanced Recycle and Disposal Fee and Deposit Refund Systems[78]. The producers or manufacturers individually or collectively delegate EEE collection, reuse and recycling to PROs and third parties. Different models of PRO schemes exist, such as monopolistic schemes that are effective in small economies and competition-based schemes followed in large economies[79]. In the Advanced Recycle and Disposal Fee scheme, the consumers remit recycling and disposal fees to the producer in advance. The revenue collected as an advance fee shall be used to manage the product life cycle. The upfront fee payment is primarily intended to reduce illegal dumping and evade the payment if it is postponed at the time of disposal[80]. In the Deposit Refund Scheme (DRS), the consumers are asked to make payment of an amount at the time of purchasing the product, and the exact amount will be credited to their account when they return. The DRS also serves the idea of reducing illegal dumping and inspires consumers to collect e-waste and return it to the concerned producer[81].

EPR was introduced in Germany in 1990 for packaging materials. Now, e-waste is part of the EPR scheme in various countries, including Switzerland, Netherland, UK, States in the US, Taiwan, India, Thailand etc[82]. Compared to other regulatory standards, the EU directive is the most comprehensive regulation that directs the member states to implement producer liability and achieve the minimum collection rate prescribed under the directive. The member states are responsible to ensure that that the products placed on the product are according to the standards and the proper management of all WEEE[83].

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78 Circular Economy and Extended Producer Responsibility, Global Alliance on Circular Economy and Resource Efficiency, European Union 6 (2022) (Feb.17, 2024, 10PM), https://www.unido.org/sites/default/files/unidopublications/202311/GACERE_Circular%20Economy%20and%20Extended%20Producer%20Responsibility_webinar%20report.pdf.

79 *Id.*

80 Alexandros Dimitropoulos, Extended Producer Responsibility - Design, Functioning And Effects 18 (July 2021).

81 *Id.* at 20.

82 Utsav Bhadra and Prajna Paramita Mishra, supra note 81 at 431.

83 DIRECTIVE 2012/19/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on waste electrical and electronic equipment (WEEE), 4 July 2012, art. 12.

Though EPR has emerged as an accepted norm enforced through laws in developed countries, it is in the nascent stage in developing countries, including India. In most developing countries, e-waste is collected and dismantled by the informal sector[84]. Lack of technology, infrastructure, and skilled persons are significant hurdles to the implementation of EPR in developing countries. Additionally, consumer awareness and lack of incentives to attract consumers to hand over e-waste to authorised collection agencies are crucial for the successful implementation.

5. Management of E-Waste in India: Regulatory Measures and Challenges

India has made a quantum leap in the electronic and digital market by introducing various policies and manufacturing electronic hardware as a priority area for the government. India achieved a compound annual growth rate of 24% in the production of electronic goods by 2019-20[85]. Globally, India is in the third place in consuming raw materials, which will require 15 billion tonnes of materials by 2030, including metals like iron, copper, silver, gold, aluminium, and other rare earth elements[86]. As per the Global E-Waste Monitor Report 2020, India moved from fifth to third position in 2019 for e-waste generation[87]. However, the recycling ratio is comparatively low. India collected and recycled only 22.7% of the total 10,14,961.21t tonnes of e-waste generated during 2019-20[88]. It was only 21.35 % and 9.79%

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84 Extended Producer Responsibility – Guidance for Efficient Waste Management, OECD, 2016 (Feb.16, 2024, 11PM), https://www.oecd.org/en/publications/extended-producer-responsibility_9789264256385-en.html. See, Robert Reagan, Supra note 77.

85 Circular Economy in Electronics and Electrical Sector, Draft Policy Paper, Ministry of Electronics and Information Technology, Government of India 4 (2021).

86 *Id* at 2.

87 The Global E-Waste Monitor 2020, the United Nations University/United Nations Institute for Training and Research and the International Telecommunication Union (Feb. 15, 2024, 10.30 AM), https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_ july1_low.pdf. See Dr. Ashok Kumar Jain & Dr. Kumari Dibya, *Harmful Effects of E-waste on Living Beings and Environment,* DEW JOURNAL 82 (2016).

88 Radheshyam Jadhav, *Around 78% of India's e-waste is not being collected or disposed by the government*, THE HINDU BUSINESS LINE (Feb. 17, 2024, 4AM), https://www.thehindubusinessline.com/data-stories/data-focus/around-78-of-indias-e-waste-is-not-being-collected-or-disposed-by-the-government/article65406820.ece.

in the 2018-29 and 2017-18 periods, respectively. India introduced regulatory and policy initiatives that are in tune with the general approach of countries across the globe. However, these initiatives are still in the nascent stage of implementation due to various factors such as lack of technological support, insufficient infrastructural facilities, lack of consumer incentives etc.

India introduced the Environmental Protection Act of 1986 in the backdrop of the first World Conference on Environment held in Stockholm in 1972[89]. Under the Environmental Protection Act, the Hazardous Waste (Management and Handling) Rules 1989 was adopted, and later, the amended and revised version, the Hazardous Waste (Management, Handling and Transboundary Movement) Rules, was introduced in 2008. Though e-waste is hazardous in nature, a specific regulation (the Electronic Waste (Management and Handling) Rules, 2011) was introduced only in 2011. It went through revisions multiple times, and the E-Waste (Management) Rules, 2016, was adopted with new features such as extended producer liability. Considering the necessity of revisiting the e-waste regulations, the Ministry introduced the E-Waste (Management) Rules 2022 (hereinafter referred to as Rules 2022). The new Rules are discussed in detail here in comparison with Rules 2016.

5.1. Meaning and Classification of Electronic Waste

Electronic wastes are discarded electrical or electronic devices or equipment. The e-waste covered under national legislation differs considerably[90]. Under the Rules 2022, e-waste means whole or part of electrical and electronic equipment discarded as waste and rejected from manufacturing, refurbishment and repair processes. The solar photovoltaic modules, panels, or cells also come within the purview of Rule 2022[91]. The definition of e-waste has remained the same since the adoption of the first set of Rules in 2011, except for the addition of solar modules and panels. The definition of e-waste under Rule 2022 is similar to EU directive 2012[92]. Nevertheless, there exists a disparity in the classification of e-waste under Rule 2022 and the EU Directive.

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89 United Nations Conference on Human Environment, 1972 (Feb. 18, 2024, 5AM), https://www.un.org/en/conferences/environment/stockholm1972.

90 Forti V., Baldé C.P., et. al, supra note 4 at 21.

91 E-Waste (Management) Rules 2022, Rule 3(1) (India).

92 Directive 2012/19/EU, supra note 87.

The Schedule I to the Rule provides seven categories of E-Waste. Around 106 types of devices are listed under the seven categories of E-waste in the Rule 2022. Under Rule 2016, hardly 21 pieces of equipment were placed under two categories in Schedule I. Due to the diversity in defining and categorising e-waste the United Nations University developed uniform categories known as UNU-KEYS for measuring and compiling e-waste statistics[93]. The EU Directive 2012 generally follows UNU-KEYS classification which is based on category classification model. However, the classification under Rules 2022 is not adhering to UNU – KEYS. So, following the internationally accepted uniform categories in listing e-waste would be beneficial in e-waste identification, management and preparing statistics. Also, no reference to nano e-waste exists under Rules 2022.

5.2. Responsibilities of Stakeholders

As per Rule 22, every manufacturer, producer refurbisher, dismantler and recycler involved in manufacturing, selling, transferring, purchasing, refurbishing, dismantling, recycling and processing of e-waste or electrical and electronic equipment listed in Schedule I are under its purview[94]. In contrast to Rule 2016, the present Rules do not explicitly mention consumers, bulk consumers, and e-retailers. As per the Rules 2022 and 2016, the manufacturers, producers etc, can store e-waste for a period of 180 days and must maintain a record of the sale, transfer and storage of e-waste[95]. Both the Rules 2022 and 2016 also prescribe the specific statutory responsibilities of stakeholders.

Comparison of Responsibilities under Rules 2022 and 2016

Sl. No	Category	E-Waste (Management) Rules, 2022	E-Waste (Management) Rules, 2016
1	Manufacturers (Covered under Both the Rules)	Mandatory registration with CPC in the Portal Collect, recycle and dispose of e-waste File annual and quarterly returns	Obtain authorisation CPCB Channelise EEE for recycling and disposal Maintain records and file an annual return.

93 Forti V., Baldé C.P., et. al, supra note 8.

94 E-Waste (Management) Rules 2016, Rule 15 and E–Waste (Management) Rules 2022, Rule 11 (India).

95 *Supra* note 94, Rule 2.

2	Producer (Covered under Both the Rules)	Mandatory registration with CPCB in the Portal. Implement the EPR target set out in Schedules III& IV (EPR standards are not provided in the Rules) Create awareness File annual and quarterly returns	Obtain authorisation from CPCB. Meet the EPR target prescribed in Schedule III. Follow EPR standards prescribed in the Rules for EEE collection, recycling and disposal. Create awareness File annual returns
3	Refurbisher (Covered under both the Rules)	Mandatory registration Collect waste and hand it over to registered recyclers. Ensure the quality of refurbished products as per the Compulsory Registration Scheme of the Ministry of Electronics and Information Technology and Standards of Bureau of Indian Standards. File annual and quarterly returns.	Obtain authorisation from the State Pollution Control Board. Collect and channelise EEE waste to authorised dismantlers or recycling facilities. Ensure the refurbishing is not harmful to the environment or health Maintain records File annual returns.
4	Bulk Consumer (Covered under both Rules)	There is no mandatory registration. Hand over e-waste to registered producers, refurbishers, and recyclers.	No authorisation required Channelise e-waste through authorised producers, dismantlers or recyclers. Maintain records of e-waste generated. Ensure e-waste does not get mixed with radioactive substances. Annual return to SPCB

5	Recycler (Covered under both the Rules)	Mandatory registration with CPCB in the Portal. Follow the standards prescribed by CPCB for recycling e-waste. Channelise the non-recycled materials and residue to respective recyclers and disposal facilities. Accept e-waste not listed in Schedule I and free of radioactive substances. Create awareness. Take the help of dismantlers for recycling. Maintain records of e-waste collected, dismantled, recycled and sent to registered recyclers on the Portal. File annual and quarterly returns.	Authorisation from the State Pollution Control Board. Follow the standards prescribed by CPCB. Recycling should not affect the environment and health. If working without authorisation, it shall be deemed that such entities are damaging the environment. Can accept any e-waste not given in Schedule I if not mixed with radioactive substances. Maintain records of e-waste collected, dismantled and recycled. File annual returns.
6	Collection Centres (Not covered under Rule 2022)	Not Covered	No authorisation Collect and store e-waste on behalf of producers, dismantlers, recyclers, and refurbishers. Follow the standards prescribed by CPCB. Maintain records of e-waste handled.

7	Dealers (Covered only under Rule 2016)	No specific responsibilities are assigned, and there is no provision for informal sector partnership.	No authorisation. On behalf of producers, dealers, retailers, and e-retailers collect e-waste. They shall refund the amount under the take–back / Deposit Refund Scheme to the depositor of e-waste. Transport e-waste to the authorised dismantler or recycler. Ensure that no damage is caused to the environment.
8	Dismantler Not covered under Rule 2022, though R.2 mentions dismantlers as a category to whom the Rules are applicable.	No specific responsibility is assigned.	Compulsory authorisation. Procedures shall be in accordance with the standards prescribed by CPCB. No adverse impact on health and environment. Functioning without authorisation will deem that such dismantlers are causing damage to the environment. Segregate e-waste and send it to authorised recycling and disposal facilities. Maintain records of e-waste collected, dismantled and send to recycler. File annual return.

On review of the primary duties and responsibilities of e-waste management authorities, Rule 2022 brought mandatory registration through an online portal maintained by the Central Pollution Control Board (CPCB). Registration is also mandatory for manufacturers,

producers, recyclers, and refurbishers under the new Rules. Under Rule 2016, the producers, manufacturers, etc., only had to get authorisation from the State Pollution Control Board. Rule 2022 retained the EPR scheme introduced by Rules 2016. However, in contrast to the Rules 2016, the new Rules do not clearly prescribe the EPR standards to be followed by the producers. Instead, it provides recycling targets for different types of producers. Since EPR is a core strategy adopted in India for e-waste management, it is imperative to incorporate it into the Rules. Also, Rules 2022 excludes the dealers, collection centres and dismantlers and keeps them outside the e-waste management framework. However, for the proper implementation of a circular economy, the role of collection centres and dismantlers must be identified and accommodated to avoid illegal and inappropriate waste dumping.

5.3. Extended Producer Responsibility

Rule 2022 retained and enhanced the EPR regime launched by Rule 2016. As per the new Rules, the producer shall comply with EPR targets provided under Schedules III and IV with the support of Producer Responsibility Organisations, collection centres, dealers etc[96]. To ensure transparency in the implementation of the EPR Scheme, the producer is responsible for submitting all relevant data on the CPCB Portal. A producer can fulfil his EPR liability by purchasing an EPR certificate from a registered recycler[97]. The details provided by the producer and recycler will be cross-checked on the Portal, and an environmental audit by CPCB or any authorised agency is also envisaged under the EPR scheme for its effective implementation[98]. The EPR scheme envisages two types of certificates, one for recycling and refurbishing will be issued to the respective recyclers and refurbishers by CPCB, who comply with the norms for issuing the same. The producer can purchase these certificates from the individual recyclers or refurbishers corresponding to the target fixed under Schedules III and IV[99]. The producer's EPR responsibility will

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96 E-Waste (Management) Rules 2022, Rule 13 (India).

97 E-Waste (Management) Rules 2022, Rule 13(3) (India)..

98 *Id.* Rule 13(3).

99 E Waste (Management) Rules 2022, Rule 14 (India).

be deemed to be not fulfilled until he produces a recycled certificate. Also, it is essential to note that importers of EEE have 100% EPR for the material if it is not re-exported[100].

The recycling regime is an old approach in the EPR Scheme. However, the new approach to the EPR scheme intends to make the producer responsible till the end of the life cycle of a product, or it is finally disposed off in an environmentally friendly manner. However, the new Rules confine its EPR scheme only to recycling e-waste, and no provision exists for repairing or disposing of e-waste. Developed countries have moved their recycling regimes to reverse logistics. The reverse logistics make the producers responsible for designing EEE ecologically sustainable from the very first stage of manufacturing. Also, the scheme presented in Rule 2022 lacks incentives for producers or consumers. There is no scheme for recycling and disposal fees or a Product Refund Scheme, though it has some references about such incentives. Thus, the the recycling of E-waste needs to be replaced by an adequately crafted circular economy based on reverse logistics and EPR.

5.4. Reduction of Hazardous Substance

To reduce toxicity and environmental pollution, Rules 2022 provide measures to reduce the use of hazardous substances in the manufacturing process of EEE. Manufacturers are bound to restrict the use of Lead, Mercury, Cadmium, Hexavalent Chromium, polybrominated biphenyls and polybrominated diphenyl ethers not beyond the percentage allowed in the production of new electrical and electronic equipment and their components or consumables after 2014[101]. Schedule II to Rules 2022 lists the permitted hazardous substance level. The manufacturers are responsible for using technology or methods to facilitate recycling the end product[102]. It also allows manufacturers to provide detailed information to users regarding the constituents of equipment and their parts and a declaration of conformance to rules relating to reducing hazardous

[100] E-Waste (Management) Rules 2022, Schedule III (India).

[101] E-Waste (Management) Rules 2022, Rule 16 (1) & (2) (India).

[102] E Waste (Management) Rules 2022, Rule 16 (9) (India).

substances[103]. Equipment manufactured as per the limits prescribed under the Rules will only be allowed to be imported or placed in the market[104]. To monitor and verify compliance with the Rules, the CPCB can conduct random sampling of equipment placed in the market, and the cost shall be borne by the producer[105]. The CPCB can direct the producer to withdraw or recall products from the market if the hazardous substance standards are not complied with[106]. The Rules 2016 also had provisions to reduce the use of hazardous substances. However, the conditions for making products recyclable and empowering CPCB to recall products that do not comply with the Rules are additions to the New Rules.

5.5. Responsibilities of Authorities

The principal implementing agency is CPCB. It integrates functions of all stakeholders, takes care of the operation and maintenance of EPR, coordinates SPCB, prepares SOP for collection, storage, transportation, segregation, dismantling, recycling and disposal of waste, and ensures EPR and RoHS compliance by conducting random checks in the market, an submit an annual report to the Ministry[107]. The State Pollution Control Board (SPCB) role is also crucial as it is empowered to prepare an inventory of e-waste, ensure compliance with EPR through random inspection, and implement environmentally sound recycling[108]. The local bodies segregate e-waste mixed with solid waste and channel it to registered recyclers or refurbishers. They are bound to collect all orphan waste and hand it over to approved facilities for recycling and refurbishing. They are responsible for setting up facilities for collection, segregation and disposal of e-waste.

The Department of Industry in every state and union territory has to set up industrial space in existing and upcoming industrial

[103] E-Waste (Management) Rules 2022, Rule 16(5) (India).
[104] E-Waste (Management) Rules 2022, Rule 16(6) (India).
[105] E-Waste (Management) Rules 2022, Rule 16(11) (India).
[106] E-Waste (Management) Rules 2022, Rule 16(12) (India).
[107] E-Waste (Management) Rules 2022, Schedule V (India).
[108] E Waste (Management) Rules 2022, Schedule V (India).

parks to dismantle and recycle e-waste[109]. The Labour Department is responsible for recognising and ensuring the registration of dismantling workers, and they shall be encouraged to set up dismantling facilities. The Labour Department is duty-bound to provide skill development training to dismantling workers and to ensure the health and safety of such workers[110]. The Ministry of Electronics and Information Technology and the Bureau of Indian Standards are responsible for developing standards for refurbished products. The Port authorities are also responsible for ensuring EPR in imports and exports of EEE and reporting illegal traffic to appropriate authorities[111].

5.6. Environmental Compensation and Prosecution

The Rules 2022 empowers the CPCB to lay down regulations for imposing environmental compensation on producers who do not comply with the EPR and on unregistered manufacturers, producers, recyclers and refurbishers. The CPSB can separate the environmental compensation fund, which can be used to recycle or dispose of uncollected, historical, or orphaned waste. CPCB can also use it for R&D, incentivising the producers and supporting local bodies in waste management. A Steering Committee will decide the modalities and heads of utilisation with the approval of the Ministry of Environment, Forest and Climate Change. In addition to imposing compensation, persons providing false information for obtaining EPR or, willfully violating the directions given under the Rules or failing to cooperate with the verification and auditing proceedings can be prosecuted under S.15 of the Environmental Protection Act, 1986.

6. Challenges in the Implementation of E-Waste Management Rules

a) Improper Implementation: India introduced e-waste management rules way back in 2011 and subsequently modified them several times. These Rules endowed the CPCB and SPCB with the powers to manage e-waste effectively. However, these statutory bodies failed in their mission. The lethargic approach of these

[109] E-Waste (Management) Rules 2022, Rule 10 (India).

[110] E-Waste (Management) Rules 2022, Rule 10 (India).

[111] E Waste (Management) Rules 2022, Rule 10 (India).

statutory bodies was stated by the National Green Tribunal while deciding the case *Varun Sheokand vs the Central Pollution Control Board and others.* [112]. The litigation was filed against the illegal and unscientific management of e-waste Sarurpur industrial areas in Haryana. Industrial units in this area engaged in illegal burning and dumping of e-waste and no proper action was taken against it. The CPCB and SPCB filed their reports. Considering the reports the tribual oberserved that "there are huge gaps in compliance of rules which are being more held in breach than observance showing the authorities charged with the obligation of ensuring pollution free environment in poor light. There are clear governance deficits on the subject and higher authorities are not adequately concerned about the plight of the citizens on account of such serious violations to the detriment of health of the citizens"[113]. The NGT gave specific directions to the SPCB and CPCB for the effective implementation of e-waste management norms.

b) Right to Repair: In the US and UK, the right to repair is recognised as an effective measure to retain e-waste in the product life cycle. The Indian E-Waste Rules have no reference to the right to repair or the duties of producers/manufacturers to provide basic information or spare parts to the consumer to facilitate repair by themself or a third party. However, India launched the right to repair as part of the LiFE (Lifestyle for Environment) movement by the Department of Consumer Affairs[114]. Only four categories of equipment are covered under the scheme. Most importantly, to endow the consumers with the right, it must be part of statutory regulations. Otherwise, the scheme will remain discretionary for manufacturers/producers, and the question of enforceability will also arise.

c) Lack of Consumer Awareness: India, with the largest population in the world and little information about e-waste, is the single

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[112] Varun Sheokand v. Central Pollution Control Board & Ors., Original Application No.8/2022, The National Green Tribunal (India) (Feb. 18, 2024, 10AM), https://indiankanoon.org/doc/189521742/.

[113] *Id.* at Para 23.

[114] *Right to Repair Portal India* (Feb. 19, 2024, 11pm), https://righttorepairindia.gov.in/#!.

most crucial factor for improper handling of e-waste. Under the new Rules, producers/manufacturers are responsible for creating awareness among people. However, no consistent effort has been made so far either through digital or print media by the producers/manufacturers. It leads to improper handling and dumping of waste.

d) Transboundary Imports: Illegal import of e-waste is prohibited under the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. However, there were around 29 reported cases of illegal importation of e-waste in different states in India in 2019[115]. E-waste reaches developing countries either by mixing with other waste, declaring it as non-hazardous, or classifying it as second-hand goods[116]. The lack of proper regulation to identify and eliminate e-waste from second-hand goods makes the enforcement difficult.

e) Inventory of EEE: For the proper management of e-waste, a statistical analysis of EEE produced at the local, state and national levels and the generation of waste need to be documented. The regulations imposed the duty of preparing inventories on SPCBs. However, no such inventories have been released so far[117]. It is also necessary to have data on the cross-border transfer of e-waste. Accurate data on e-waste is necessary to develop an effective collection, segregation, transportation, dismantling, recycling, and disposal scheme.

f) Informal Sector: India has a large network of informal sector collection centres and dismantlers, along with the registered formal sector of almost 150 dismantlers and recyclers. However,

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[115] 29 cases of illegal import of e-waste detected since 2019: Centre tells Parliament, Indian Express (Feb.17, 2024, 10PM), https://indianexpress.com/article/india/29-cases-of-illegal-import-of-e-waste-detected-since-2019-centre-tells-parliament-7842379/.

[116] Illegal waste trafficking: more data is key to getting a better grip on this trade, World Customs Organisation (Feb.10, 2024 4AM), https://mag.wcoomd.org/magazine/wco-news-88/illegal-waste-trafficking-more-data-is-key-to-getting-a-better-grip-on-this-trade/.

[117] Rama Mohana R. Turaga, *Public Policy for E-Waste Management in India*, 44 VIKALPA 130 (2019).

these companies in the formal sector struggle to function at their installed capacity due to improper channelisation of waste[118]. The information sector collects e-waste for nominal amounts, and such financial incentives instigate the consumers to sell e-waste to the informal sector. Though the Rules envisaged consumer incentives, producers have not implemented them properly. This leads to illegal and improper handling of e-waste. To resolve this issue, formal and informal sector partnerships need to be developed at the policy level by recognising the role and capacity of the informal sector.

g) Financial Incentives and Product Refund Scheme: The Product Refund Scheme and other schemes like Advanced Recycle Fee (ARF) or Advanced Disposal Fee (ADF) are unpopular in India which incentivise the consumers and producers/recyclers[119]. EPR was introduced by Rule 2016, and new Rules have provisions directing the producers to introduce incentive schemes for consumers. However, such measures remain in statute books. A product refund scheme similar to the one existing in Germany and other European Countries must be implemented in India as it is the only way to channel e-waste from households to authorised recycling/disposal facilities.

h) Technology and skill development: India lacks indigenous technology for managing e-waste cost-effectively. The recyclers authorised to handle e-waste in India heavily depend on the developed countries to process the valuable parts in e-waste due to the non-availability of such technologies locally[120]. Also, the informal sector facilities and workers lack the skills to handle e-waste safely.

i) Upstream Management: Upstream management of EEE is equally important as that of downstream management. Downstream management involves measures for scientific e-waste management

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[118] Daniel Hinchliffe, Morton Hemkhaus et. al., *Informal–Formal Partnerships in the Indian Electronic Waste Sector in India* 44 VIKALPA 136 (2019).

[119] Rama Mohana R. Turaga , *Supra* note 117 at 130. THERE IS NO FOOTNOTE NO.123

[120] Sandip Chatterjee, *Technologies for E-Waste Management*, 44 VIKALPA 139(2019).

through recycling, refurbishing, and disposal. However, the upstream management of EEE has not yet been included in the Indian regulations. For upstream management, countries have adopted reverse logistics to make the manufacturing process green from the very first production or manufacturing stage. This approach can reduce waste substantially.

j) Nanomaterials and materials that are not common: With the development of nanoscience and technology, the use of nanomaterials in EEE has increased significantly. However, the existing statutory provisions do not address its usage and proper disposal[121]. It is essential to address the issue of nano e-waste, though India is only in a nascent phase of e-waste management. The manufacturers also use many uncommon materials to improve efficiency and compactness. The scientific fraternity has yet to decipher the impact of those uncommon materials. Thus, strict regulatory guidelines must be adopted for the use of nano and uncommon materials in electronic devices.

7. Conclusion

The expanding horizons of human satisfaction tempt business entities to develop devices or equipment to cater to the needs of society's changing lifestyle. This has resulted in the generation of e-waste across the globe. The nation-states have devised various strategies to address this issue, and India, in tune with the measures adopted at the international level, has also launched statutory norms for the management of e-waste. On reviewing India's position in comparison with the measures existing in other countries, the study finds that India is in a nascent stage of adopting the concept of circular economy, extended producer liability, and reverse logistics. Though the newly introduced E-Wate Management Rules, 2022 is intended to bring reforms in e-waste management, the Rules address only the downstream management of wastes. The following suggestions are made based on the issues discussed in the paper. No law can be effective unless the bodies endowed with the powers are not

[121] Nouha Bakaraki Turan, Guleda Onkal Engin et.al., Nanoparticles in solid waste: Impact and management strategies (Feb. 20, 2024, 10PM), https://doi.org/10.1016/bs.coac.2022.01.001.

working efficiently. CPCB and SPCB have not seriously attempted to implement the previous regulation India adopted. Thus, it is peremptory to ensure the proper implementation of new rules. The extensive network of individuals and entities in the informal sector needs to be attracted to the formal structure by providing adequate training for skill development in e-waste management. Consumers' awareness levels must be enhanced to encourage them to deposit e-waste only through the proper channels. Financial incentives for consumers and recycling institutions shall be implemented through Product Refund Schemes and Product Recycling Fees or Disposal Fees. Encouraging producers and manufacturers to focus on reverse logistics is also essential. A shift from the management of e-waste to reducing the generation of waste would be more cost-efficient. The flow of EEE and its inventory need to be prepared at the state and national levels. This will help to identify illegal imports and fix the responsibility of producers, manufacturers and importers. Thus, concerted effort at the policy and implementation levels is required to manage e-waste in an environmentally sustainable manner.