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3. E-Waste Management for better tomorrow

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Abstract:

The electronic waste (e-waste) generated from the disposal of electrical and electronic equipment is a prime environmental concern. E-waste recycling is a systematic collection of e-waste and recycling of it into value-added products. The recycling of e-waste is associated with the generation of toxic substances. The efficiently recycling of e-waste without threatening public health is a holistic tactic to ensure the minimal emission of perilous e-waste to the ecosystem.

The present chapter dealt with the possible prospects, constrictions, and approaches for enhanced e-waste management. The global inclination toward e-waste recycling progression and strategies makes it efficient and environmentally benign. The holistic paradigm of e-waste management is discussed in the chapter with an aim of the proper implantation of the best possible way for e-waste management.

Keywords:

E-waste management, electrical and electronic equipment, value-added products.

3.1 Introduction:

Invest India, an investment promotion agency quoted that India would reach up to $ 1 TN of the digital economy by 2025. The Indian electronic Market (e-Market) is now $118 billion and contributes 2.7% of GDP and the Indian manufacturers export electronic goods of $10.6 billion by 2020-21. The electrical and electronic equipment (EEE) are serving comfort, luxury, and accuracy with cross-cutting customized automation and utmost wellbeing in modern societies.

The electronic items viz., workstation electronics (i.e., mobile handset, air condition, computers, and lights), household electrical apparatus and tools (i.e., televisions, refrigerators, induction, oven, fan, lights, washing machine, air condition, and investors), medical devices and tools (i.e., diagnosis machinery such as MRI, CT-Scan, X-Ray, Radiological instruments, Analytical machinery, Testing tools and testing kit readers and so on).

The medical devices and household EEE have a larger market cap due to the extensive variety of products. International Energy Agency has released Key World Energy Statistics (International Energy Agency. 2017) and Energy Efficiency: Industry (International Energy Agency, 2019) and stated that the global energy demand has doubled in the last three decades due to the growing population and expanding industrial sector.

The energy-efficient and compact EEE has a shorter lifespan, limited repair options, and better alternatives; therefore, people replace them with a new ones (Chi et al., 2014). Hence, the huge defected EEE is accumulated as e-waste.

They are being used due to the physical damage, improper working, and accessibility to better alternatives. Rapid technological advancement has encouraged more e-waste generation. The research and development cells of EEE companies are releasing new EEE integrated with advanced technology in a short period that attracts most of the population having enough financial strength to buy those products.

The e-waste includes all components of EEE discarded. The massive e-waste accumulation, inappropriate disposal, unidentified recycling measures, and its associated health hazards (via plastic, metal, and hazardous chemical components) are now considered a global concern (Ongondo et al., 2011)

3.2 Characteristics of E-Waste:

Toxic substances e.g., polychlorinated biphenyls, brominated flame retardants (BFRs), and heavy metals i.e., arsenic (Ar), cadmium (Cd), hexavalent chromium (Cr-VI), lead (Pb), mercury (Hg) and selenium (Se) are present in the e-waste (Pinto, 2008).

The polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) are the major hazardous chemicals generated during the recycling of e-waste (Robinson, 2009).

These perilous chemicals are emitted into the environment and enter the ecosystem and their long-term exposure causes environmental pollution and degradation (Needhidasan et al., 2014).

One advantageous part of e-waste is the existence of recoverable metals e.g., aluminium, antimony, bismuth, copper, cobalt, gold, germanium, iridium, indium, iron, platinum, palladium, ruthenium, rhodium, and silver as a striking source of economy for recycling units and scrap dealers (Hubbert, 1956).

3.2.1 E-waste Disposal Guidelines:

e-Waste Management & Handling Rules (2011) were notified and come into implementation in 2012 But the actual implementation of e-Waste management was notified under Rules, 2016, dated 23.03.2016 under vide G.S.R. 338(E) and was effective from 01-10-2016.

The notification was published on 23rd March 2016 in the Gazette of India, Extraordinary Part-II, Sec. 3, Sub-Sec. (I), Government of India, Ministry of Environment, Forest and Climate Change published the Responsibilities of the manufacturer, collection centres, dealers and refurbishes, bulk consumer, and dismantler.

The Authorities for e-waste management are the Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCB), Committees of Union territories (CUT), Urban Local Bodies viz., Municipal Committee or Council or Corporation, Port Authority (PA) under Indian Ports Act (IPA), 1908 (15 of 1908) and Customs Authority (CAs) under the Customs Act (CA), 1962 (52 of 1962) are allotted by Government of India (Lower Middle-Income Data, 2022; CPCB, 2018). The EEE manufacturing and disposal without authorization from CPCB, is considered a violation of e-Waste Management Rules (2016) notified under E(P) Act 1986 and are punishable as per section 15 of the Act, 29 of 1986 (CPCB, 2017).

3.2.3 Strategies for Minimizing E-Waste:

EEE repairs include fixing the particular electrical fault by untrained mechanics but it is only practiced by lower-middle-income families. But, the Original equipment manufacturers (OEMs) companies have a monopoly over product design thereby the repairing cost is much higher. To overcome the situation, the argument was raised that the Right to Repair is not equivalent to the Right to replicate but not worked well.

The further advancement of the repairing system is Refurbishment. Refurbishment involves the repairing, servicing, and replacement of damaged consumable items, polishing, finishing, and packaging to make the old product close to the freshly brought new product.

The refurbishment is often executed by professionals. Such practices are very effective for the minimization of e-waste. Some online vendors like Amazon, are practicing refurbishment of old exchanged products.

3.2.4 E-waste Recycling Opportunities:

The EEE is the largest and fastest-growing manufacturing sector. Besides, the upsurge in sales of EEE and rapid obsolescence i.e., technological advancement, fashionable looks, and style push the huge e-waste generation. The hazardous components of e-waste laid adverse effects on the environment and human health.

The e-waste management system in India lacks proper implementation of suggested guidelines and protocols and seeks infrastructure augmentation for e-waste disposal and recycling (Vats and Singh, 2014). Thereby, the implementation of well-organized, innovative, and cost-effective practices is needed to safeguard the ecosystem and environment.

The state viz., Maharashtra (MS), Tamilnadu (TN), Telangana (TL), Andhra Pradesh (AP), Uttar Pradesh (UP), West Bengal (WB), Delhi (DL), Karnataka (KR), Gujarat (GJ), Madhya Pradesh (MP) and Punjab (PB) are account for 70% of the total e-waste generated in Indian continent (Agarwal, 2014) due to a large number of Tech Parks & electronic manufacturing units situated in their premises.

The categorization of E-Waste is depicted in Figure 3.1.

Figure 3.1: Different Categories of E-Waste

When repair and refurbishment are not appealing then the EEE goods come under the recycling process. The recycling process includes; (a) collection, (b) storage, (c) shortening, dismantling, and shredding, (d) mechanical separation, and (e) recovery of valuable products.

A printed circuit board (PCB) is a sandwich construct of conductive and insulating layers E-waste recycling and resource reimbursement are the multi-directional tactics that are required for a holistic solution to the e-waste threat to the global economy and eco-conservation.

The e-waste recycling methodology, regulatory affairs and legislation, circular economy models, the impact of e-waste on the environment and human health, and sustainable management (Islam et al., 2020; Pini et al., 2019; Awasthi et al., 2016; Gupta et al., 2014; Jadhav, 2013; Kahhat et al., 2008;) have been extensively explored in various works of literature. PCBs occupy up to 70 wt. % of the non-metallic e-waste and it is a challenging task for recycling (Yoo et al., 2009).

The component of non-metallic PCBs is including thermosetting plastics (TS), glass fibers (GF), and ceramic fractions (CF). The TS resists reformation due to its cross-linked polymeric assembly.

The first option is to Incinerate but glass fiber content reduces its efficiency as fuel (Goosey and Kellner, 2003). The second one is to dispose of by landfill but it is resource-wasting and causes pollution (Guo et al., 2009).

The modern approach is mechanical pre-treatment for the removal of plastic or ceramic materials coated over metallic elements and facilitates the liberation and separation of value-added products by hydrometallurgical methods (Yoo et al., 2009). Recent research has suggested that powdered PCBs can be used as wood fillers substitute, epoxy resin, adhesives, decorating agents, and building materials due to their high mechanical and thermal expansion properties (Zheng et al., 2009; Iji, 1998). Steps involved in the metal recovery from e-waste are depicted in Figure 3.2.

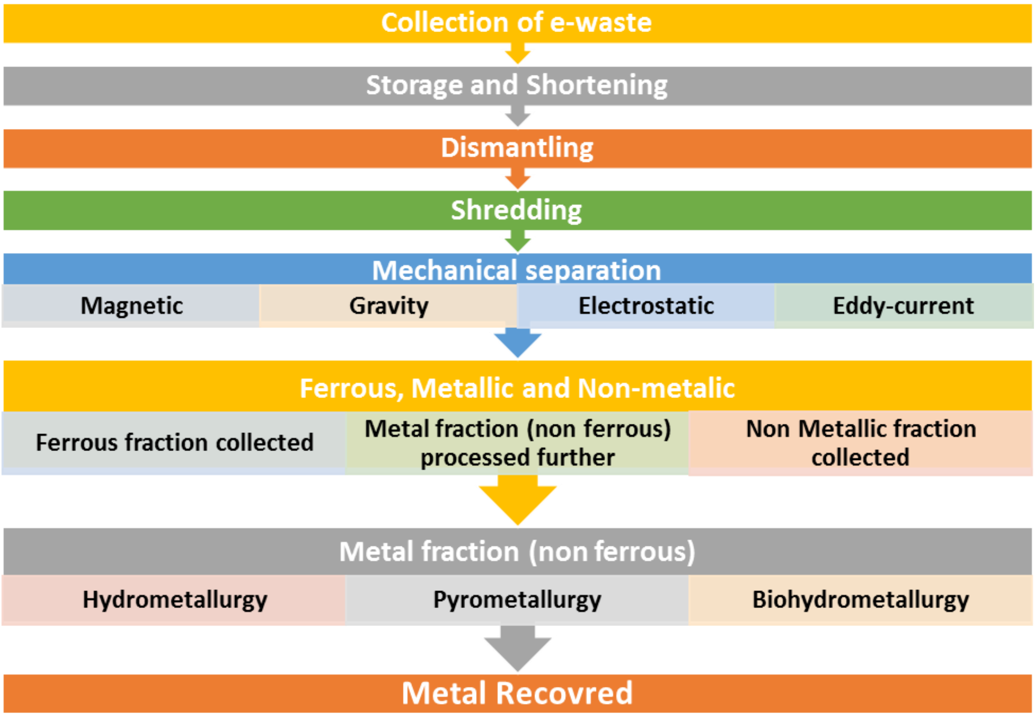

Figure 3.2: General Outline of the Metal Recovery from E-Waste

3.3 Conclusion:

Electrical and Electronics Equipment (EEE) occupy around $118 billion. The rapid technological advancement attracts consumers to replace much faster their EEE with the latest model of EEE having updated configuration and advanced features. Most consumers are not interested in repairing or using refurbished EEE due to the unavailability of trustable repair or refurbishment shops. Moreover, the energy-efficient and technologically advanced EEE has a short lifespan.

Due to the aforementioned reasons a huge amount of e-waste is accumulated. The traditional e-waste recycling approach is associated with environmental and health concerns. The present tactics offer the opportunities to extract value-added products i.e., precious metals and epoxy resin additives, from e-waste. The well-documented regulations and legislative frameworks available for e-waste management.

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