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E-waste Management: Challenges and opportunities

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Abstract

The escalating environmental foci of the past couple of decades have directed considerable attention toward the incongruent issues arising from the disposal of durable consumer goods. End of life (EoL) electrical and electronic equipment (EEE) known as e-waste is one of the fastest growing areas of the international waste stream and is increasing at a much higher rate than all other waste streams. Safe management or disposal of electronic products are increasing significantly on a global scale and is becoming a major problem for many countries around the world. In this article, India's status on E-waste management is described based on recent surveys and statistics. The variety and projections in e-waste composition is also identified due to the technological improvement in the electronic industry, which introduces difficulty for the development of a universal, environmentally benign and sustainable recovery process. The collection and management of EEE waste remain a key challenge. This necessitates the shift to a more circular approach for the e-waste management sector. An overview of the practices followed in the country is presented and the manner in which they contribute to the sustainable management of e-waste is discussed.

Introduction

E-Waste is a topic of national importance to every country. According to the Global E-Waste Monitor 2020, the world generated a striking 53.6 Mt of e-waste, an average of 7.3 kg per capita in 2019. The growing amount of e-waste is directly linked to higher consumption rates of EEE, short product life-cycles, rapid technological advancement and few repair options.

Asia generated the highest quantity of e-waste in 2019 at 24.9 MT, followed by the Americas (13.1 Mt) and Europe (12 Mt), while Africa and Oceania generated 2.9 Mt and 0.7 Mt, respectively. Globally, by 2050, the rate of consumption of resources would be three times higher than the rate at which earth can replenish. Only an estimated 17.4 % of e-waste generated is taken for recycling with the rest going into landfills.

India ranks third amongst the largest e-waste producing countries, after USA, and China, with over 3.2 MT of e-waste generated in 2020 and only an estimated ~0.2 MT (5%) is taken for recycling. The factors that led to a growth of e-waste are digital transformation, Social and economic growth, rapid technology advances, dumping trash etc. Close to 90 per cent of the world's electronic waste — worth nearly $19 billion — is illegally traded or dumped each year, to destinations half way across the world. While the European Union, the U.S. and Japan are the primary origins of e-waste shipments, China, India, Malaysia and Pakistan are the main destinations, as per reports. In Africa, Ghana and Nigeria are the biggest recipients of e-waste.

E-waste contains precious and special metals, including gold, silver, palladium and platinum, as well as potentially toxic substances such as lead, mercury, cadmium and beryllium. Therefore, responsible end-of-life management of e-waste is imperative in order to recover valuable components and properly manage hazardous and toxic components. End-of-life management of e-waste includes reuse of functional electronics, refurbishment and repair of electronics, recovery of electronic components, recycling e-waste, and disposal. Reuse, refurbishment or repair of electronic products is most desirable since this option increases the life span of the electronic product and higher resource efficiency.

Although E-waste management is an intricate problem to tackle with, it also offers promising business opportunity of increasing significance. The fraction including iron, copper, aluminium, gold and other metals in e-waste is over 60%, while pollutants comprises 2.70 % (Widmer et al., 2005). Recycling of electronics allows for precious and special metals to be recovered, reduces the environmental impact associated with electronic manufacturing from raw materials, and ensures that hazardous and toxic substances are handled properly. Although there are clear benefits to recycling e-waste, the recycling rate of e-waste is relatively low, due to lack of recycling and regulatory infrastructure.

In India e-waste collection, transportation, segregation, dismantling, recycling and disposal are done manually by untrained labours in informal sector. The large share of e-waste (more than 90%) gets channelized to informal sector as they use low-cost rudimentary methods of processing to recover materials. Lack of consumer awareness is another reason for channelization of e-waste to informal sector. In addition, disposal of the e-waste in landfills results in loss of high amounts of valuable metals like gold, silver, copper etc. and also pose a risk because of toxic chemical compounds.

Challenges

The explosion of e-waste highlights its dual (and duelling) identities as both environmental scourge and potential economic resource. Though often laced with lead, mercury or other toxic substances, e-waste also contain valuable elements like gold, silver and copper. When e-waste is exposed to the heat, toxic chemicals are released into the air damaging the atmosphere; this is one of the biggest environmental impacts of e-waste. Those toxic materials can then seep into the groundwater there by detrimentally affect human health. Electronic waste can also contribute to air pollution.

The South Asian region has begun to recognise the importance of proper e-waste management. India is the only country in Southern Asia with e-waste legislation,although several other countries are in the process of enacting such legislations. In India, laws to manage e-waste have been in place since 2011, mandating that only authorised dismantlers and recyclers collect e-waste. A manufacturer, dealer, refurbisher, and Producer Responsibility Organization (PRO) were brought under the ambit of the E-Waste (Management) Rules 2016. The National Resources Policy also envisages a strong role for producers in the context of recovering secondary resources from e-waste. Legislation in India has been a driver for the setting up of formal recycling facilities, and there are 468 authorised recyclers in India as of 2021. However, the large majority of the waste is still handled by the informal sector. There are 31 authorised PROs providing compliance services, including the collection and channelization of e-waste to formal recycling facilities, as well as the administration of awareness campaigns. Enforcing rules remains a challenge, as do other aspects, such as the lack of proper collection and logistics infrastructure, limited awareness of consumers on the hazards of improper disposal of e-waste, the lack of standards for collection, dismantling of e-waste and treatment of it, and an inefficient

and tedious reporting process. In spite of legislation by Govt. of India, poor implementation of e-waste management and handling rules remains a key challenge.

Most of the e-waste handled by informal sector and formal recyclers facing dearth of e-waste. Most of the e-waste generated in the country ends up in the informal sector for recycling and disposal. Many workers function from homes to reprocess waste.

Moradabad in Uttar Pradesh and Seelampur in Delhi are the largest informal e-waste dismantling centres in India. Adults and children work in dismantling facilities without any safety precautions. E-waste recyclers use processes such as open incineration and acid-leeching to recover valuables. The majority of the e-waste collected in India is managed by this unorganized sector.

For instance, to extract metals from circuit boards, gas torches are used to heat circuit boards just enough to melt the solder, which separates the metal parts from the boards.

Metals are also extracted by soaking the circuit boards in open acid bath followed by manual scrapping to extract copper and precious materials next to open drains. This situation could be improved by creating awareness and improving the infrastructure of recycling units along with the prevalent policies. In order to mitigate the informal recyclers and promoting the formal recycling is a major challenge considering the cost effectiveness of informal and unscientific recycling practices in India. Huge capital involved in setting up the recycling facility and dearth of indigenous technology to extract precious metals from e-waste.

It is estimated that about half the circuit boards used in the appliances in India end up in Moradabad (Uttar Pradesh) also called Peetal Nagri. The circuit board recycling process involves either open burning of the circuit boards or using acid stripping. Following the chip extraction and burning, the boards themselves are burned in an open pit to retrieve the rest of the metal solder and copper. After burning, the ashes are floated in water to remove lighter ash. Another process involves utilizing nitric acid on the circuit boards to remove gold and platinum. There is a perceived need to increase the awareness level of consumers towards health hazards caused due to e-waste, disposal practices, environmental problems resulting out of poor disposal of e-waste and awareness towards legislative policies related to e-waste management in India.

Opportunities

E-waste is a rich source of metals such as gold, silver, and copper, which can be recovered and brought back into the production cycle. There is significant economic potential in the efficient recovery of valuable materials in e-waste and can provide income-generating opportunities for both individuals and enterprises. There is countless business opportunities present in the current waste sector, and these are not restricted to large companies with limitless capital. Small entrepreneurs and SMEs can also tap into the potential that the recycling sector holds.

Growing quantum of e-waste offers opportunities to entrepreneurs. E-Waste Management is on the verge of building an "Industry Sector". It opens up opportunities in setting up new business start-up as recyclers, dismantlers, e-waste collectors, and refurbisher. It is found that 1 MT of printed circuit boards (PCBs) recycling produces 120-150 gram of gold, whereas only 1 to 2 gm of gold can be recovered from 1MT ore extraction.

In a developing country like India, a holistic approach is required for better e-waste management, which means the formal and informal sectors need to work together. For example, the informal sector can be involved in the collection, segregation and dismantling while the formal sector can take responsibility for recycling, metal extraction and recovery, and disposal of e-waste safely and scientifically without causing damage to the environment and human health. A major advantage of good e-waste management is its cost effectiveness. Studies have shown that 1.2 kg of Cobalt can be extracted from 1 ton of its ore, whereas 35 to 40 kg cobalt can be extracted in pure form from 1 ton of waste smart mobile phone batteries. Therefore, an increase in the number of formal sector units with adequate infrastructure for recycling can be beneficial for a developing country like India, which is expected to support National Missions such as Make in India, Swachha Bharat, Digital India etc.

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Biosketch of Dr. Ratheesh

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