The Dynamics of E-Waste Generation, Management and Environmental Impact

M. S. Bisen[1], D. L. Chaudhari[1] and R. U. Gadpayle[2]
[1]Yashwantrao Chawhan College, Lakhandur,
Dist. Bhandara, Maharashtra – 441803 (India)
[2]S.S. Jaiswal College, Arjuni/Mor, Dist. Gondia,
Maharashtra - 441701(India)
rug.sci@gmail.com

Abstract:

India is among the fastest growing market in terms of capital inflow as well as infrastructure development. The growth of Information Technology based industry worldwide has also gave a major boost to the Indian economy and became one of the major contributors to India's GDP. However, along with the economic development, the country is burdened with growing solid waste that is not only creating economic hurdle but adversely impacting the environment and human health. The maximum numbers of consumer appliances available today in market and households have at least some electronic components in them. Furthermore, availability of large varieties of appliances, attractive features and cost affordability has resulted in high rate of obsolescence leading to high volumes of solid waste, particularly E-waste, in India. Aim of this article is to give a conscientious view on growing E-waste burden in India and its environmental impact.

Keywords: E-waste, Environmental Impact, Hazardous Waste, Waste Management, Recycling

Introduction:

The industrialization has not only benefited mankind immensely but also burdened it with the human-generated waste that paradoxically, itself, is threatening the very existence of not only the humankind but also the environment and other biological lives. The electrical and electronic waste is such an example of human-generated waste of New Age era that is said to be one of the fastest growing waste streams in the world. Its adverse impact on human health and environment as well as the huge volume of waste generated per year has made all the stakeholders to take strict measures to contain the growing burden this solid waste. The severity of the problem can be somewhat guessed from the report that the global volume of e-waste generated is expected to reach 93.5 million tons in 2016 from 41.5 million tons in 2011, a 17.6% increase from 2011 to 2016 (1). Moreover, India is also not far behind in this issue. It was estimated by Central Pollution Control Board (CPCB) that in India there would be about 8 lakh tones or 0.8 MT waste by 2012 (2). A Government of India document on E-waste specifically mentions that ten states alone out of total 29 states and 5 Union Territories in India generate about 70% of the total e-waste in India where about Sixty-five cities contribute a major share (more than 60%) of the total e-waste generated in India (3). Thus, it is imperative to understand the growing menace of E-waste and there is urgent need to develop new sustainable practices to minimize E-waste generation and its safe disposal. In this article, authors have tried to review the various factors responsible for E-waste generation, treatment and disposal in light of recent developments and information available.

E-WASTE

The 'E-Waste' or more technically termed as 'Waste Electrical and Electronic Equipments' (WEEE) is said to be generated when any electrical or electronic equipment or any device with an electronic or electrical component therein is discarded either after it malfunctions/damaged or considered as obsolete and not considered by user as repairable or reusable. The e-waste inventory based obsolescence rate in India by the year 2012 was estimated to surpass 800000 tonnes (2). The region wise contribution to E-waste generation was reported to be as from North(21%), East(14%), West(35%) and South(30%) (4). Further, it was estimated that the total amount of hazardous material to be accumulated by 2020 would be about 1.09 lakh MT plastics, 0.15 lakh MT copper, 0.2 lakh MT lead, 140 MT Mercury, 146 MT Cadmium, 491 MT Zinc from desktops, laptops, mobile phones and televisions combined (5). The E-waste comprises of a wide list of heterogeneous devices coming from any of the generation points viz., manufacturing points (factories, fabrication units, etc), supply chains (packaging, transportation damage) and households (used, malfunctioning, obsolete, damaged devices, etc). The composition of E-waste is diverse and varies depending upon i) the type of items it receives as waste, ii) quantity of particular types of waste and iii) site of collection of waste.

The E-waste can be broadly grouped into two types of waste, viz., White goods and Brown goods. The white goods are referred to certain appliances such as air conditioners, dishwashers, refrigerators, and washing machines where the electrical and electronic components comprise a small part of the whole appliance while larger part consists of metal, rubber, plastic or wood. The brown goods are referred to the appliances where maximum part of the devices is comprised of electrical and electronic components. The brown goods contains devices such as computers, accessories such as keyboards, mouse, laptops, monitors, printers, scanners, fax machines, mobile phones, CRT/LCD/Plasma TV, remotes, calculators, medical equipments, electronic toys, etc. The E-waste items have about 26 identifiable and removable common components in them such as metal, insulation, wiring, external electric cables, motor, CFC/HCFC/HFC/HC, cooling compressor, electrolyte capacitors, LCD, batteries, plastic, brominated flame retardant (BFR)-containing plastic, rubber, transformer, magnetic component, circuit board, fluorescent lamp, incandescent lamp, heating element, thermostat, glass, textile, concrete, refractory ceramic fibers and radioactive substances (2,3).

Human and Environmental Hazards

The electrical and electronic equipments have a multitude of components often consisting of complex and composite materials. These composite materials often contain toxic substances and hence the E-waste is considered as 'hazardous waste' by virtue of their potential risk of adverse impact on human health and environment. The toxic substances that may be present in the E-waste are lead (printed circuit boards, CRT screens, batteries), mercury (fluorescent lamps, switches, alkaline batteries), chromium (data tapes), lithium (batteries), cadmium (batteries, CRT fluorescent layer, printer drums, toners, inks), arsenic (light emitting diodes, solar cells, microwaves), beryllium (power supply boxes, x-ray

lenses), barium (filler lubricants), polybrominated biphenyls, polybrominateddiphenylethers, polyvinyl chloride, phosphor compounds and fire retardants (plastics and fire retardant for printed circuit boards), etc (2,3).

The E-waste components are potentially toxic to human health and also adverse impact on environment. The potential deleterious effects on human and animal health includes but not limited to skin diseases, chronic organ dysfunctions (liver, kidney, eyes, heart, and brain), nerve conductions impairment, memory loss, infertility or reduced fertility, retarded growth, congenital disabilities, skin, lung and stomach cancers, compromised immune system, and other physiological problems. The toxic elements and other substances present in E-waste can contaminate air, surface water, soil and ground water through evaporation, dust formation, leaching or chemical reactions with surrounding environment. Due to the toxic nature of the substances present in E-waste, it can render the air, soil, and water as hazardous environment in the vicinity as well as can spread out to distant region and deposit toxic contents potentially risking human and animal health within a larger area. The sulphur and phosphor compounds can contribute to acid rain which may affects a larger area and threaten biodiversity by causing death or retarded growth of microorganisms, plants, animals as well as erosion of soil quality. The toxic substances present in E-waste are often environmentally persisting and eventually reach food chain causing adverse effects on animal and human health. Therefore, E-waste management has become a priority issue today to provide a quality life to present and future generations of humankind without compromising on health and environment.

Management of E-Waste

The hazardous nature of E-waste has led Group of Countries, individual Governments, social watch groups, NGOs and private companies (manufacturers to waste management units) to frame various acts and policies so as to contain the menace of E-waste. In India, Ministry of Environment and Forest (MoEF), Central and State Pollution Control Boards (CPCB, SPCB) are anchor institutions to monitor the E-waste generation, categorization, recycling, processing, disposal and impact assessment. In India, the Central Pollution Control Board (CPCB), under the legislative act known as 'the Environment Protection Act, 1986', was conferred the task to implement rules on hazardous wastes, bio-medical wastes, municipal solid wastes and plastic wastes. The Division of Hazardous Waste Management, under the purview of CPCB, was entrusted to oversee the management of e-waste. Further, under the auspices of Ministry of Environment and Forest, by the power conferred upon the Central Government under sections 6, 8 and 25 of the Environment (Protection) Act, 1986, vide S.O. 1125(E) has enacted a legislation known as E-Waste (Management and Handling) Rules, 2011 (effective from May 1, 2012) and reads that the manufacturers (producers) are mandated to ensure collection, transport to specific collection, dismantling and processing units, and safely dispose E-waste under the principles of Extended Producer Responsibility (EPR) failure to which or contravention would incur conviction and penalties (2,3,4).

Presently, the E-waste management includes collection, sorting, recycling, dismantling, physical and chemical processing, biological processing and disposal. The treatment of E-waste has been done traditionally through either of the or a combination of the four ways viz. a) disposal or dumping of E-waste in landfills, b) incineration or burning of E-waste, c) Reuse (as second hand item with slight modifications, or working parts), and d) Recycling (of basic components/substances). However, all the above methods of E-waste treatment have disadvantages. For example, landfills require large surface area for storing of wastes; and they can directly contaminate soil, air and water through toxic leachate and dust, release toxic gases and foul odor to surrounding area. It was reported that about 70% of heavy metals found in landfills had come from E-waste and since then the US and European Union has banned dumping of E-waste in landfills. However, in India, awareness about the hazards of E-waste to common public is very limited and therefore a significant quantity of the E-waste is still observed to be present in Municipal Solid Waste. Incineration of solid waste can also release smoke in the air along with heavy metals such as lead, mercury and cadmium and toxic substances such as dioxins. Reuse of electrical or electronic components or parts of devices can be thought of as an environmental process, however, it has been observed that due to reduced or limited lifespan of such components, the appliances eventually end up as E-waste sooner than the newly manufactured appliances. The recycling have been traditionally considered as 'safe' practice of E-waste treatment, though it involves sorting, dismantling, scrapping, burning, etc. the practices which in itself are considered as health hazard to workers. However, the recycling process can recover several of the precious, semi-precious metals and rare elements which can be used in de-novo manufacturing leading to overall reduction in carbon footprint as well as reducing the volume of waste disposal. The recycling can also limit the amount of toxic substances released to the environment if processed in a proper way. The valuable materials that can be recovered from E-waste are gold, silver, platinum, copper, cadmium, palladium, aluminium, tin, zinc, cobalt, vanadium, etc. It was estimated that complete recycling of 1Ton of PC E-waste generates about Rs 58,535 (6). Due to this recycling has become a major business in several of developing or underdeveloped countries due to availability of cheap labor and poor governance regarding E-waste import/export and processing. *Toxic Links* reports suggested that India generated $ 1.5 million worth of E-waste annually in 2005 (7,8,9). It was estimated that at a projected growth rate of 8.8 per cent annually, the E-waste business would cross $17 billion by 2014/15 (10). Another estimate reports that the revenue generated from the e-waste management market would grow from $9.15 billion in 2011 to $20.25 billion in 2016. Presently, the authorized E-waste processing industry in India can capture about 3-5% of E-waste generated today and the rest is processed by informal recycling units (11, 12).

Conclusion:

E-Waste, particularly in India and globally in general, is now recognized as a major concern of the human civilization today. The E-waste volume is rising at an unprecedented rate due to increased manufacturing and high obsolescence rate of

electrical and electronic appliances. The adverse effect on environment and human health is due to the presence of toxic components as constituents of the E-waste. By reduction, reuse and recycling, the huge burden on waste management services can be limited to an extent. The recycling can reduce the exploitation of natural resources and minimize pollution while generating some revenues for the country. However, recycling of E-waste has to be done in eco-friendly manner otherwise the procedures involved in recycling themselves pose serious threat to health of workers and to the environment. Globally, there are very few institutions that are claimed to follow hazardous waste recycling through environmentally safe procedures. India, at present, is right on track with regards to monitoring of generation, import/export and handling of E-waste through various policies and guidelines. However, there is urgent need to have more public and private partners in management of E-waste. On the positive note, with bright prospects of energy and revenue generation from E-waste processing, India is expected to witness steady growth of the formal and informal E-waste processing industry in future to contain the menace of electrical and electronic waste hazards.

References:

1. **Global E-Waste Management Market (2011 – 2016).** Report Code : SE 1588. A report by MarketsandMarkets, 2011.

2. E-waste in India. A Report by Research Unit (LARRDIS), RAJYA SABHA SECRETARIAT, New Delhi, June 2011.

3. Guidelines for environmentally sound management of E-waste : Ministry of Environment and Forests, Central Pollution Control Board, Delhi, March 2008.

4. E-waste assessment in India: Indo-European E-waste Initiative (IEeWASTE) report, 2007

5. **S. Ahmed, R.M. Panwarand A. Sharma.** Forecasting E-waste amounts in India. *International Journal of Engineering Research and General Sciences*, Vol.2 (6), 2014.

6. Garbage to Gold: E-waste processing in India, IndigoEdge Insight Report, 2013.

7. Beary: Bangalore faces E-waste hazards. 2005

8. Greenpeace report on Recycling of electronic waste in China and India, 2005.

9. Toxic Links Report: Mumbai: Choking on E-waste (A study on status of e-waste in Mumbai), 2007

10. International News on Electronic Recycling, IAER Newsletter, January 2009, No. 3, p.5-6.

11. **P.D. Badoni.** E-waste management in India, *Electronics for You,* 2009.

12. WHO Sponsored report on Inventorization of E-waste in two cities of Andhra Pradesh and Karnataka (Hyderabad and Bangalore), Environment Protection Training and Research Institute (EPTRI), Hyderabad, 2009.