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E-WASTE MANAGEMENT IN INDIA

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Abstract- This paper highlights the hazards of e-wastes, its effects on the environment and human health, the need for its appropriate management, options that can be implemented and its management in India. The current practices of e-waste management in India suffer from a number of drawbacks like the difficulty in investorisation, unhealthy condition of informal recycling, inadequate legislation, poor awareness and reluctance on part of the cooperate to address the critical issues. It is a popular, informal name for electronic products nearing the end of their "useful life". Some electronic products contain materials that are hazardous and these hazardous materials pose a threat to human health and environment. Many of these products can be reused, refurbished, or recycled so that they are less harmful to the environment. Discarded electrical or electronic devices if improperly disposed can leach lead and other substances into soil and groundwater.
Keywords- Electronics waste, Hazardous waste, Electronic equipment, E-waste management

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Introduction

The electronic is the world's largest and fastest growing manufacturing industry. This development has helped the human race; mismanagement has led to new problems of contamination and pollution. The technical prowess acquired during the last century has posed a new challenge in the management of wastes. The Environmental Protection Agency (EPA) refers to Electronic waste as "electronic products that are discarded by consumers". This term cover almost all type of electrical and electronics equipment (EEE) that has or could enter the waste stream. Improper disposal affects human and environmental health because many of these products contain toxic substances. The fraction including iron, aluminium, gold and other metals in e-waste is over 60%, while plastics account for about 30% and the hazardous pollutants compromise 2.70%. E-waste is growing exponentially simply because the markets in which these products are produced are also growing rapidly [1]. Electronic waste (e-waste) refers to all electronics devices, surplus, broken or obsolete, which have been discarded by their original owners. These days computer has become most common and widely used gadget in all kinds of activities ranging from schools, residences, offices to manufacturing industries. E-toxic components in computers could be summarized as circuit boards containing heavy metals like lead and cadmium; batteries containing cadmium; cathode ray tubes with lead oxides and barium; brominated flameretardants used on printed circuit boards, cables and plastic casing; poly vinyl chloride (PVC) coated copper cables and plastic computer casings that release highly toxic dioxins and furans when burnt to recover valuable metals; mercury switches; mercury in flat screens; poly chlorinated biphenyl's (PCB's) present in older capacitors; transformers; etc. Basel Action Network (BAN) estimates that the 500 million computers in the world contain 2.87 billion kgs of plastics, 716.7 million kgs of lead and 286,700 kgs of mercury. The average 14-inch monitor uses a tube that contains an estimated 2.5 to 4 kgs of lead [2].

Types of E-Waste

- -Mobiles Phones
- -TV
- -Scanners
- -Microwave
- -Mother Board
- -Security devices[3]
- -Computers
- -Calculators
- -Printers
- -Alarm
- -CD

Impact of E-Waste

Electronic waste can cause widespread environmental damage due to the use of toxic materials in the manufacture of electronic goods. Hazardous materials such as lead, mercury and hexavalent chromium in one form or the other are present in such wastes primarily consisting of Cathode Ray Tubes (CRTs), Batteries, Liquid Crystal Displays (LCDs). All electronics equipment contains printed circuit boards which are hazardous because of their content of lead, brominated flame retardants (5-10% by weight). Landfilling of e-waste can lead to the leaching of lead into the ground water. If the CRT is crushed and burned, it emits toxic fumes into the air. These products contain several rechargeable battery types, all of which contain toxic substances that can contaminate the environment when burned in incinerators or disposed of in landfills. The cadmium from one mobile phone battery is enough to pollute 600 m3 of water. The quantity of cadmium in landfill sites is significant, and considerable toxic contamination is caused by the inevitable medium and long-term effects of cadmium leaking into the surrounding soil. Because plastics are highly flammable, the printed wiring board and housings of electronic products contain brominated flame retardants, a number of which are clearly damaging to human health and the environment [4]. No sophisticated machinery or personal protective equipment is used for the extraction of different materials. All the work is done by the bare hands and only with the help of hammers and screwdrivers. Waste components which does not have any resale or reuse value are openly burnt or disposed off in open dumps. Pollution problems associated with such backyard smelting using crude processes are resulting in fugitive emissions and slag containing heavy metals of health concern [5]. Municipal waste is commonly known as trash or garbage. It is a waste type consisting of everyday items we consume and discard. It predominantly includes food wastes, yard wastes, containers and product packaging, and other miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources. On the other hand, e-waste contains many valuable and precious materials. In fact up to 60 elements from the periodic table can be found in complex electronics. Take a example of Personal Computer (PC), a normal Cathode Ray Tube (CRT) computer monitor contains many valuable but also many toxic substances. One of these toxic substances is cadmium (cd); which is used in rechargeable computer batteries and contacts and switches in older CRT monitors. Electrical goods contain a range of other toxic substances such as lead (Pb), beryllium (Be), brominated flame retardants. Because of this complex composition of valuable and hazardous substances, specialized, often "high-tech" methods are required to process e-waste in ways that maximize resource recovery and minimize potential harm to humans or the environment [6].

E-Waste in India

There is no separate collection of e-waste in India, there is no clear data on the quantity generated and disposed of each year and the resulting extent of environmental risk. The preferred practice to get rid of obsolete electronic items in India is to get them in exchange from retailers when purchasing a new item. The business sector is estimated to account for 78% of all installed computers in India. It is estimated that the total number of obsolete personal computers emanating each year from business and individual households in India will be around 1.38 million. According to a report of Confederation of Indian Industries, the total waste generated by obsolete or broken down electronic and electrical equipment in India has been estimated to be 1,46,000 tons per year [8]. With extensively using computers and electronic equipments and people dumping old electronics goods for new ones, the amount of e-waste generated has been steadily increasing.

Table 1- Effects of E-Waste Constituent on Human Health [7]

Source of e-wastes	Constituent	Health effects
Solder in printed circuit boards, glass panels and gaskets in computer monitors	Lead (PB)	Damage to central and peripheral nervous systems, blood systems and kidney damage. Affects brain development of children.
Chip resistors and semiconductors	Cadmium (CD)	Toxic irreversible effects on human health. Accumulates in kidney and liver. Causes neural damage. Teratogenic.
Relays and switches, printed circuit boards	Mercury (Hg)	Chronic damage to the brain. Respiratory and skin disorders due to bioaccumulation in fishes.
Corrosion protection of untreated and galvanized steel plates, decorator or hardner for steel housings	Hexavalent chromium (Cr) VI	Asthmatic bronchitis. DNA damage.
Cabling and computer housing	Plastics including PVC	Burning produces dioxin. It causes Reproductive and developmental problems; Immune system damage; Interfere with regulatory hormones
Plastic housing of electronic equipments and circuit boards.	Brominated flame retardants (BFR)	Disrupts endocrine system functions
Front panel of CRTs	Barium (Ba)	Short term exposure causes: Muscle weakness; Damage to heart, liver and spleen.
Motherboard	Beryllium (Be)	Carcinogenic (lung cancer) Inhalation of fumes and dust. Causes chronic beryllium disease or beryllicosis. Skin diseases such as warts.

At present Bangalore alone generates about 8000 tonnes of computer waste annually and in the absence of proper disposal, they find their way to scrap dealers. E-Parisaraa, an eco-friendly recycling unit on the outskirts of Bangalore which is located in Dobaspet industrial area, about 45 km north of Bangalore, makes full use of e-waste. The plant which is India's first scientific e-waste recycling unit will reduce pollution, landfill waste and recover valuable metals, plastics and glass from waste in an eco-friendly manner. India as a developing country needs simpler, low cost technology keeping in view of maximum resource recovery in environmental friendly methodologies. It is imperative that developing countries and India in particular wake up to the monopoly of the developed countries and set up appropriate management measures to prevent the hazards and mishaps due to mismanagement of e-wastes [9].

Table 2- E-Waste Generated in Different Indian Cities [10]

Cities	Tonnes of e-waste per year
Mumbai	50000
Delhi	35000
Bangalore	30000
Chennai	25000
Kolkata	19000
Ahmedabad	14000
Hyderabad	13000
Pune	10000
Indore	8000

E-Waste Management

It is estimated that 75% of electronic items are stored due to uncertainty of how to manage it. These electronic junks lie unattended in houses, offices, warehouses etc. and normally mixed with household wastes, which are finally disposed off at landfills. This necessitates implementable management measures. In industries management of e-waste should begin at the point of generation. This can be done by waste minimization techniques and by sustainable product design [11]. The major components of management are:

- E-waste collection, sorting and transportation.
- E-waste recycling; it involves dismantling, recovery of valuable resource, and sale of dismantled parts and export of processed waste for precious metal recovery [12].

The various strategies followed to manage e-waste are as under:

- Inventory management,
- Production –process modification,
- Volume reduction,
- Recovery and reuse [13].

Production-Process Modification

Waste reduction can be accomplished by the more efficient use of input materials in the production process. Potential waste minimization techniques can be broken down into three categories:
Improved operating and maintenance procedures:
This can be accomplished by reviewing current operational procedures and examination of production process for waste to improve efficiency. A strict maintenance program, which stresses corrective maintenance, can reduce waste generation caused by equipment failure.

Material change

Hazardous material used in production process may be replaced by less hazardous material. For example, a circuit board manufacturer can replace solvent based product with water based flux and simultaneously replace solventvapor degreaser with detergent part washer.

Process equipment modification

Modifying existing equipment to take advantage of better production techniques can significantly reduce waste generation. For example, in many electronic manufacturing operations, which involve porting a product, such as electroplating or painting, chemical are used to strip off coating from rejected products so that they can be recoated [14].

Volume Reduction

Volume reduction includes those techniques that remove the hazardous portion of a waste from a non-hazardous portion. These techniques are usually to reduce the volume, and thus the cost of disposing of a waste material. The techniques that can be used to reduce waste-stream volume can be divided into 2 general categories: source segregation and waste concentration. Segregation of waste is in many cases a simple and economical technique for waste reduction. Wastes containing different types of metals can be treated separately so that the metal value in the sludge can be recovered. Concentration of a waste stream may increase the likelihood that the material can be recycled or reused. Methods include gravity and filtration, ultra filtration, reverse osmosis, freeze vaporization etc.

Recovery And Reuse

The technique could eliminate waste disposal costs, reduce raw material costs and provide income from a salable waste. Waste can be recovered on-site, or at an off-site recovery facility, or through inter industry exchange. A number of physical and chemical techniques are available to reclaim a waste material such as reverse osmosis, electrolysis, condensation, electrolytic recovery, filtration, centrifugation etc. for example, a printed circuit board manufacturer can use electrolytic recovery to reclaim metals from copper and tin-lead plating bath [15].
The best option for dealing with E-Wastes is to reduce the volume. Designers should ensure that the product is built for reuse, repair and upgradeability. Stress should be laid on use of less toxic, easily recoverable and recyclable materials which can be taken back for refurbishment, remanufacturing, disassembly and reuse. Recycling and reuse of materials are the next level of potential options to reduce e-waste. Recovery of metals, plastic, glass and other materials reduces the magnitude of e-waste. These options have a potential to conserve the energy and keep the environment free of toxic material that would otherwise have been released [16]. Sustainability of e-waste management systems has to be ensured by improving the effectiveness of collection and recycling systems. The policy shall address all issues ranging from production and trade to final disposal, including technology transfers for the recycling of electronic wastes [17]. Extended Producer Responsibility (EPR) is an environmental policy approach in which a producer's responsibility for a product is extended to the post consumer stage of the product's life cycle, including its final disposal. The best option for e-waste management is reduced, reused and recycles.

Fig.1- E-Waste Management [18]

Status of E-Waste Management in India

Despite a wide range of environmental legislation in India there are no specific laws or guidelines for electronic waste. As per the Hazardous Waste Rules (1989), e-waste is not treated as hazardous unless proved to have higher concentration of certain substances. As the collection and re-cycling of electronic wastes is being done by the informal sector in the country at present, the government has taken the following action/steps to enhance awareness about environmentally sound management of electronic waste.

- Several Workshops on Electronic Waste Management was organized by the Central Pollution Control Board (CPCB) in collaboration with Toxics Link.
- Action has been initiated by CPCB for rapid assessment of the

E-Waste generated in major cities of the country.

- A National Working Group has been constituted for formulating a strategy for E-Waste management [19].

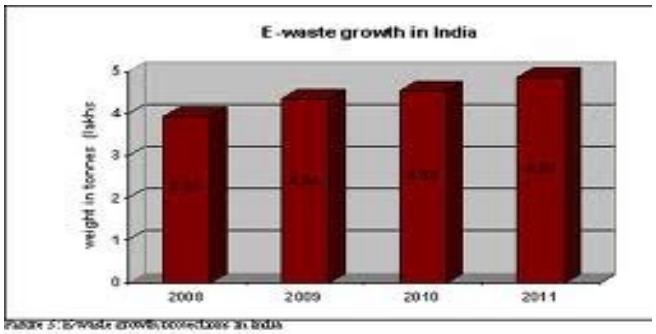

Fig. 2- E-Waste Growth in India [20]

The various agencies and non-governmental organization involved in the management of e-waste in India are [21]:

Knowledge bank for e-waste management in India [22]

The Asia Pro Ecoprogramme supported by the European Commission is dedicated to the environmental performance in Asian Economic sectors through the exchange of environmental policies, technologies and practices and to promote sustainable investment and trade between the European Member States and South Asia, South East Asia and China.

The E-waste Guide, India (www.ewaste.in)

An Initiative of the Indo-German –Swiss Partnership [Ministry of Environment and Forests, German Federal Ministry for Economic Cooperation and Development and Swiss statement Secretariat for Economic Affairs] It is designed to serve as an information resource on e-waste as well as a common collaborative work platform for stakeholders.

National Solid Waste Association of India (NSWAI) (www.nswai.com)

A leading professional non-profit organization in the field of solid-waste management. It include toxic and hazardous waste and biomedical waste in India. It was formed in 1996. Its objectives include development of solid waste as a profession, research and development, development of expertise, standards and goods practices with regards to solid-waste management.

Toxic Link (www.toxicslink.org)

A Delhi-based environment activist group with a mission of working for environmental justice and freedom for toxics. It is also actively involved in creating public awareness on environmental issues through publications, reports, articles and environment news bulletins besides organizing.

Conclusion

Solid waste management which is already a mammoth task in India is becoming more complicated by the invasion of e-waste, particularly computer waste. There exists an urgent need for a detailed assessment of the current and future scenario including quantification, characteristics, existing disposal practices, environmental impacts etc. Institutional infrastructures, including e-waste collection, transportation, treatment, storage, recovery and disposal, need to be established, at national and regional levels for the environmentally sound management of e-wastes. Establishment of e-waste collection, exchange and recycling enters should be encouraged in partnership with private entrepreneurs and manufacturers. Model facilities employing environmentally sound technologies and methods for recycling and recovery are to be established.

Criteria are to be developed for recovery and disposal of E-Wastes.

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