

ELECTRONIC WASTE MANAGEMENT-SPECIAL REFERENCE TO INDIA

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Abstract- The electronic industry is the fastest growing industry in the world. Inevitable consequences occur for rapid growth of any kind. Here the consequence of this enormous growth is electronic waste or e-waste. Improper disposal of e-waste results in the release of hazardous compounds like dioxins, furans, lead, mercury, poly brominated flame retardants etc into the atmosphere. Advancement in the production of electronic devices results in ever more generation of e-waste. Illegal recycling of e-waste is done to extract precious elements like gold, silver and platinum. This process exposes the workers in the recycling units to hazardous compounds besides polluting soil, air and water. In this paper the hazardous problems associated with the disposal and management of e-waste are reviewed. The impact of this electronic waste on the workers working at the recycling units are also discussed.

Keywords – e-waste, hazardous compounds, recycling, e-waste disposal, hazardous problems

I. INTRODUCTION

Desktop computers, mobiles, laptops, communication devices, television and household devices has become an essential part of all aspects of human life at private and public area. The electronic devices are almost used in education, industry, healthcare, security, defence, communication, entertainment, trading, military and information system. Billions of electronic devices are yearly consumed and millions of electronic devices are yearly discarded. This paves way to the biggest environmental problem called E-Waste. The Electronic TakeBack Coalition in 2012 stated that the global sales for PC and laptop were 350 million in 2010 and in 2011 the sales was 353 million. Televisions were 247 million and 248 million in 2010 and 2011 respectively. Smartphones were 304 million in 2010 and 491 million in 2011. iPhone were 47 million in 2010 and 93 million in 2011 [17]. In the recent years, the discarded electronic devices are becoming one of the major waste streams in terms of toxicity and quantity. In India the import of electronic waste is banned by the central government. But, many illegal electronic traders import e-waste in the name of refurbishment. The workers working at the dismantling units are poor and uneducated. They doesn't seem to understand the health problems that the dismantling of electronic devices cause under unsupervised conditions. There is not any proper recycling method followed in India. Toxic dust found on the computer monitors have chemicals that affect the reproductive system and may also cause neurological disorders.

II. CHARACTERISATION OF ELECTRONIC COMPONENTS

A single electronic device has many electronic components. The electronic components can be classified into Passive components and Active components.

A. Passive Components

These components are used to control the flow of current and to divide the voltage. The components include Resistors, Rheostate, Thermistors, Varistors, Capacitors, Varactors, Transformers and Inductors.

B. Active Components

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These components are used to control frequency ranges and to manage the electrical conductivity. The components include Semiconductor diodes, Zener diode, Bipolar junction transistor, triode, Vacuum tube devices and photo sensitivity devices.

The segregation of e-waste are important because while recycling all the components has to be separated. The most commonly used illegal method to separate the precious metals from e-waste is open burning. A single motherboard will have many components burning these components will release toxic gases into the atmosphere.

III. LIFECYCLE OF ELECTRONIC WASTE

Lifecycle of e-waste comprises of five stages namely Collection, Pre-treatment, Treatment, Disposal.

A. Collection

The first step is the collection of the discarded electronic devices. These discarded products will be picked up from retailer, public drop-off and third part service station. Many NGO's actively participate in the collection of discarded electronic devices.

B. Pre-treatment

The recyclers will pick up the discarded electronic devices from the collection centres. This e-waste will be subjected to dismantling where the segregation takes place. Components will be speared and grouped based on their composition.

C. Treatment

Once the components are grouped and sorted, treatment takes place. This treatment includes four process namely:

- Reuse
- Repair
- Remanufacture
- Recycling

Reuse and repair are not practiced widely because of the less demand for refurbished products. Remanufacturing increases the production cost. The sales forecast will be less, hence this treatment is also not used widely. The last option is recycling. But in India these is not any strict law for recycling. The recyclers import the e-waste from developed countries in the name of recycling to extract the precious metals and other compounds.

D. Disposal

Once electronic devices are discarded they become electronic waste. Illegal methods of disposal endangers the environment as well as the people working at the disposal sites. The recycling process done by the unorganised sector in a hazardous manner results in various health problems for all the people working in those sites. The two unconventional methods of disposing electronic wastes are

- UncontrolledLandfill (Dumping).
- Incineration.
- Acid bath

Landfills are the most preferred disposal of solid waste including electronic waste. Historically, landfills have been the most common methods of waste disposal and remain so in many places around the world. Landfill are commonly known as time bomb. Lead, arsenic, selenium , beryllium, copper, zinc, antimony trioxide, cadmium, polybrominated flame retardants and mercury are some of the more toxic materials that can leach into the soil from dumped e-waste. However, due to the problems associated with health due the toxic nature of e-waste chemicals, landfill is banned by US and UK governments. Incineration is a waste treatment technology that involves the combustion of organic materials. Incinerator plants are the source of series toxic pollutants. The emissions from the incinerator are extremely toxic which contain carcinogens and neurotoxins. These noxious fumes include dioxins and furans. Acid bath is used to extract copper by placing the circuit board in sulphuric acid for about 14 hours. The precipitated copper sulphate is taken and processed.

IV. MATERIAL RESOURCES - ELECTRONIC DEVICE

The demand for metals increases as the demand for electronic devices increases. Electronic devices demand about 80% of world's indium. Indium are used in LCD glass as transparent conductive layers. Manufacturing of hard disks require about 80% of world's ruthenium and 50% of flame retardants such as antimony[12]. Large amount of land are required for mining process. Mining is done to extract earth metals. Large amount of carbon is emitted during the manufacturing process. Production of 1 ton of gold results in the emission of 10,000 of carbon dioxide[9]. The hazardous compounds present in the electronic waste are as follows:

TABLE 1: HAZARDOUS COMPOUNDS

No	SUBSTANCE	OCCURANCE
1	Selenium	Circuit boards as power supply rectifier
2	Lead	Cathode ray tube
3	Arsenic	Older cathode ray tube and solder
4	Antimony trioxide	Flame retardants
5	Chromium	Steel for corrosion protection
6	Cobalt	Steel for structure and magnetism
7	Cadium	Circuit boards and semiconductors
8	Polychlorinated biphenyl (PCB)	Condensers, Transformers
9	Chlorofluocarbon	Cooling unit, Insulation foam
10	Arsenic	Light emitting diodes
11	Lithium	Li-batteries
12	Mercury	Backlighting in LCD
13	Toner dust	Laser printers
14	Americium	Medical equipment, fire detectors
15	Nickel	Rechargeable NiCd batteries
16	Barium	Spark plugs, fluorescent lamps

These compound when subjected to open burning or incineration causes various damages to the health and environment.

V. IMPACTS OF ELECTRONIC WASTE

An Assocham-cKinetics study pointed out that the volume of e-waste globally generated is expected to reach from 93.5 MT in 2016 to 130 MT in 2018. Now, India is emerging as one of the world's major e-waste generators, causing serious damage to the environment and to the health of the human beings. Indians are becoming wealthier and are able to send a lot on electronic devices and various other appliances. This indirectly means more generation of e-waste. Over 95% of this is managed by the unorganised sector mostly scrap dealers. Here in India children in the age group of 10-15 years are engaged in these activities. There is no adequate protection or safety norms followed. Inadequate legislation and the loop holes in them makes it difficult to control these happenings. E-Waste workers in India are ignorant on its hazardous effects. Most of the workers suffer from respiratory problems. As for the child labour, by the time they reach the age of 40-45 they are absolutely incapable of working itself, says a study [5]. One major things which attracts these workers is the recovery of precious metals like gold, platinum etc. To dismantle this concentrated acids are used. Mobile phones, televisions and computers are the most dangerous because they contain high levels of lead, mercury and cadmium. These are discarded more because of their short life span. 75% of the total waste generation in India comes from the government, public and private sector. 70% of heavy metals and 40% of the lead found in landfills is generated from such e-waste. This contaminates the ground water, pollutes the atmosphere and also leads to soil acidification. India is the second largest mobile market and is

also the fifth largest producer of e-waste [7]. Hence unsafe methods of recycling e-waste leads to damage of nervous system, kidney and brain development, skin disorders, lung cancer etc. In short it leads to the damage of all vital organs in the human body.

TABLE 2 : E-WASTE GENERATION - TOP CITIES.

No	City	E-Waste generated (tonnes)
1	Mumbai	1,20,000
2	Delhi	98,000
3	Bengaluru	92,000
4	Chennai	67,000
5	Kolkata	55,000
6	Ahemhabad	36,000
7	Hyderabad	32,000
8	Pune	26,000

(Source: EWM Ministry of Environment, India, 2016)

India totally generates approximately 18.5 million MT of e-waste every year. Only 2.5% of India's total e-waste gets recycled. More than 95% of the e-waste are managed by the unorganised sector and scrap dealers in the market. Poor infrastructure and inadequate legislations lead to harmful effects on man and environment during the process of recycling of e-waste [8]. A very alarming fact is that in India about the age group of 10-14 are engaged in various e-waste activities, without proper protection [9]. Proper recycling of electronic devices are needed as they contain toxic materials like zinc, lead, nickel, barium and chromium. These metal occur in high concentrations than the regulated levels. Proper recycling is also needed for data security. E-Waste when disposed without any proper data destruction results in data breaches and identity theft. E-waste is not going anytime soon, it's only going to get worse. By 2017, the volume of e-waste throughout the world is expected to rise by 35% from 2012 and the weight of this garbage will be equal to eight of the Great Pyramids of Egypt [4].

VI. MANAGEMENT OF ELECTRONIC WASTE

The most safe method is incorporating a industry wide system for the collection of electronic waste. Wearing gloves, masks and using safety glass for dismantling e-waste has to be made compulsory. Government has to take steps to avoid landfill as the toxic chemicals could leach and affect the ground water. The government must monitor the collection centres for proper storage system. Action has to be taken against unapproved recycles and collectors. Encourage scientists to determine alternate safe raw materials that can be disposed in an eco friendly way. Environmental groups such as Basel Action Network (BAN), NRDC have created a certification system. This certification system are for recognising recyclers and refurbishment companies. They are known as e-stewards. This certification system ensures that the recycling units has all the facilities for an environmental safe recycling process. United States of America has passed a law stating that the manufactures have to take responsibility of recycling e-waste. Likewise, the Indian Government has to take necessary steps to make the manufactures recycle their own products. Finally, the most important step is to educate the public on the harm that the e-waste can cause.

VII. CONCLUSION

The results obtained from the study sheds light on the problems caused by electronic waste on our health and the environment. The workers working at the dismantling sites needs to be properly educated on the harm that can be caused by e-waste. They have to be provided with proper masks, gloves and other dismantling equipments for proper recycling. The law has to made more strict in order to curb the import of e-waste. E-Waste recycling for the recovery of raw materials is essential. The management has to be done in such a way that the environment benefits from the recycling of e-waste. It is confirmed that the cooperation between the public and the manufactures are needed. Protecting the internationally agreed environmental legislations is the main responsibility of the Government.

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