e-Waste: Impact and treatment issues

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***Abstract* - In the recent years, there has been growing concerns about negative impacts that IT industry or its products are having on both society and environment. With the rapid growth of IT industry, the consumption of materials, energy and other resources has been accelerating in a way that can not be sustained. One such major issue that is becoming talk of every mouth these days is renownedly known as Electronic-Waste(E-Waste). Like hazardous waste, the problem of e-waste has become an immediate and long term concern as its unregulated accumulation and recycling can lead to major environmental problems endangering human health. The information technology has evolutionized the way we live, work and communicate bringing countless benefits and wealth to all its users. The creation of innovative and new technologies and the globalization of the economy have made a whole range of roducts available and affordable to the people changing their lifestyles significantly. But on the other hand, it has also led to unrestrained resource consumption and an alarming waste generation. The rapid growth of technology, upgradation of technical innovations and a high rate of obsolescence in the electronics industry have led to one of the fastest growing waste streams in the world which consist of end of life of electrical and electronic equipment products. This papers highlights all the major concerning issues regarding the hazardous e-waste problem and its effect on society and health, discussing all the recycling techniques to get rid of the hazardous problem.**

I. INTRODUCTION

E-waste or electronic-waste, broadly, describes loosely discarded, surplus, obsolete and broken electrical or electronic devices. E-waste consists of all waste from electronic and electrical appliances which have reached their end- of- life period or are no longer fit for their original intended use and are destined for recovery, recycling or disposal. It includes computer and its accessories- monitors, printers, keyboards, central processing units; typewriters, mobile phones and chargers, remotes, compact discs, headphones, batteries, LCD/Plasma TVs, Air Conditioners, Refrigerators and other household appliances.

A. Composition of E-waste

The composition of E-waste is diverse and falls under 'hazardous' and 'non-hazardous' categories. Broadly, it consists of plastics, glass, wood and plywood, printed circuit boards, concrete, ceramics, rubber and other items. Obsolete computers pose the most significant environmental and health hazard among the e-wastes.

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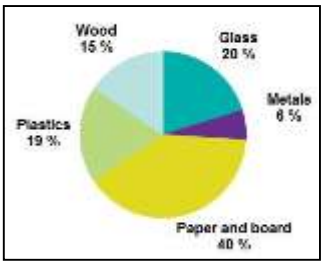

Figure-1

B. Source of E-waste

The main sources of electronic waste in India are the government, public and private (industrial) sectors, which account for almost 70 per cent of total waste generation. The contribution of individual households is relatively small at about 15 per cent; the rest being contributed by manufacturers. Though individual households are not large contributors to waste generated by computers, they consume large quantities of consumer durables and are, therefore, potential creators of waste.

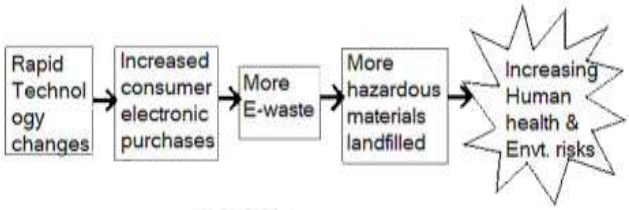

Figure-2

II. IMPACTS OF ELECTRONIC WASTE

E-Waste is a fast emerging threat to the environment and human health. The rapid growth of e-waste and the effectiveness of its management will have profound impacts on the environment and human health. Due to complexity of e-waste composition and abundance of toxic materials released, the health hazards and other associated symptoms are varying in nature. Generally, the toxic substances may affect multiple vital organs in the body. Broadly, adverse health outcomes due to e-wastes may be triggered by either heavy metals or complex organic compounds. **Heavy metals and other metals** includes : **Lead** – Lead damages the central and peripheral nervous system affecting brain development and intelligence in children. It damages the kidney and endocrine system.

Common symptoms of lead toxicity are appetite loss, abdominal pain, constipation, fatigue, sleeplessness, irritability and headache. However, even low levels of lead may impair intellectual development, behavior and hearing in case of infants and young children.

Mercury – Mercury is toxic for lungs, kidney and nervous system. Low exposure causes headache, fatigue and weakness. Neurological manifestations include numbness, depression, emotional instability, memory impairment, irritability, defects in hearing, vision and speech, difficulty in writing and tremors.

Cadmium – Cadmium affects the kidneys, cardiovascular system, bones and testicular function. Cadmium accumulates in amounts that cause symptoms of poisoning. Acute exposure to cadmium fumes causes flu-like symptoms of weakness , fever, headache, chills, sweating and muscular pains.

Beryllium – Beryllium has been classified as a human carcinogen because its exposure leads to lung cancer. The common form of beryllium exposure is inhalation of dust, fume or mist. Exposure to beryllium also causes a form of skin disease, characterized by poor wound healing and wart-like swelling.

Chromium – Most chromium compounds are irritating to eyes and skin. Chronic exposure to chromium compounds can cause permanent eye injury, unless properly treated.

Chemical	Uses	Health Effects (HE) / Environmental Effects (EE)
Mercury	Flat screen monitors , Fluorescent tubes	**HE :** Highly Toxic, Memory Loss, Muscle weakness, damage to central nervous system and kidneys. **EE :** Reduced fertility, Slower growth and development in animals.
Lead	CRT Monitor Glass	**HE :** Highly Toxic, damage to blood system, kidneys, reductive organs. **EE :** Highly toxic effects for animals and aquatic life.
Cadmium	Nickel-cadmium batteries , light sensitive resistors	**HE :** Severe lung damage, kidney damage, bone toxicity. **EE :** Harmful to microorganisms and to ecosystem.
Beryllium	Heat insulation for CPUs and power transistors	**HE :** Chronic Beryllium disease, Beryllium related allergies and sensitivity.

Table-1

E-waste typically contains complex combinations of materials and components down to microscopic levels. The wastes are broken down in not just for recycling but for the recoverable materials such as plastic, iron, aluminium, copper and gold. However, since e-waste also contains significant concentration of substances that are hazardous to human health and the environment, even a small amount of e-waste entering the residual waste will introduce relatively high amount of heavy metals and halogenated substances.

Unless suitable safety measures are taken, these toxic substances can critically affect the human health – who manually sort and treat the waste- by entering their waste :

1. through respiratory tracts.
2. through the skin.
3. through the mucous membrane of the mouth and the digestive tract.

Thus the health impact of e-waste is evident which has been linked to growing incidence of several health conditions including cancer, neurological, and respiratory disorders.

III. METHODS OF ELECTRONIC WASTE TREATMENT AND DISPOSAL

In order to deal with the situation of e-waste, certain e-waste disposal methods have been adapted as :

A. Landfilling

It is one of the most widely used methods for disposal of e-waste**.** In landfilling, trenches are made on the flat surfaces. Soil is excavated from the trenches and waste material is buried in it, which is covered by a thick layer of soil. At present it is not possible to quantify environmental impacts from E-waste in landfills for the following reasons:

- Landfills contain mixtures of various waste streams
- Emission of pollutants from landfills can be delayed for many years

The environmental risks from landfilling of e-waste cannot be neglected because the conditions in a landfill site are different from a native soil.

B. Incineration

It is a controlled and complete combustion process, in which the waste material is burned in specially designed incinerators at a high temperature (900-1000^{o}C). Advantage of incineration of e-waste is the reduction of waste volume and the Utilization of the energy content of combustible materials. By incineration some environmentally hazardous organic substances are converted into less hazardous compounds. Disadvantage of incineration are the emission to air of substances escaping flue gas cleaning and the large amount of residues from gas cleaning and combustion. e-waste incineration plants contribute significantly to the annual emissions of cadmium and mercury.

C. Recycling of E-waste

The composition of e-waste consists of diverse items like ferrous and non ferrous metals, glass, plastic, electronic components and other items and it is also revealed that e-waste consists of hazardous elements. Therefore, the major approach

to treat e-waste is to reduce the concentration of these hazardous chemicals and elements through recycle and recovery. In the process of recycling or recovery, certain e-waste fractions act as secondary raw material for recovery of valuable items. The recycle and recovery includes the following unit operations.

- Dismantling

Removal of parts containing dangerous substances (CFCs, Hg switches, PCB); removal of easily accessible parts containing valuable substances (cable containing copper, steel, iron, precious metal containing parts)

- Segregation of ferrous metal, non-ferrous metal and plastic

This separation is normally done in a shredder process.

- Refurbishment and Reuse

Refurbishment and reuse of e-waste has potential for those used electrical and electronic equipments which can be easily refurbished to put to its original use.

- Recycling/Recovery of valuable materials

Ferrous metals in electrical are furnaces, non-ferrous metals in smelting plants, precious metals in separating works.

- Treatment/disposal of dangerous materials and waste

Shredder light fraction is disposed of in landfill sites or sometimes incinerated (expensive), CFCs are treated thermally, PCB is incinerated or disposed of in underground storages, Hg is often recycled or disposed of in underground landfill sites. The value of recovery from the elements would be much higher if appropriate technologies are used.

D. Reuse

It constitutes direct second hand use or use after slight modifications to the original functioning equipment. It is commonly used for electronic equipments like computers, cell phones etc. Inkjet cartridge is also used after refilling. This method also reduces the volume of e-waste generation.

Large companies should purchase the used equipments back from the customers and ensure proper treatment and disposal of e-waste by authorized processes. This can considerably reduce the volume of e- waste generation.

CONCLUSION

The future scenario has, indeed, presented both challenges and opportunities in terms of minimizing ants, managing e-waste as well as developing cleaner and more sustainable products. It is, therefore, important that viable solutions are found to address the problem of the e-waste involving skilled manpower from the informal sector of the economy and the use of appropriate technology. More importantly, the cardinal principles of accountability, transparency and sustainability need to be incorporated in any policy or regulation on e-waste to ensure its proper implementation.

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