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ELECTRONIC WASTE EFFECTS ON HUMAN AND ENVIRONMENT

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Abstract: *Industrial revolution along with increasing population has led to great contribution in the field of technology. Now a days technology is becoming advance not only in the field of mechanical, architectural, civilian but also in the field of information technology. The changing life style of people is more surrounded with the use of sophisticated electronic equipment which not only reduces man power but also decreases time consumption. Along with associated benefits management of electronic equipment have led to much bigger problem with respect to contamination and pollution. And this happens in a way that once the appliance is been used and then discarded which contributes in the form of "e-waste" and if they are disposed improperly it will lead to release of different pollutants which are toxic in nature both associated with acute and chronic effects. This research paper deals with the types of e-waste, its potential sources and its effects on human and environment.*

Key Words: *Biodegradable, Non-biodegradable, Hazardous, Pollutants and Composition.*

1. INTRODUCTION:

In general scenario there is an increase in consumption of resources either being natural or artificial. For the sake of reduction in the extinction of natural resources, their alternative are searched and used ubiquitously. Though information technology has revolutionized the way we live, work and communicates with people bringing along countless wealth still with a positive side but it had a negative side too. Though new electronic products are more efficient, fast; provided with latest technology which have more sense of security, easy and faster acquisition of operation. But as the life of various products once used lasts it is dumped as trash. This may contribute in the form of a biodegradable or a non-biodegradable waste. But one with biodegradable nature can be cured and managed easily in comparison to that which is non-biodegradable in nature. This waste when dumped haphazardly lead to its ill effects on the environment which include animals, human beings, the associated micro life and even properties.

Life Cycle of Electronic Product

Life Cycle assessment is a method to assess the human health and environmental impact associated with all the stages of product's life starting from its production to distribution, use, repair and maintenance. E-waste is ubiquitous and popularly renowned not only among the concerned authorities but also among users. E-waste is been considered as dangerous as it contains hazardous constituents depending on its composition and density. In general e-waste is a term which covers all items of Electricity and Electronic Equipment also abbreviated as EEE or WEEE i.e. Waste Electrical and Electronic Equipment. This waste comprises of wide range of products starting from circuitry or electrical components, power or battery supply from any household or business item.

Once the E-waste is generated after using the electrical product managing this waste plays an important role during it's life cycle. So that managing e-waste it can be possible through 'reuse' further Reuse consists of major three steps (UNEP, 2007):

1. E waste Collection Sorting and Transportation: This system involves producer/ retailer municipal collection system, take back system and also addresses recycler's/dismantler's collection system. Since E-waste is hazardous in nature, it is collected, sorted, stored and transported under controlled conditions.

2. E-Waste Treatment System: E-waste treatment techniques are decontamination step where disassembly or repair followed by shredding of different fractions. Now, emitted E-waste fractions after shredding go for metal recovery.

3. E-Waste Disposal System: Just after metal recovery, the remaining E-waste fractions are disposed of either in landfills or directly incinerated.

Composition of E-Waste

E- waste have diverse composition been categorized as 'hazardous' and 'nonhazardous' and consists of ferrous, non-ferrous metals, plastics, glass, wood, plywood, ceramics and rubber components. Among entire waste load, iron and steel constitute about 50% of the waste, followed by plastics (21%), non-ferrous metals (13%) and rest represents other constituents. Non-ferrous metals comprises of metals like copper, aluminum and precious metals like silver, gold, platinum, palladium and so on. Hazardous nature of e-waste is tagged due to the presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium and also flame retardants beyond threshold quantities is the reason which makes e waste hazardous in nature.

2. SOURCES OF E-WASTE

In today's scenario there could be various sources of E waste, ranging from domestic appliances to IT and communication equipment used in offices; from personal product to industrial machinery.

Toxic substances such as lead oxide and cadmium releases from CRT (Cathode Ray Tubes) monitor; cadmium and releases from lead the computer batteries, circuit boards; mercury from switches and in flat screen monitors; cadmium in; polychlorinated biphenyls releases from older capacitors and transformers and brominated flame retardants on printed circuit boards. Plastic casings, cables and PVC cable insulation also releases highly toxic dioxins and furans when it burn to retrieve copper from the wires. The detailed source and associated pollutants have been listed in Table 1.1.

Table 1.1: Sources of e-waste

S. No.	**Source of e-waste**	**Pollutant**
1.	Fire retardant	Antimony
2.	Gallium arsenide used in LED, semiconductor, microwaves,solar cells	Arsenic (As)
3.	Front panel and getters in CRTs, electron tubes, plastic andrubber filters and lubricant additives	Barium(Ba)
4.	Power supply boxes (which contain silicon controlledrectifiers), X-ray lenses and in Motherboard	Beryillium(Be)
5.	Electronic equipment at housing, casing, circuit boards(plastic) and PVC cables	BFR
6.	Chip resistors, semiconductors, Rechargeable NiCd-batteries, fluorescent layer, Monitor CRT, printer inksand toners, photocopying-machines, pigments, solder and circuit boards,	Cadmium (Cd)
7.	Cooling unit and Insulation foam	CFC
8.	Dyes/pigments, switches or in solar panel	Chrome
9.	Insulators	Cobalt (Co)
10.	Conducted in cables, copper ribbons, coils, circuitry, pigments	Copper(Cu)
11.	To use for Corrosion protection of untreated and galvanized steel plates, also use in decorator or hardenerfor steel housings, Data tapes and in floppy-disks also.	Hexavalent Chromium(Cr) VI
12.	Used as Solder in printed circuit boards and in glass panels,gaskets in computer monitors or in CRT screens, Lead rechargeable batteries, transistors, lasers,	Lead (Pb)

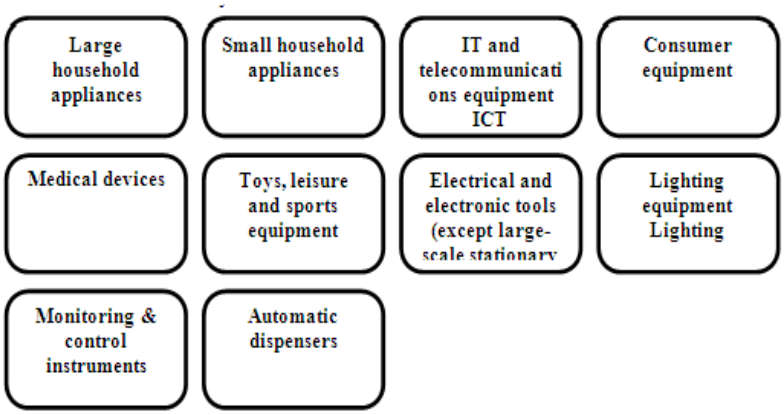
	printed wiring boards, circuit boards, or in lithium batteries and in PVC stabilizers	
13.	Displays	Liquidcrystal
14.	Li-batteries, mobile telephones, photographic equipmentand video equipment (batteries)	Lithium(Li)
15.	Relays, switches, printed circuit boards, Fluorescentlamps used as backlight in LCDs, alkaline batteries, copper machine components, steam irons, pocket calculators and mercury wetted switches	Mercury(Hg)
16.	Rechargeable Ni Cd batteries or Ni-MH batteries,electron gun used in CRT, alloys or in relays	Nickel (Ni)
17.	Use in condensers, capacitors, softening agents for paints,glue and Transformers	PCB
18.	Insulating cable and computer housing	Plastic including PVC
19.	Medical equipment, fire and in smoke detector	Radio-active substances
20.	Fluorescent layer (CRT-screen)	Rare Earthelements
21.	Photoelectric cells, Old photocopy machines (photo drums)and in fax machines	Selenium(Se)
22.	Capacitors, switches (contacts), batteries and in resistors	Silver (Ag)
23.	Plastic Fire retardants (thermoplastic components, cableinsulation)	TBBA, PBB, PBDE
24.	Solder metal glue or in LCD	Tin(Sn)
25.	Toner cartridges for laser printers / copiers	Toner Dust
26.	Steel, brass, alloys, luminous substances and Interiorof CRT screens	Zinc sulphide

(Source: Gaidajis* et al., 2010)

* Brominated Flame Retardants (BFR); Chlorofluorocarbon (CFC); Polychlorinated Biphenyl (PCB); Poly Vinyl Chloride (PVC); Tetrabromobisphenol A(TBBA); Polybrominated Biphenyls (PBB);Polybrominated Diphenyl Ethers (PBDE); Cathode Ray Tube(CRT), Light Emitting Diodes (LED) and Liquid Crystal Display (LCD)

3. TYPES OF E-WASTE

As per a report by United Nations University (UNU), 2014 named the Global E waste monitor, various categories had been classified in the domain of EEE namely:



The details of equipments in the above mention categories are explained below:

1. Temperature exchange equipment: Commonly referred as, cooling/freezing equipment. For example: refrigerators, freezers and air conditioners.

2. Screens and Monitors: Categorically comprise stele visions, computer monitor, laptops, notebooks and tablets.

3. Lamps: Comprises fluorescent lamps (straight and compact fluorescent lamps), high intensity discharge lamps and LED lamps.

4. Large equipment: Constitution of washing machines, dryers (clothes), dish washing machines, electric stoves, large printing and copying equipment and solar photovoltaic panels.

5. Small equipment: Small equipment comprises vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, calculators, radio sets, video cameras, electronic toys, and tools, small medical devices, small monitoring and control instrument.

6. Small IT and telecommunication equipment: Under this category equipment comprises of mobile phones, Global Positioning System (GPS), pocket calculators, routers, personal computers, printers and telephones.

And in a general scenario e-waste has been divided into two major categories:

IT and telecommunication equipment: Centralized data processing unitsλ (Central processing unit with input and output devices); Minicomputers; Personal computers, Laptop computers, Notebook computers, Notepad computers, Printers and Copying equipment including cartridges, Electrical and electronic typewriters, User terminals and systems, Facsimile, Telex, Telephones (Pay telephones, Cordless telephones, Cellular telephones and Answering systems)

Consumer electronics: Television sets (based on Liquid Crystal Display and Light Emitting Diode technology), Refrigerator, Washing Machine, Air Conditioners excluding centralized air conditioning plants.

The fact lies that for each e-waste category, function, weight, size, material and composition differs. Also the economic values, recycling ability and generated waste quantities varies from equipment to equipment. Along with this the potential environmental and health effect of each e-waste category differs. The environmental issues associated with e-waste arise due to major three reasons low collection rates, low or no segregation and improper disposal. The waste ultimately ends up in to the undesirable channels and destinations.

4. EFFECTS OFE-WASTE

The illegal dumping of e-waste is a major problem faced in various regions across the globe. Uncontrolled fires may arise in improperly monitored landfill and along with this landfill produces contamination through leachate which, at last ends up into ground water pollution. The toxicants from wastes such as acids, sludge can further enter into the freshwater bodies like rivers, ponds, lakes etc. Incinerations of such waste can reduce toxic fumes and gases which pollutes air. On the other side as e waste burns associated plastic also burns with waste and releases various carcinogenic pollutants like Polychlorinated dibenzodioxins (PCDDs), Polybrominated dibenzodioxins (PBDDs) and Polychlorinated dibenzo furans (PCDFs) etc. The toxic fall outs from burning and open dumping of e-waste not only cause respiratory dysfunctions for human beings but also for the animals and birds. Hereby, Table 1.2 summarizes the health effects of various e-waste constituents, how they contribute as pollutant in environment and possess danger to life of human beings.

Table 1.2: Health effects of various e-waste released pollutants

S. No.	Constituent	Health effects
1	Lead (Pb)	Damage to central and peripheral nervous systems, affects reproductive system, neurotoxinalso affects blood systems, kidney damage andbeside this brain development of children. Mechanical breaking of CRTs and removingsolder from microchips release lead as powderand fumes.
2	Cadmium (Cd)	Carcinogenic and teratogenic in nature, long termexposure causes **Itai-Itai disease.** Toxic irreversible effects on human health(accumulatesin kidney and liver, cases neural damage)
3	Mercury(Hg)	Readily bioavailable to fishes: Reason for Chronicdamage to brain and respiratory system and also causes skin disorders. Affects central nervous system, kidney and immune system, impair fetus growth and harms infants through mother's milk, when enters in water bodies changes into organic formi.e. methyl mercury through microbial activity and gets biomagnified, finally enters into humanchain.
4	Hexavalent Chromium (Cr) VI	Liver and kidney damage, also causing Asthmatic bronchitis, lung cancer and DNA damage.

5	Plastic including PVC	Carcinogenic in nature, Burning of the productsproduces dioxin. It is immune toxicant and causesreproductive and developmental problems, damage immune system, interfere with regulatoryhormones and hormonal disorder.
6	Brominated Flame Retardant (BFR)	It Harms reproductive and immune system by causing hormonal disorder, Disrupts endocrinesystem functions
7	Barium(Ba)	Reason for damage to heart muscles: Short term exposure causes muscle weakness, and damageto heart muscles, liver and spleen disorder.
8	Beryllium(Be)	Carcinogenic nature causes lung cancer, Inhalation of fumes and dust, causes chronic berylliumdisease or **beryllicosis**, and also skin diseasessuch as warts formation.
10	Acid	Suphuric and hydrochloric acid are used o separate metals from circuit boards its fumescontain chlorine and sulphur dioxide which causes respiratory problems and also corrosive to eyesand skin.
11	Arsenic	Affect skin and decreases nerve conduction velocity, and also chronic exposure may causelung cancer and can be fatal in nature.
12	Chlorofluorocarbon (CFC)	Affects ozone layer and causes skin cancer and responsible for genetic damages.
13	Polychlord Biphenyl (PCB)	May cause cancer in animals and affects immune, reproductive, nervous and endocrine system.Persistently contaminate on environment.
14	Polyvinyl Chloride (PVC)	When burnt produces Hydrogen Chloride gas which in turn produces hydrochloric acid andcauses respiratory dangers.
15	Dioxin	Leads to fetus malfunctioning, decreases reproduction and growth rates and affect immune system.

(Source: Krishna et al., 2011)

5. CONCLUSION

Although E-waste reduces man power and makes our task easier and quicker but it is considered as a dangerous and ubiquitously found pollutants with both carcinogenic and teratogenic in nature. Different composition of e-waste has been already reported which directly contributes to its toxic nature. E-waste enters into the environment (hydrosphere, atmosphere or lithosphere) through a complex pathway and is the reason for various consequences. Based on their sources, e-waste has been broadly categorized into two groups originated either from large or small scale appliances. Already discussed above, various laws have been enacted globally and so nationally but still there is a dire need to stringent those laws as per the provided guidelines. Last but not the least e-waste has hazardous effects on environment and its biota.

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