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Socio-economic and environmental impact of electronic waste

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ABSTRACT

In today's world, most of us have the luxury of not having to face the daily realities of all the damage humans do to the planet. It is difficult to understand the devastation created by human beings unless you travel to a developing nation or actively try to find it in our own country -- pictures or words will never do it justice. E-Waste (Electronic Waste) is the rapidly growing stream of waste from discarded electronics and appliances. These items include anything from computers, TVs and phones to washing machines and refrigerators to everything else in between. Most of these electronics appliances are often not trash, but simply outdated and traded up for the latest version on the market. To manufacture one computer and its monitor it takes 530lbs of fossil fuels, 48 pounds of chemicals, and 1.5 tons of water. Toxic substances when burnt at low temperature create additional toxins such as halogenated dioxins and furans- harmful to mankind. According to the most recent report released by the United Nations University (UNU) on the matter, findings show that globally we produced 41.8 million tons of e-waste in 2014. Even more startling -- it is believed that less than one-sixth is properly recycled or reused. While the negative impact of e-waste is vast and growing, most people are probably unaware of its reach. The lack of proper recycling leads to harmful toxins like lead and mercury leaching into the environment. Harmful materials like these and many others found in e-waste, cause all sorts of health issues like neurological damage, kidney damage and some cancers, to name a few. And let's not forget about the ozone-depleting chlorofluorocarbons left behind. Maybe the worst part of this issue is that most e-waste from developed countries is exported to developing countries like India, Africa and China. Often the pits of discarded computers and other electronics are picked over by locals who attempt to mine profitable materials like copper and gold from them. The improperly performed recovery methods like acid baths and burning of electronics are extremely harmful and are often performed by local women and children. These issues are environmental as well as social and related to mankind. So, it is for us to choose, whether we want to choose life of doomsday by the invasion of machines and radiations over us completely so as we lose humanity and mankind from this planet completely and forever.

Keywords: E-Waste, Degradation, Disposal issue

INTRODUCTION

Electronic waste, e-waste, e-scrap, or Electronic-disposal, waste electrical and electronic equipment (WEEE) describes discarded electrical or electronic devices.

"Electronic waste" may be defined as discarded computers, office electronic equipment, entertainment device electronics, mobile phones, television sets and refrigerators. This definition includes used electronics which are destined for reuse and repair electronics. In fact, whole categories of old electronic items contribute to e-waste such as VCRs being replaced by DVD players, and DVD players are replaced by Blu-ray players. E-waste is created from anything electronic: computers, TVs, monitors, cell phones, PDAs, VCRs, CD players, fax machines, printers, etc.[1]

Display units (CRT, LCD, LED monitors), Processors (CPU, GPU, or APU chips), memory (DRAM or SRAM), and audio components have different useful lives. Processors are most frequently outdated and are more likely to become "e-waste", while display units are most often replaced while working without repair attempts, due to changes in wealthy nation appetites for new display technology.[2]

•An estimated 50 million tons of E-waste are produced each year. USA discards 30 million computers each year and 100 million phones are disposed of in Europe each year.

•The Environmental Protection Agency estimates that only 15-20% of e-waste is recycled, the rest of these electronics go directly into landfills and incinerators.

•United States is the world leading producer of electronic waste, tossing away about 3 million tons each year.

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•China already produces about 2.3 million tons (2010 estimate) domestically, second only to United States. And, despite having banned e-waste imports, China remains a major e-waste dumping ground for developed countries.

•According to a report by United Nation Environment Programme(UNEP) titled, "Recycling - from E-Waste to Resources," the amount of e-waste being produced - including mobile phones and computers - could rise by as much as 500 percent over the next decade in some countries, such as India.[3]

ELECTRONIC WASTE SUBSTANCES

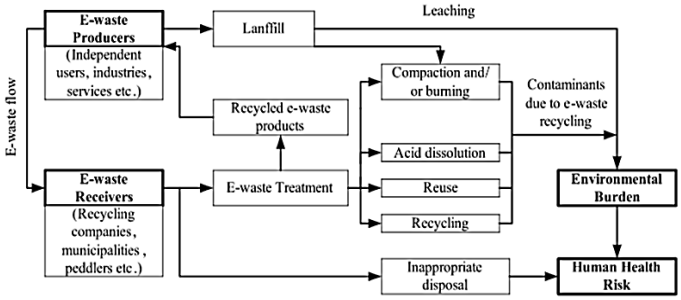

Figure 1. E waste routes

Some computer components can be reused in assembling new computer products, while others are reduced to metals that can be reused in applications as varied as construction, flatware, and jewelry. Substances found in large quantities include epoxy resins, fiberglass, PCBs, PVC (polyvinyl chlorides), thermosetting plastics, lead, tin, copper, silicon, beryllium, carbon, iron and aluminum. Elements found in small amounts include cadmium, mercury, and thallium. Elements found in trace amounts include americium, antimony, arsenic, barium, bismuth, boron, cobalt, europium, gallium, germanium, gold, indium, lithium, manganese, nickel, niobium, palladium, platinum, rhodium, ruthenium, selenium, silver, tantalum, terbium, thorium, titanium, vanadium. Almost all electronics contain lead and tin (as solder) and copper (as wire and printed circuit board tracks), though the use of lead-free solder is now spreading rapidly.[4,5]. E waste routes are shown in Figure 1.[6] and Potential environmental pollutants produced by E waste management procedures is shown in Table 1.[6] and electronic waste and procedures are shown in Table 2.

ENVIRONMENTAL IMPACTS OF ELECTRONIC WASTE

Reasons for growing electronic waste are Human Greed and materialization, unprecedented advancements in Technology, Improper handling of used E-products. The processes of dismantling and disposing of electronic waste in the third world lead to a number of environmental impacts as illustrated in the graphic. Liquid and atmospheric releases end up in bodies of water, groundwater, soil and air and therefore in land and sea animals – both domesticated and wild, in crops eaten by both animals and human, and in drinking water. Harmful effects are described below.[4,5]

•Airborne dioxins – one type found at 100 times levels previously measured

Table 1. Potential Environmental Pollutants produced from e-waste management procedures

Substance	Occurrence in e-waste	Typical concentration in e-waste (mg/kg)[a]	Global emissions (tons)[b]
Halogenated compounds:			
PCB	Condensers, Transformers	14	280
TBBA, PBB, PBDE	Fire retardants for plastics (thermoplastic components, cable insulation)		
CFC	Cooling unit, Insulation foam		
PVC	Cable insulation		
Heavy metals and other metals:			
Antimony	Fire retardant, plastics	1,700	34,000
Arsenic (As)	Small quantities in the form of gallium arsenide within light emitting diodes		
Barium (Ba)	Getters in CRT		
Beryllium (Be)	Power supply boxes which contain silicon controlled rectifiers and x-ray lenses		
Cadmium (Cd)	Rechargeable NiCd-batteries, fluorescent layer (CRT screens), printer inks and toners, photocopying-machines (printer drums)	180	3,600
Chromium (Cr)	Data tapes, floppy-disks	9,900	198,000
Copper (Cu)	Cabling	41,000	820,000
Lead (Pb)	CRT screens, batteries, printed wiring boards	2,900	58,000
Lithium (Li)	Li-batteries		
Mercury (Hg)	Fluorescent lamps that provide backlighting in LCDs, in some alkaline batteries and mercury wetted switches	0.68	13.6
Nickel (Ni)	Rechargeable NiCd-batteries or NiMH-batteries, electron gun in CRT	10,300	206,000
Rare Earth elements	Fluorescent layer (CRT-screen)		
Selenium (Se)	Older photocopying-machines (photo drums)		
Tin (Sn)	Solder metal glue, LCD	2,400	48,000
Zinc sulphide	Interior of CRT screens, mixed with rare earth metals	5,100	102,000
Others:			
Toner Dust	Toner cartridges for laser printers / copiers		
Radio-active substances	Medical equipment, fire detectors, active sensing element in smoke detectors		

Table 2. Electronic waste source and effects

E-Waste Component	Process Used	Potential Environmental Hazard
Cathode ray tubes (used in TVs, computer monitors, ATM, video cameras, and more)	Breaking and removal of yoke, then dumping	Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphor
Printed circuit board (image behind table - a thin plate on which chips and other electronic components are placed)	De-soldering and removal of computer chips; open burning and acid baths to remove final metals after chips are removed.	Air emissions as well as discharge into rivers of glass dust, tin, lead, brominated dioxin, beryllium cadmium, and mercury
Chips and other gold plated components	Chemical stripping using nitric and hydrochloric acid and burning of chips	Hydrocarbons, heavy metals, brominated substances discharged directly into rives acidifying fish and flora. Tin and lead contamination of surface and groundwater. Air emissions of brominated dioxins, heavy metals and hydrocarbons
	Shredding and low temp melting to be reused	Emissions of brominated dioxins, heavy metals and hydrocarbons
Computer wires	Open burning and stripping to remove copper	Hydrocarbon ashes released into air, water and soil.

•Levels of carcinogens in duck ponds and rice paddies exceeded international standards for agricultural areas and cadmium, copper, nickel, and lead levels in rice paddies were above international standards

•Heavy metals found in road dust – lead over 300 times that of a control village's road dust and copper over 100 times.

HAZARDOUS EFFECTS

A. Mercury: Found in fluorescent tubes (numerous applications), tilt switches (mechanical doorbells, thermostats), and flat screen monitors. Health effects include sensory impairment, dermatitis, memory loss, and muscle weakness.[15]

B. Sulphur: Found in lead-acid batteries. Health effects include liver damage, kidney damage, heart damage, eye and throat irritation. When released into the environment, it can create sulphuric acid.

C. Cadmium: Found in light-sensitive resistors, corrosion-resistant alloys for marine and aviation environments, and nickel-cadmium batteries. The inhalation of cadmium can cause severe damage to the lungs and is also known to cause kidney damage.

D. Lead: Solder, CRT monitor glass, lead-acid batteries, some formulations of PVC: Adverse effects of lead exposure include impaired cognitive function, behavioral disturbances, attention deficits, hyperactivity, conduct problems and lower IQ

E. Polyvinyl chloride (PVC) is a chlorinated plastic used in some electronics products and for insulation on wires and cables. Chlorinated dioxins and furans are released when PVC is produced or disposed of by incineration (or simply burning). These chemicals are highly persistent in the environment and many are toxic even in very low concentrations.

There is also evidence of cytotoxic and genotoxic effects of some chemicals, which have been shown to inhibit cell proliferation, cause cell membrane lesion, cause DNA single-strand breaks, and elevate Reactive Oxygen Species (ROS) levels.[7,16]

•DNA breaks can increase the likelihood of developing cancer

•DNA damages are a special problem in non-dividing or slowly dividing cells, where unrepaired damages will tend to accumulate over time.

•Elevated Reactive Oxygen Species (ROS) levels can cause damage to cell structures (oxidative stress).[17]

E-WASTE MANAGEMENT ASSOCIATION

•The e-Waste Association of South Africa (eWASA) has been instrumental in building a network of e-waste recyclers and refurbishers in the country. It continues to drive the sustainable, environmentally sound management of all e-waste in South Africa.

•E-Cycling Central is a website from the Electronic Industry Alliance which allows you to search for electronic recycling programs in your state. It lists different recyclers by state to find reuse, recycle, or find donation programs across the country.

•Ewaste.guide.info is a Switzerland-based website dedicated to improving the e-waste situation in developing and transitioning countries. The site contains news, events, case studies, and more.

•StEP: Solving the E-Waste Problem This website of StEP, an initiative founded by various UN organizations to develop strategies to solve the e-waste problem, follows its activities and programs.[8]

Approach of reuse and recycling of solid waste is shown in Figure 2.

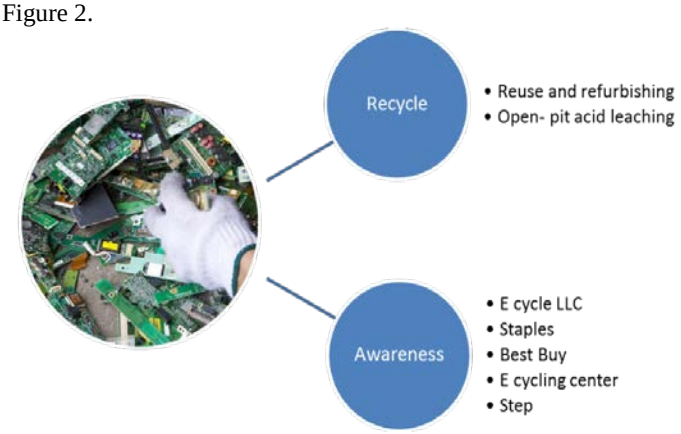

Figure 2. Approach of reuse and recycling of solid waste

BENEFITS OF RECYCLING

Recycling raw materials from end-of-life electronics is the most effective solution to the growing e-waste problem. Most electronic devices contain a variety of materials, including metals that can be recovered for future uses. By dismantling and providing reuse possibilities, intact natural resources are conserved and air and water pollution caused by hazardous disposal is avoided. Additionally, recycling reduces the amount of greenhouse gas emissions caused by the manufacturing of new products.[9]

Benefits of recycling are extended when responsible recycling methods are used. In the U.S., responsible recycling aims to minimize the dangers to human health and the environment that disposed and dismantled electronics can create. As properly disposing of or reusing electronics can help prevent health problems, reduce greenhouse-gas emissions and create jobs. Responsible recycling ensures best management practices of the electronics being recycled, worker health and safety, and consideration for the environment locally and abroad.[10-12] Flowchart of benefits and process of recycling electronic waste accompanied with pollution prevention hierarchy is shown in Figure 3, Figure 4[13]& Figure 5[14] respectively.

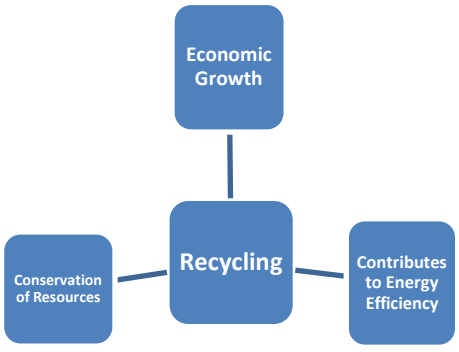

Figure 3. Flow Chart of benefits of Recycling Electronic Waste

Figure 4. Flow chart of Recycling of electronic waste

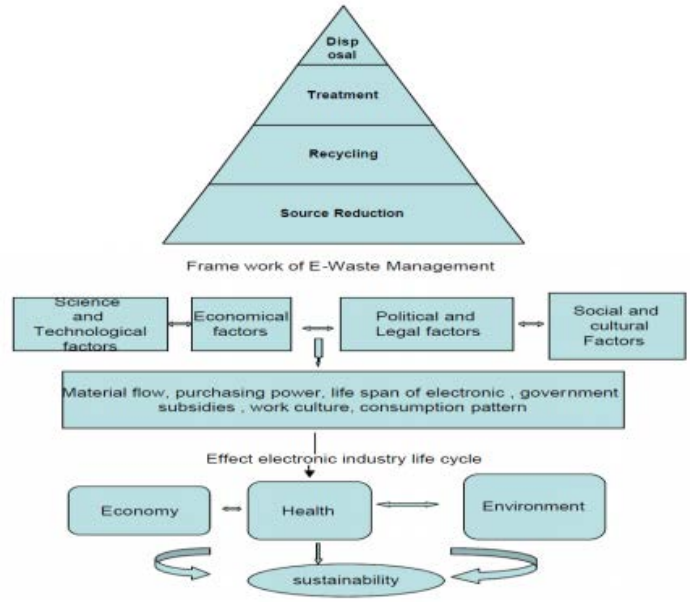

Figure 5. Pollution prevention hierarchy

It is important that any e-waste processor is fully certified in safe destruction and follow certified documented procedures to safely dispose of electronic waste. India is placed in a very interesting position in recycling different types of e-waste. The need of the hour is an urgent approach to the e-waste hazard and increase in public awareness such that it can convert this challenge into an opportunity to show the world that India is ready to deal with future problems and can set global credible standards concerning environmental and occupational health.

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