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E-Waste management of electronics and its impact on environment and health

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Abstract

Electronic industry is the world's largest and innovative industry for its kind. Every year tons of electronic items are shipped over oceans, however, after their usage time they become a complex waste matter which consists of many hazardous heavy metals, acids, toxic chemicals and non-degradable plastics. Many are dumped, burnt or exported to recyclers. However, strict regulations are currently being followed as on approval of such firms such as e-steward certification by Basel action network in US, they also involved in public awareness programs; this review is based on collected information from various journal articles, websites including the technical note by Greenpeace international. This paper tries to analyze the current progress on e-waste management of electronic gadgets and computer accessories in India.

Keywords: Electronics, Industries, e-Waste, health problems

Introduction

Waste electrical and electronic equipment (WEEE) is becoming a major threat to the whole world. Its toxic emissions mixed with virgin soil and air and causing harmful effects to the entire biota either directly or indirectly. Direct impacts include release of acids, toxic compounds including heavy metals, carcinogenic chemicals and indirect facts such as bio-magnification of heavy metals.

Waste management has always been part of human society and its study reveals a wealth of details over the way of life it results from. For example, paleontology relies for a large part on the study of wastes (such as bones or broken utensils) to generate the knowledge we have of prehistoric civilizations. However, about 75% of e-wastes are uncertain for their use or finding ways to use them which includes refurbishment, remanufacture and reuse their parts for repair etc. While others are junk occupying usable space at houses, apartments, firms and industries.

Review of Literature

Waste electrical and electronic equipment (WEEE) is one of the fastest-growing pollution problems worldwide given the presence of a variety of toxic substances which can contaminate the environment and threaten human health, if disposal protocols are not meticulously managed. This paper presents an overview of toxic substances present in e-waste, their potential environmental and human health impacts together with management strategies currently being used in certain countries. Several tools including Life Cycle Assessment (LCA), Material Flow Analysis (MFA), Multi Criteria Analysis (MCA) and

Extended Producer Responsibility (EPR) have developed to manage e-wastes especially in developed countries. (Peeranart Kiddee | Ravi Naidu | Ming H).

The dynamic increase in the manufacture of rubber products, particularly those used in the automobile industry, is responsible for a vast amount of wastes, mostly in the form of used tires, of which more than 17 million tones are produced globally each year. The widely differing chemical compositions and the cross-linked structures of rubber in tyres are the prime reason why they are highly resistant to biodegradation, photochemical decomposition, chemical reagents and high temperatures. The increasing numbers of used tyres therefore constitute a serious threat to the natural environment. The progress made in recent years in the management of polymer wastes has meant that used tyres are starting to be perceived as a

potential source of valuable raw materials. (Maciej Sienkiewicz Justyna Kucinska-Lipka Helena Janik Adolf Balas Volume 32).

Most e-recyclers were exporting the toxic materials such as leaded glass, circuit boards, and mercury lamps usually to China, Africa and India (Basel Action uploaded on 2013). Dismantling process takes much labor, in countries like China and some parts of India there are tones e-wastes junked and dismantled; dismantling is not only involve in

unscrewing but also shredding, tearing and burning. The smoke and dust particle consists of carcinogens and other hazardous chemicals which causes severe inflammations and lesions including many respiratory and skin diseases. Circuits are burnt to hunt the valuable metals such as gold, platinum, cadmium but the wire coat of those consists of PVC and PCB which may produce erotic smoke, and carbon particles from the toners are carcinogens, they may lead to lung and skin cancer (Kevin *et al.*, 2008) ^[1, 2, 3, 4]

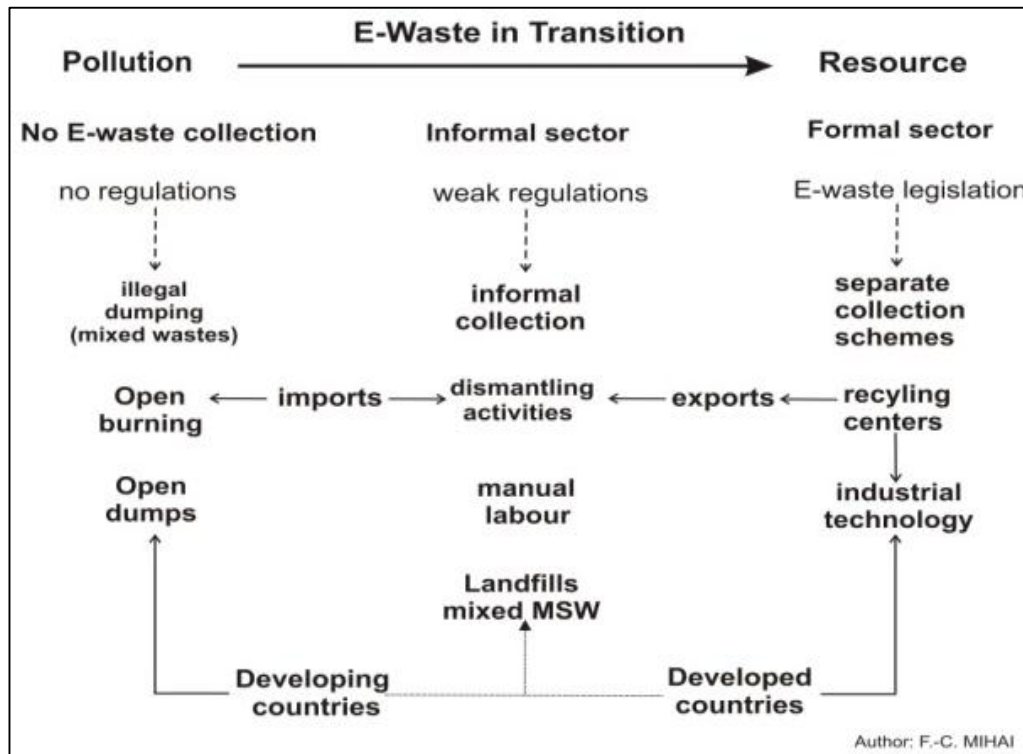


Fig 1: E-Waste in Transition

Effect of e-wastes in India

About 80,000 people working for recycling sector, some villages such as Seelampur has scrap markets where piles of e-wastes are separated for recycling. They separate copper from wires after burning them. Plastic and PVC codes produce noxious smoke which is irritable to eyes and cause respiratory problems. In addition, acid treatment is given to isolate metals; corrosive acids also released from used batteries of cell phones and computers, according to scientists of Greenpeace recycling of a computer in India costs just 2\$ while it is 20\$ in US (Keekeesocean uploaded on 2012), not only cheap labor but also for the profit from recovered metals of circuit boards such as copper gives earning of 3 to 5\$ per day workers are spending on dismantling e-wastes rather considering their own health (Figure 3). However, currently they are building an e-waste recycling plant in Bangalore which was estimated as having the capacity to handle 60,000 tons of ewastes annually. In India about 24% of e-waste was produced from Mumbai, and, Delhi, Bangalore and Chennai are 21.2, 10.1 and 9.1 respectively.

Effects on Environment and Human Health

Disposal of e-wastes is a particular problem faced in many regions across the globe. Computer wastes that are landfilled produces contaminated leachates which eventually pollute the groundwater. Acids and sludge

obtained from melting computer chips, if disposed on the ground causes acidification of soil. For example, Guiya, Hong Kong a thriving area of illegal e-waste recycling is facing acute water shortages due to the contamination of water resources.

This is due to disposal of recycling wastes such as acids, sludges etc., in rivers. Now water is being transported from faraway towns to cater to the demands, of the population. Incineration of e-wastes can emit toxic fumes and gases, thereby polluting the surrounding air. Improperly monitored landfills can cause environmental hazards. Mercury will leach when certain electronic devices, such as circuit breakers are destroyed. The same is true for polychlorinated biphenyls (PCBs) from condensers. When brominated flame retardant plastic or cadmium containing plastics are landfilled, both polybrominated diphenyl ethers (PBDE) and cadmium may leach into the soil and groundwater. It has been found that significant amounts of lead ion are dissolved from broken lead containing glass, such as the cone glass of cathode ray tubes, gets mixed with acid waters and are a common occurrence in landfills.

Sources of Electronic E-Wastes

Almost every used electronic items are considered as e-waste such as discarded cellphones, cameras, CD players, TVs, radios, drillers, fax machines, photocopiers, printers, toners, ink cartridges, batteries, re-chargeable batteries,

digital calculators and clocks, CRT monitors, electric solders, computer motherboards, key board, industrial and house hold electronic machinery such as oven, fridge, sewing & washing machines, fan, air-conditioner, grinder, iron, heater, military and laboratory electronic equipment's etc.,

Impact of Products from E-Waste in Human Health

There are chances of accidents like cuts and burns during the dismantling, shredding, acid baths and incineration process, in addition, exposure to following, chemicals have many long-term effects. Phthalates such as DEHP in tis monomer form effects the development of testis, Butylbenzyl phthalate (BBP) and dibutyl phthalate (DBP) also hazardous to reproduction exposure to phthalates in pregnancy reduces ano-genetal index in male child (distance between anus and genitals) (Swan *et al.* 2005), DINP and DIDP (diisodecyl phthalate) effects liver and kidneys. Chlorinated compounds includes Polychlorinated biphenyls (PCBs), PCB accumulates in fishes and other organisms and undergo bioaccumulation which result in high value in toplevel carnivore such as humans, PCB also absorbable via skin and inhaled or ingested causing neurotoxicity, liver

damage, tumors, immunosuppression and behavioral changes, and reproductive disorders, abnormal sperms (Allsopp *et al.* 1999, Allsopp *et al.* 2001a). Chlorobenzene causes acute and chronic effects in mammals, effects CNS (central nervous system), liver and thyroid. Increasing degree of chlorination such as tetrachlorobenzenes also affects kidneys. Hexachlorobenzene (HCB) are group 2B carcinogens it damages immune system, liver, thyroid, CNS, kidney and nervoussystem (van Birgelen 1998). It is also reported the bioaccumulation of HCB. Polybrominated diphenyl ethers (PBDEs) is an environmentally persistent compound, which is also reported in bioaccumulation, it causes abnormal brain development during the initial development of a fetus, it also associated with impacts on learning, memory, behavior and thyroid, oestrogen hormone systems and effecting the immune system, (Legler & Brouwer 2003). When PBDEs are burnt they produce brominated dioxins/furans which are similarly hazardous. Triphenyl phosphates (TPP) are a contaminant in human blood (Jonsson *et al.* 2001),

Current Disposal Methods of E-Waste

Currently following methods are used to get rid of e wastes they are Incineration, Acid baths, Landfills



Fig 2: India's E-Waste

1. It's critical to keep electronic waste out of landfills:

The EPA has stated that e-waste is dangerous when improperly disposed of. Electronic devices are comprised of toxic substances and heavy metals. Materials such as chromium, cadmium, mercury and lead can leach into the soil contaminating the air and waterways. EPA estimates there are about 60 million tons of e-waste per year globally. Recycling this material will save landfill space. For these reasons, there are numerous state laws that now ban e-waste in landfills.

2. Electronic products are comprised of valuable materials such as precious metals like gold, silver

and platinum along with copper, aluminum, plastic and glass: Through the recycling process, these materials can be reclaimed. Most electronic devices are nearly 100 percent recyclable. It would be poor stewardship to landfill these materials.

- 3. Reclaiming valuable materials from the recycling process means there will be decreased demand for new raw materials:** This will help conserve important natural resources. According to the EPA, one metric ton of circuit boards contains 800 times the amount of gold mined from one metric ton of ore.
- 4. Using recycled material will also help reduce greenhouse gas emissions produced when**

manufacturing or processing new product known as “virgin material.”: The more recycled material is available, the lower the demand for virgin material.

5. **Discarded electronic devices can also be kept out of the landfill if they are refurbished, reused and donated to a worthy cause:** A quick Google search will provide a list of organizations in most areas that rebuild old electronics and provide them to those who otherwise would go without. “Reuse” is an important component of keeping material out of the waste stream. The EPA’s webpage has a listing of donation programs, at: epa.gov/recycle/electronics-donation-andrecycling#where

Landfills

E-wastes ending up as landfills are described as toxic time bomb. They may release to the environment after several years by natural means, and there is a possibility of leaching of wastes such as batteries releases acids and heavy metals mercury, nickel and cadmium, electronic circuits have lead, zinc, Nickel, Copper, Mercury and cadmium. These may reach the land water and reaches animals and humans, and mixes with other fresh water sources such as rivers and streams.

Acid baths

Acid bath method is used to extract Copper, here the circuit board is submerged in to Sulfuric acid for about 12hours to dissolve copper then solution is boiled, precipitated copper sulfate is taken and remaining solution is added with scraped particles, subsequently copper smudges are removed. Acid baths also used to dissolve the lead and in the extraction of Gold and Silver.

Safe Methods for Disposal of Waste and Managing Authorities

Most safe method is recycling materials including metals and reusing them, which includes industry wide system for the collection of e-wastes. Implementing proper rules to make following as mandatory wearing protective masks and gloves and safety glass when dismantling and avoid easy methods of extraction such as incineration which results harmful fumes, avoid dumping and avoid using acid baths, and implementing strict rules against dumping e-wastes in landfills as it could leach out towards ground water or may be released after long time. Implementing proper storage system for collected and extracted e-wastes until it is reused as products, strengthen the implementation of agreed legislations of Basel convention and implementing potent laws to prevent political invasions or pressures.

Take action against unapproved illegal e-waste collectors and dismantlers, encourage research scientists in finding alternatives to hazardous chemicals and carcinogen, banning the electronic products with hazardous ingredients, monitoring the transportation of e-waste within the state municipal limits as well as ports and harbors. Consulting with manufactures e-waste processors, environmental groups such as NRDC, Basel Action Network (BAN) have created a certification system for recycling, refining and refurbishing companies known as e- Stewards. E-steward certification assures the recyclers keep up the standards which allow the recycling process in a way that protects workers health and the environment. BAN also maintains a list of companies which are permitted to act as subscribed e-

stewards (NRDC 2012), in 2010 the first certified standard was announced. And NRDC, BAN and other advocates are currently working on ensuring the strong implementation of the laws against e-waste exporters (NRDC 2012). Moreover. In many states of US have implemented the system to make electronic manufactures to take responsibility for their products, Thus, electronic manufactures are given great responsibility to collecting the products after their use and recycling them. It is also important to educate the public on handling and disposal of e-waste through awareness programs.

Responsibilities of the Citizen

Waste prevention is perhaps more preferred to any other waste management option including recycling. Donating electronics for reuse extends the lives of valuable products and keeps them out of the waste management system for a longer time. But care should be taken while donating such items i.e. the items should be in working condition.

Reuse, in addition to being an environmentally preferable alternative, also benefits society, By donating used electronics, schools. Non-profit organizations, and lower-income families can afford to use equipment that they otherwise could not afford. E-wastes should never be disposed with garbage and other household wastes. This should be segregated at the site and sold or donated to various organizations.

Conclusion

It is evident that the public awareness and cooperation of manufactures are essential for the advancement of e-waste management system. And also it is the responsibility of governments to allocate sufficient grants and protecting the internationally agreed environmental legislations within their borders, Licensing of certification like stewardship may ensure the security to prevent illegal smugglers and handlers of e-waste. Basel Action Network is now working at their best to stop or control trans boundary e-waste movements, they also involved in conducting public awareness programs to enlighten the world community and opening research areas to find better methods or alternatives. As e-wastes are the known major source of heavy metals, hazardous chemicals and carcinogens, certainly diseases related to skin, respiratory, intestinal, immune, and endocrine and nervous systems including cancers can be prevented by proper management and disposal of e-waste.

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