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EFFECTS OF UNCONTROLLED DISPOSAL OF E-WASTES AND ITS MANAGEMENT

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Abstract: E-wastes consist of discard of electronic appliances such as computers, mobiles and telephones. Major producers of e-wastes are USA, China, Europe and Australia and the total estimate of these products is about 25 million tonnes per year. These countries are forced to adopt the “reuse” procedure to save environment and money flow. However certain e-wastes are having their self-life, which cannot be reuse. Hence, it is essential to recycle or disposal of these with suitable precautions. Uncontrolled disposal and recycling activities generate and release high toxic metals such as Hg, Pb, Cd, Cr, Cr(IV), Co, Cu, Ni, and Zn. These also release high concentrations of different types of flame retardants such as Poly Brominated Diphenyl Ethers (PBDEs), Poly-Chlorinated Biphenyls (PCBs) and Organo -Chlorine Pesticides (OCPs). In this current research paper, potential environmental health consequences of these toxic metals and organo compounds are described. This article mainly focuses on overview of India’s current e-waste scenario and their problems in recycling and disposal of e-waste. The tools for e-waste management like life cycle assessment (LCA), material flow analysis (MFA) have been developed to manage e wastes especially in developed countries. By developing eco-design devices and collecting e-waste and safe handling the disposal brings clean environment. There is no exact tool to solve this issue.

Keywords: Toxic metals, E-waste, Environmental hazard, Recycle, Reuse

Introduction:

"E-waste" is a popular, informal name for electronic products nearing the end of their useful life.

E-wastes are considered dangerous, as certain components of some electronic products contain materials that are hazardous, depending on their condition and density. The hazardous content of these materials pose a threat to human health and environment. Discarded computers, televisions, VCRs, stereos, copiers, fax machines, electric lamps, cell phones, audio equipment and batteries if improperly disposed can leach lead and other substances into soil and groundwater. Many of these products can be reused, refurbished, or recycled in an environmentally sound manner so that they are less harmful to the ecosystem. This paper highlights the hazards of e-wastes, the need for its appropriate management and options that can be implemented (Devi et al.,2004;Ramesh and Joseh,2006).

Industrial revolution followed by the advances in information technology during the last century has radically changed people's lifestyle. Although this development has helped the human race, mismanagement has led to new problems of contamination and pollution. The technical prowess acquired during the last century has posed a new challenge in the management of wastes. For example, personal computers (PCs) contain certain components, which are highly toxic, such as chlorinated and brominated substances, toxic gases, toxic metals, biologically active materials, acids, plastics and plastic additives. The hazardous content of these materials pose an environmental and health threat (Jain,2009). Thus proper management is necessary while disposing or recycling ewastes.

These days computer has become most common and widely used gadget in all kinds of activities ranging from schools, residences, offices to manufacturing industries. E-toxic components in computers could be summarized as circuit boards containing heavy metals like lead & cadmium; batteries containing cadmium; cathode ray tubes with lead oxide & barium; brominated flameretardants used on printed circuit boards, cables and plastic casing; poly vinyl chloride (PVC) coated copper cables and plastic computer casings that release highly toxic dioxins & furans when burnt to recover valuable metals; mercury switches; mercury in flat screens; poly chlorinated biphenyl's (PCB's) present in older capacitors; transformers; etc. Basel Action Network (BAN) estimates that the 500 million computers in the world contain 2.87 billion kgs of plastics, 716.7 million kgs of lead and 286,700 kgs of mercury. The average 14-inch monitor uses a tube that contains an estimated 2.5 to 4 kgs of lead. The lead can seep into the ground water from landfills thereby contaminating it. If the tube is crushed and burned, it emits toxic fumes into the air (Jain,2009; UNEP,2010).

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, Guiyu, 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 Mercury will leach when certain electronic devices, such as circuit breakers are destroyed. The same is true for polychlorinated biphenyls (PCBs) from condensers (UNEP,2010). When brominates flame retardant plastic or cadmium containing plastics are land filled, both polybrominateddiphenyl 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. The toxic fall-out from open air burning affects both the local environment and broader global air currents, depositing highly toxic byproducts in many places throughout the world (Sivakumar, 2011; Ramachandra and Saira, 2004).

The health effects of certain constituents in e-wastes were summarized in Table-1.International outrage following these irresponsible activities led to the drafting and adoption of strategic plans and regulations at the Basel Convention. The Convention secretariat, in Geneva, Switzerland, facilitates and implementation of the Convention and related agreements. It also provides assistance and guidelines on legal and technical issues, gathers statistical data, and conducts training on the proper management of hazardous waste (Freeman,1989;Hilty,2005)

Table-1: Effects of E-Waste constituent on health.

Source of e-wastes	**Constituent**	**Health effects**
Solder in printed circuit boards, glass panels and gaskets in computer monitors	Lead (PB)	· Damage to central and peripheral nervous systems, blood systems and kidney damage. · Affects brain development of Children
Chip resistors and semiconductors	Cadmium (CD)	· Toxic irreversible effects on human health. · Accumulates in kidney and liver. · Causes neural damage. · Teratogenic
Relays and switches, printed circuit boards	Mercury (Hg)	· Chronic damage to the brain. · Respiratory and skin disorders due to bioaccumulation in fishes.
Corrosion protection of untreated and galvanized steel plates, decorator or hardner for steel housings	Hexavalent chromium (Cr) VI	· Asthmatic bronchitis. · DNA damage.

Cabling and computer housing	Plastics including PVC	Burning produces dioxin. It causes · Reproductive and developmental problems; · Immune system damage; · Interfere with regulatory Hormones
Plastic housing of electronic equipments and circuit boards.	Brominated flame retardants (BFR)	· Disrupts endocrine system functions
Front panel of CRTs	Barium (Ba)	Short term exposure causes: · Muscle weakness; · Damage to heart, liver and spleen.
Motherboard	Beryllium (Be)	· Carcinogenic (lung cancer) · Inhalation of fumes and dust. Causes chronic beryllium disease orberyllicosis. · Skin diseases such as warts.

Management of e-wastes

It is estimated that 75% of electronic items are stored due to uncertainty of how to manage it. These electronic junks lie unattended in houses, offices, warehouses etc. and normally mixed with household wastes, which are finally disposed off at landfills. This necessitates implementable management measures.

E-waste management tips

1. Don't throw the waste cell phones, dumped systems into the landfills. Properly, deliver them to the
organizations where recycling is carried out.
2. Get the electronic goods from the vendors who can take back for recycling.
3. Take care of the lifetime of your hardware equipments and so that e waste can be efficiently decreased
4. Big Industries may buy recyclers that can be used for long time.
5. Citizens should turn their interests to use the recycled products
6. Support green engineering.

In industries management of e-waste should begin at the point of generation. This can be done by waste minimization techniques and by sustainable product design. Waste minimization in industries involves adopting:

_ inventory management,
_ production-process modification,
_ volume reduction,
_ recovery and reuse.

Inventory management

Proper control over the materials used in the manufacturing process is an important way to reduce waste generation. By reducing both the quantity of hazardous materials used in the process and the amount of excess raw materials in stock, the quantity of waste generated can be reduced. This can be done in two ways i.e. establishing material-purchase review and control procedures and inventory tracking system. Developing review procedures for all material purchased is the first step in establishing an inventory management program. Procedures should require that all materials be approved prior to purchase. In the approval process all production materials are evaluated to examine if they contain hazardous constituents and whether alternative non-hazardous materials are available (Hilty et al,2004).

Production-process modification

Changes can be made in the production process, which will reduce waste generation. This reduction can be accomplished by changing the materials used to make the product or by the more efficient use of input materials in the production process or both. Potential waste minimization techniques can be broken down into three categories:

i) Improved operating and maintenance procedures,
ii) Material change and
iii)Process-equipment modification.

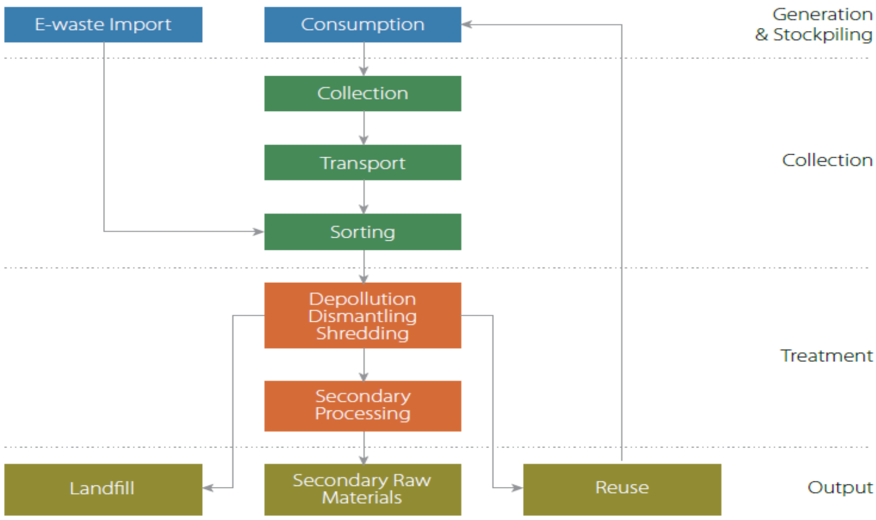
Improvements in the operation and maintenance of process equipment can result in significant waste
reduction. A strict maintenance program, which stresses corrective maintenance, can reduce waste generation caused by equipment failure. An employee-training program is a key element of any waste reduction program (Sinha and Khetriwal,2002; Sinha et al.,2009). Training should include correct operating and handling procedures, proper equipment use, recommended maintenance and inspection schedules, correct process control specifications and proper management of waste materials. Hazardous materials used in either a product formulation or a production process may be replaced with a less hazardous or non-hazardous material. This is a very widely used technique and is applicable to most manufacturing processes. Implementation of this waste reduction technique may require only some minor process adjustments or it may require extensive new process equipment. For example, a circuit board manufacturer can replace solvent-based product with water-based flux and simultaneously replace solvent vapor degreaser with detergent parts washer.

Volume reduction

Volume reduction includes those techniques that remove the hazardous portion of a waste from a nonhazardous portion. These techniques are usually to reduce the volume, and thus the cost of disposing of a waste material. The techniques that can be used to reduce waste-stream volume can be divided into 2 general categories: source segregation and waste concentration. Segregation of wastes is in many cases a simple and economical technique for waste reduction. Wastes containing different types of metals can be treated separately so that the metal value in the sludge can be recovered. Concentration of a waste stream may increase the likelihood that the material can be recycled or reused. Methods include gravity and vacuum filtration, ultra filtration, reverse osmosis, freeze vaporization etc. For example, an electronic component manufacturer can use compaction equipments to reduce volume of waste cathode ray-tube(Sepulveda et al., 2010).

Recovery and reuse

This technique could eliminate waste disposal costs, reduce raw material costs and provide income from a salable waste. Waste can be recovered on-site, or at an off-site recovery facility, or through inter industry exchange [23]. A number of physical and chemical techniques are available to reclaim a waste material such as reverse osmosis, electrolysis, condensation, electrolytic recovery, filtration, centrifugation etc. For example, a printed-circuit board manufacturer can use electrolytic recovery to reclaim metals from copper and tin-lead plating bath. However recycling of hazardous products has little environmental benefit if it simply moves the hazards into secondary products that eventually have to be disposed of. Unless the goal is to redesign the product to use nonhazardous materials, such recycling is a false solution. Some steps of recycling e-wastes are as follows.



Sustainable product design

Minimization of hazardous wastes should be at product design stage itself keeping in mind the following factors-

Rethink the product design: Efforts should be made to design a product with fewer amounts of hazardous materials. For example, the efforts to reduce material use are reflected in some new computer designs that are flatter, lighter and more integrated. Other companies propose centralized networks similar to the telephone system.

Use of renewable materials and energy: Bio-based plastics are plastics made with plant-based chemicals or plant-produced polymers rather than from petrochemicals. Bio-based toners, glues and inks are used more frequently. Solar computers also exist but they are currently very expensive.

Use of non-renewable materials that are safer: Because many of the materials used are nonrenewable, designers could ensure the product is built for re-use, repair and/or upgradeability. Some computer manufacturers such as Dell and Gateway lease out their products thereby ensuring they get them back to further upgrade and lease out again.

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