E-waste: Environmental Problems, its Causes & Current Management

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Abstract - "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. [1]

Keywords : E-waste, Effects, Causes, Management, Environment, Responsibility

I. INTRODUCTION

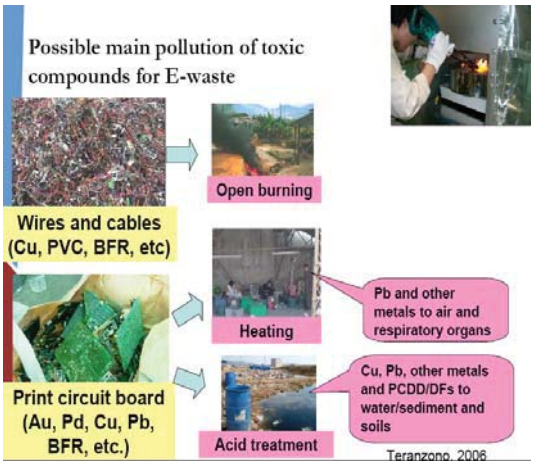
Industrial revolution followed by the advances in information technology during the last century has radically changed people's lifestyle. Although this development has helped the human race, mismanagement has led to new problems of contamination and pollution

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 brominates 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. Thus proper management is necessary while disposing or recycling e-wastes. 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;** brominates flame retardants 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. [2]

QUICK FACTS:
Following are the facts which have drawn the attention of environmentalist.

- 1200 tons of scrap / yr , Only 11% of e-waste get recycled
- India's hospitals to see patients with 10 times the expected level of lead in their blood
- In India, a water sample revealed levels of lead 190 times as high as the drinking water standard set by the World Health Organization.
- Thousands of children throughout the India are attending schools that were built on or near toxic waste sites, with increased risk of developing asthma, cancer, learning disorders and other diseases linked to environmental pollutants.



II. EFFECTS ON ENVIRONMENT AND HEALTH THE HUMAN

Disposal of e-wastes is a particular

Problem faced in many regions across the globe. Computer wastes that are land filled 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, sledges 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 land filled, 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 rays tubes, gets mixed with acid waters and are a common occurrence in landfills. Not only does the leaching of mercury poses specific problems, the vaporization of metallic mercury and dimethylene mercury, both part of Waste Electrical and Electronic Equipment (WEEE) is also of concern. In addition, uncontrolled fires may arise at landfills and this could be a frequent occurrence in many countries. When exposed to fire, metals and other chemical substances, such as the extremely toxic dioxins and furans (TCDD- tetrachloro - dibenzo - dioxin. PCDDs-polychlorinated dibenzodioxins. PBDDs-polybrominated dibenzo-dioxin and PCDFs - polychlorinated dibenzo furans) from halogenated flame retardant products and PCB containing condensers can be emitted. The most dangerous form of burning e-waste is the open-air burning of plastics in order to recover copper and other metals. 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. The health effects of certain constituents in e-wastes. If these electronic items are discarded with other household garbage, the toxies pose E-Waste Management a threat to both health and vital components of the ecosystem. In view of the ill-effects of hazardous wastes to both environment and health, several

countries exhorted the need for a global agreement to address the problems and challenges posed by hazardous waste. Also, in the late 1980s, a tightening of environmental regulations in industrialized countries led to a dramatic rise in the cost of hazardous waste disposal. Searching for cheaper ways to get rid of the wastes, "toxic traders" began shipping hazardous waste to developing countries. 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.[3]

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2.1 BASEL CONVENTION

The fundamental aims of the Basel. Convention are the control and reduction of transboundary movements of hazardous and other wastes including the prevention and minimization of their generation, the environmentally sound management of such wastes and the active promotion of the transfer and use of technologies. A Draft Strategic Plan has been proposed for the implementation of The Basel Convention. The Draft Strategic Plan takes into account existing regional plans, programmed or strategies, the decisions of the Conference of the Parties and its subsidiary bodies ongoing project activities and process of international environmental governance and sustainable development. The Draft requires action at all levels of society: training, information, communication, methodological tools, capacity building with financial support, transfer of know-how, knowledge and sound, proven cleaner technologies and processes to assist in the concrete implementation of the Basel Declaration. It also calls for the effective involvement and coordination by all concerned stakeholders as essential for achieving the aims of the Basel Declaration within the approach of common but differentiated responsibility.

A set. of interrelated and mutually supportive strategies are proposed to support the concrete implementation of the activities as indicated in the website is described below: a) To involve experts in designing communication tools For creating awareness at the highest level to promote the aims of the Basel Declaration on environmentally sound management and the ratification and implementation of the Basel Convention, its amendments and protocol with the emphasis on the short-term activities. b) To engage and stimulate a group of interested Parties to assist the secretariat in exploring fund raising strategies including the preparation of projects and in making full use of expertise in non-governmental organizations and other institutions in joint projects. c) To motivate selective partners among various stakeholders to bring added value to making progress in the short term. d) To disseminate and make information easily accessible through the internet and other electronic and printed materials on the transfer of know-how, in particular through Basel Convention Regional Centers (BCRCs). e) To undertake periodic review of activities in relation to the agreed indicators; f) To collaborate with existing institutions and programmed to promote better use Source of e-wastes Constituent Health effects Solder in printed circuit boards, glass Lead (PB) . Damage to central and peripheral nervous panels and gaskets in computer systems, blood systems and kidney monitors 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, Relays and switches, printed circuit Mercury (Hg). Chronic damage to the brain and boards. Respiratory and skin disorders due to bio accumulationin fishes. Corrosion protection of untreated Hexavalent chromium (Cr) Asthmatic bronchitis and galvanized steel plates, decorator VI .DNA damage or hardener for steel housings cabling and computer housing Plastics including PVCB .urning produces dioxm. It causes Reproductive and developmental problems. Immune system damage; Interfere with Rulatory hormones Plastic housing of electronic Brominated flame retardants. The Basel Convention brought about a respite to the trans boundary movement of hazardous waste. India and other countries have ratified the convention. However United States (US) is not a party to the ban and is responsible for disposing hazardous waste, such as, e-waste to Asian countries even today. In the European Union, where the annual quantity of electronic waste is likely to double in the next 12 years, the European Parliament recently passed legislation that will require manufacturers to take back their electronic products when consumers discard them called Extended Producer Responsibility .It also mandates a timetable for phasing out most toxic substances in electronic products. [4]

2.2 The fate of E-waste

The e-waste of developed countries ends up in China, India, Africa, and Latin America's poor communities where e-waste is dismantled in appalling conditions, using primitive methods that fail to provide any protection to the workers and environment

III. 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 is finally disposed

Off at landfills. This necessitates implement able management measures. 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.

3.1.1 Inventory management

Proper control over the materials used in the manufacturing process is an important E-Waste Management way to reduce waste generation (Freeman, 1989). 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. Another inventory management procedure for waste reduction is to ensure that only the needed quantity of a material is ordered. This will require the establishment of a strict inventory tracking system. Purchase procedures must be implemented which measure that materials are ordered only on an as-needed basis and that only the amount needed for a specific period of time is ordered.

3.1.2Production-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. This can be accomplished by reviewing current operational procedures or lack of procedures and examination of the production process for ways to improve its efficiency. Instituting standard operation procedures can optimize the use of raw materials in the production process and reduce the potential for materials to be E-Waste Management lost through leaks and spills. 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. 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. Installing more efficient process equipment or modifying existing equipment to take advantage of better production techniques can significantly reduce waste generation. New or updated equipment can use p:'ocess materials more efficiently, producing less waste. Additionally such efficiency reduces the number of rejected or off-specification products, thereby reducing the amount of material which has to be reworked orm disposed of. Modifying existing process equipment can be a very cost-effective method of reducing waste generation. In many cases the modification can just be relatively simple changes in the way the materials are handled within the process to ensure that they are not wasted. For example, in many electronic manufacturing operations, which involve coating a product, such as electroplating or painting, chemicals are used to strip off coating from rejected products so that they can be recoated. These chemicals, which can include acids, caustics, cyanides etc are often a hazardous waste and must be properly managed. By reducing the number of parts that have to be reworked, the quantity of waste can be significantly reduced.

3.1.3 Volume reduction

Volume reduction includes those techniques that remove the hazardous portion of a waste from a non-hazardous 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 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 re-used. 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.

3.1.4 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. 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- 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.

3.1.5 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.

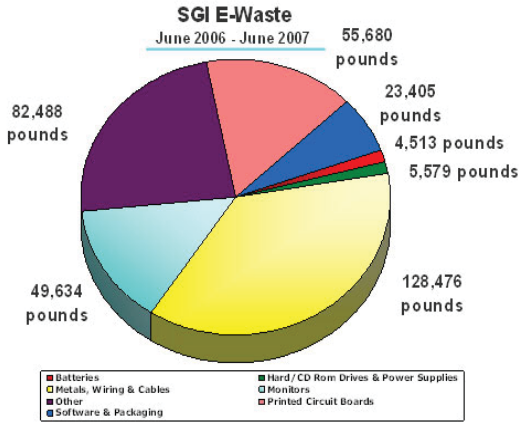
Use of non-renewable materials that are safer:

Because many of the materials used are non-renewable, 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

IV. THE INDIAN SCENARIO

While the world is marveling at the technological revolution, countries like India are facing an imminent danger. E-waste of developed countries, such as the US, disposes their wastes to India and other Asian countries.



A recent investigation revealed that much of the electronics turned over for recycling in the United States ends up in Asia, where they are either disposed of or recycled with little or no regard for environmental or E-Waste Management worker health and safety. Major reasons for exports are cheap labour and lack of

environmental and occupational standards in Asia and in this way the toxic effluent of the developed nations' would flood towards the world's poorest nations. The magnitude of these problems is yet to be documented. However, groups like Toxic Links India are already working on collating data that could be a step towards controlling this hazardous trade. It is imperative that developing countries and India in particular wake up to the monopoly of the developed countries and set up appropriate management measures to prevent the hazards and mishaps due to mismanagement of e-wastes.

V. MANAGEMENT OPTIONS

Considering the severity of the problem, it is imperative that certain management options be adopted to handle the bulk e-wastes. Following are some of the management options suggested for the government, industries and the public.

5.1.1 Responsibilities of Government

(i) Governments should set up regulatory agencies in each district, which are vested with the responsibility of coordinating and consolidating the regulatory functions of the various government authorities regarding hazardous substances. (ii) Governments should be responsible for providing an adequate system of laws, controls and administrative procedures for hazardous waste management (Third World Network. 1991). Existing laws concerning e-waste disposal be reviewed and revamped. A comprehensive law that provides e-waste regulation and management and proper disposal of hazardous wastes is required. Such a law should empower the agency to control, supervise and regulate the relevant activities of government departments. E-Waste Management Under this law, the agency concerned should collect basic information on the materials from manufacturers, processors and importers and to maintain an inventory of these materials. The information should include toxicity and potential harmful effects. . Identify potentially handful
substances and require the industry to test them for adverse health and environmental effects. Control risks from manufacture, processing, distribution, use and disposal of electronic wastes. Encourage beneficial reuse of "e-waste" and encouraging business activities that use waste". Set up programs so as to promote recycling among citizens and businesses. Educate e-waste generators on reuse/recycling options(iii)Governments must encourage research into the development and standard of hazardous waste management, environmental monitoring and the regulation of hazardous waste-disposal, (iv)Governments should enforce strict regulations against dumping e-waste in .the country by outsiders. Where the laws are flouted, stringent penalties must be imposed. In particular, custodial sentences should be preferred to paltry fines, which these outsiders / foreign nationals can pay.(v) Governments should enforce strict regulations and heavy fines levied on industries, which do not practice waste prevention and recovery in the production facilities.(vi) Polluter pays principle and extended producer responsibility should be
adopted. (vii) Governments should encourage and support NGOs and other organizations to involve actively in solving the nation's e-waste problems,(viii)Uncontrolled dumping is an unsatisfactory method for disposal of hazardous waste and should be phased out. (viii)Governments should explore opportunities to partner with manufacturers and retailers to
Provide recycling services.

5.1.2 Responsibility and Role of Industries

1. Generators of wastes should take responsibility to determine the output characteristics of wastes and if hazardous, should provide management options. All personnel involved in handling e-waste in industries including those at the policy, management, control and operational levels, should be properly qualified and trained. Companies can adopt their own policies while handling wastes.

Some are given below:

- Use label materials to assist in recycling (particularly plastics).
- Standardize components for easy disassembly .Reevaluate 'cheap products' use, make product cycle 'cheap' and so that it has no inherent value that would encourage a recycling

infrastructure. Create computer components and peripherals of biodegradable materials. Utilize technology sharing particularly for manufacturing and de manufacturing. . Encourage / promote / require green procurement for corporate buyers. Look at green packaging options, companies can and should adopt waste minimization techniques which will make a significant reduction in the quantity of e-waste generated and thereby lessening the impact on the environment. It is a "reverse production" system that designs infrastructure to recover and reuse every material contained within e-wastes - metals such as lead, copper, aluminum and gold, and various plastics, glass and wire. Such a "closed loop" manufacturing and recovery system offers a wining situation for everyone - less of the Earth will be mined for raw materials and groundwater will be protected, researchers explain. Manufacturers, distributors, and retailers should undertake the responsibility of recycling/disposal of their own products. Manufacturers of computer monitors, television sets and other electronic devices containing hazardous materials must be responsible for educating consumers and the general public regarding the potential threat to public health and the environment posed by their products. At minimum, all computer monitors, television sets and other electronic devices containing hazardous materials must be clearly labeled to identify environmental hazards and proper materials management.

5.1.3 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. E-Waste Management 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. While buying electronic products opt for those that: are made with fewer toxic constituents use recycled content are energy efficient are designed for easy upgrading or disassembly .Utilize minimal packaging offer leasing or take back options have been certified by regulatory authorities. Customers should opt for upgrading their computers or other electronic items to the latestVersions rather than buying new equipments. NGOs should adopt a participatory approach in management of e-wastes.

VI. CONCLUSION

•Global life cycle of electronics with lead and cadmium in them.

•Differentiated impacts, mostly on vulnerable populations in developing countries.

India is placed in a very interesting position. The need of the hour is an urgent approach to the e-waste hazard by technical and policy-level interventions, implementation and capacity building 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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