

## Abstract

There is an urgent need for improvement in e-waste management covering technological improvement, institutional arrangement, operational plan, protective protocol for workers working in e-waste disposal and last but not the least education of general population about this emerging issue posing a threat to the environment as well as public health.

**Keyword:** Information Revolution, Devices, Hazard

## 1. Introduction

The benefits of the information revolution are clear for all to see. Devices such as PCs, faxes, mobile phones, music players and a host of others open up exciting possibilities for individuals and businesses alike. Yet there is a downside to this digital era - the growing mountain of electronic waste (e-waste). How we tackle this dilemma, will have major implications for sustainability. [1]

The situation is alarming as India generates about 1.5 lakh tones of e-waste annually and almost all of it finds its way into the informal sector as there is no organized alternative available at present. [2] Especially, metropolitan cities like Delhi, Mumbai and Bangalore are at higher risk of environmental pollution due to e-waste.

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.

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. 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.

## 2. Effect on Environment and Human Health

The amount of e-waste generated poses a grave threat to the environment as well as to public health. [4]

Workers in e-waste disposal sector are poorly protected against the risk of it. They dismantle e-waste, often by hand, in appalling conditions. About 25,000 workers are employed at scrap-yards in Delhi alone, where 10,000 to 20,000 tons of e-waste is handled every year, with computers accounting for 25 percent of it. Other e-waste scrap-yards exist in Meerut, Ferozabad, Chennai, Bangalore and Mumbai.[5]

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## 3. The 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, programmes 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.

## 4. Electronic waste substances

The hazardous substances found in the e-waste include substantial quantities of lead, cadmium, chromium and flame-retardant plastics. Cathode ray tubes and components with high

lead content are considered dangerous to health. Inhaling or handling such substances and being in contact with them on a regular basis can damage the brain, nervous system, lungs, kidneys and the reproductive system. Working in poorly-ventilated enclosed areas without masks and technical expertise results in exposure to dangerous and slow-poisoning chemicals. Due to lack of awareness, workers are risking their health and environment as well.

Several sizes of button and coin cell with 2 9v batteries as a size comparison. They are all recyclable in both the UK and Ireland since they contain lead, mercury and cadmium.

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 aluminium.

### 1. Hazardous

- Americium: smoke alarms (radioactive source).
- Mercury: fluorescent tubes (numerous applications), tilt switches (mechanical doorbells, thermostats).[33]
- Sulfur: lead-acid batteries.
- PBBs: Predecessor of PCBs. Also used as flame retardant. Banned from 1973-1977 on.
- PCBs: prior to ban, almost all 1930s-1970s equipment, including capacitors, transformers, wiring insulation, paints, inks, and flexible sealants. Banned during the 1980s.
- Cadmium: light-sensitive resistors, corrosion-resistant alloys for marine and aviation environments, nickel-cadmium batteries.
- Lead: solder, CRT monitor glass, lead-acid batteries, some formulations of PVC.[34] A typical 15-inch cathode ray tube may contain 1.5 pounds of lead,[1] but other CRTs have been estimated as having up to 8 pounds of lead.[16]
- Beryllium oxide: filler in some thermal interface materials such as thermal grease used on heatsinks for CPUs and power transistors,[35] magnetrons, X-ray-transparent ceramic windows, heat transfer fins in vacuum tubes, and gas lasers.
- Polyvinyl chloride Third most widely produced plastic, contains additional chemicals to change the chemical consistency of the product. Some of these additional chemicals called additives can leach out of vinyl products. Plasticizers that must be added to make PVC flexible have been additives of particular concern. Burning PVC in connection with humidity in the air creates Hydrogen Chloride (HCl), an acid.

### 2. Generally non-hazardous

- Tin: solder, coatings on component leads.
- Copper: copper wire, printed circuit board tracks, component leads.
- Aluminium: nearly all electronic goods using more than a few watts of power (heatsinks), electrolytic capacitors.
- Iron: steel chassis, cases, and fixings.
- Germanium: 1950s-1960s transistorized electronics (bipolar

- junction transistors).
- Silicon: glass, transistors, ICs, printed circuit boards.
- Nickel: nickel-cadmium batteries.
- Lithium: lithium-ion batteries.
- Zinc: plating for steel parts.
- Gold: connector plating, primarily in computer equipment.

#### Strategies for optimizing E-waste

Following strategies can be adopted:

- inventory management,
- production-process modification,
- volume reduction,
- recovery and reuse.
- Sustainable product design
- Recycling
- Consumer awareness efforts

### 3) Inventory management

Proper control over the materials used in the manufacturing process is an important 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 ensure that materials are ordered only on an as-needed basis and that only the amount needed for a specific period of time is ordered.

### 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. 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 optimise the use of raw materials in the production process and reduce the potential for materials to be 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.

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 process 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 or 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.

### 4) 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 2 general categories: source segregation and waste concentration. Segregation of wastes is in many cases a simple and economical technique for waste reduction. For example, an electronic component manufacturer can use compaction equipments to reduce volume of waste cathode ray-tube.

### 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 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 non-hazardous materials, such recycling is a false solution.

### 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.

### Recycling

Computer monitors are typically packed into low stacks on wooden pallets for recycling and then shrink-wrapped.[8]

Today the electronic waste recycling business is in all areas of the developed world a large and rapidly consolidating business. Part of this evolution has involved greater diversion of electronic waste from energy-intensive downcycling processes (e.g., conventional recycling), where equipment is reverted to a raw material form. This diversion is achieved through reuse and refurbishing. The environmental and social benefits of reuse include diminished demand for new products and virgin raw materials (with their own environmental issues); larger quantities of pure water and electricity for associated manufacturing; less packaging per unit; availability of technology to wider swaths of society due to greater affordability of products; and diminished use of landfills.

Audiovisual components, televisions, VCRs, stereo equipment, mobile phones, other handheld devices and computer components contain valuable elements and substances suitable for reclamation, including lead, copper and gold.

One of the major challenges is recycling the printed circuit boards from the electronic wastes. The circuit boards contain such precious metals as gold, silver, platinum, etc. and such base metals as copper, iron, aluminum, etc. Conventional method employed is mechanical shredding and separation but the recycling efficiency is low. Alternative methods such as cryogenic decomposition have been studied for printed circuit board recycling,[26] and some other methods are still under investigation.

### Consumer awareness efforts

- AddressTheMess.com is a Comedy Central pro-social campaign that seeks to increase awareness of the dangers of electronic waste and to encourage recycling. Partners in the effort include Earth911.org, ECOInternational.com, and the U.S. Environmental Protection Agency. Many Comedy Central viewers are early adopters of new electronics, and produce a commensurate amount of waste that can be directed towards recycling efforts. The station is also taking steps to reduce its own environmental impact, in partnership with NativeEnergy.com, a company that specializes in renewable energy and carbon offsets.

- The Electronics TakeBack Coalition [1] is a campaign aimed at protecting human health and limiting environmental effects where electronics are being produced, used, and discarded. The ETBC aims to place responsibility for disposal of technology products on electronic manufacturers and brand owners, primarily through community promotions and legal enforcement initiatives. It provides recommendations for consumer recycling and a list of recyclers judged environmentally responsible.[27]
- The CERTIFIED ELECTRONICS RECYCLER® program [2] for electronic recyclers is a comprehensive, integrated management system standard that incorporates key operational and continual improvement elements for quality, environmental and health and safety (QEH&S) performance.
- The grassroots Silicon Valley Toxics Coalition (svtc.org) focuses on promoting human health and addresses environmental justice problems resulting from toxins in technologies.
- Basel Action Network (BAN.org) is uniquely focused on addressing global environmental injustices and economic inefficiency of global "toxic trade". It works for human rights and the environment by preventing disproportionate dumping on a large scale. It promotes sustainable solutions and attempts to ban waste trade.
- Texas Campaign for the Environment (texasenvironment.org) works to build grassroots support for e-waste recycling and uses community organizing to pressure electronics manufacturers and elected officials to enact producer takeback recycling policies and commit to responsible recycling programs.
- The World Reuse, Repair, and Recycling Association (wr3a.org) is an organization dedicated to improving the quality of exported electronics, encouraging better recycling standards in importing countries, and improving practices through "Fair Trade" principles.

## 5. Conclusion

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