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E-WASTE MANAGEMENT

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ABSTRACT

E-waste is one of the fastest growing waste streams in developed as well as in developing countries. Due to the fact that the life span of computers has dropped in developed countries from six years in 1997 to just two years in 2005, and mobile phones have a lifespan of even less than two years, the amount of generated e-waste per year grows rapidly. This has a major impact on developing countries as loopholes in the current Waste Electrical and Electronic Equipment (WEEE) Directives allow the export of e-waste from developed to developing countries (70% of the collected WEEE ends up in unreported and largely unknown destinations).

What is e-waste?

Electronic waste (e-waste) comprises waste electronics/electrical goods that are not fit for their originally intended use or have reached their end of life. This may include items such as computers, servers, mainframes, monitors, CDs, printers, scanners, copiers, calculators, fax machines, battery cells, cellular phones, transceivers, TVs, medical apparatus and electronic components besides white goods such as refrigerators and air-conditioners. E-waste contains valuable materials such as copper, silver, gold and platinum which could be processed for their recovery.

Waste generated from the following electronic equipments is generally referred to as the E-waste:

- IT and Telecom equipments like computers, laptops, tablets and the systems used in the BPO call centres.
- Large household appliances like washing machines, microwave ovens, refrigerators, television etc
- Small household appliances like PC's, mobile phones, MP3players,I-Pods, Tablets etc

- Consumer and lighting equipments like bulbs, CFL, fluorescent tube lights. Toys, leisure and sports machines
- Medical devices like CT scan machine, MRI etc
- Monitoring and control devices

Why is E-waste growing?

E-waste is growing exponentially simply because the markets in which these products are produced are also growing rapidly as many parts of the world cross over to the other side of the 'Digital Divide'. For example, between 2000 and 2005, the Organisation for Economic Co-operation and Development (OECD) notes a 22% growth in Information and Communications Technology (ICT) in China. Furthermore, China was the 6th largest ICT market in 2006, after the US, Japan, Germany, UK and France. This is astounding when one considers that just ten years ago, under 1% of China's population owned a computer.

Rapid product innovations and replacement, especially in ICT and office equipment, combined with the migration from analogue to digital technologies and to flat-screen TVs and monitors, for example, are fuelling the increase. Additionally, economies of scale have given way to lower prices for many electrical goods, which has increased global demand for many products that eventually end up as e-waste.

How much E-waste is there?

Because so much of the planet's e-waste is unaccounted for, it is difficult to quantify e-waste amounts. Moreover, the types of e-waste included in government-initiated analyses and collection programmes vary from country to country. Under the current version of the WEEE Directive, the EU has 10 distinct product categories, whereas in North America it is typically limited to Information and Communications Technology (ICT) products and televisions and in Japan to four product categories including TVs, air conditioners, refrigerators and washing machines. The deviation in categorization of e-waste notwithstanding, reasonable estimates are in the order of 40 million tonnes p.a., which is enough to fill a line of dump-trucks stretching half way around the globe.

A recent review of European legislation on e-waste, known as the "Waste Electrical Electronic Equipment (WEEE)" Directive (mentioned earlier), highlights that in 2005 in Europe alone, there were between 8.3 and 9.1 million tonnes of e-waste, tendency rising. In Australia, with an average

of 22 electrical items per household, the Australian Bureau of Statistics has estimated that in the next two years, most of the 9 million computers, 5 million printers and 2 million scanners in Australian homes will be replaced. In the US the Environment Protection Agency (EPA) has reported that the US generated 1.9 to 2.2 million tonnes of e-waste in 2005, with only 12.5% collected for recycling.

Is e-waste hazardous?

E-waste is not hazardous *per se*. However, the hazardous constituents present in the e-waste render it hazardous when such wastes are dismantled and processed, since it is only at this stage that they pose hazard to health and environment. Electronics and electrical equipment seem efficient and environmentally- friendly, but there are hidden dangers associated with them once these become e-waste. The harmful materials contained in electronics products, coupled with the fast rate at which we're replacing outdated units, pose a real danger to human health if electronics products are not properly processed prior to disposal. Electronics products like computers and cell phones contain a lot of different toxins. For example, cathode ray tubes (CRTs) of computer monitors contain heavy metals such as lead, barium and cadmium, which can be very harmful to health if they enter the water system. These materials can cause damage to the human nervous and respiratory systems. Flame-retardant plastics, used in electronics casings, release particles that can damage human endocrine functions. These are the types of things that can happen when unprocessed e-waste is put directly in landfill.

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. 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. 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. 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 byproduct in many places throughout the world.

Components of e-waste management:

The major components of e-waste management are:

1. e-waste collection, sorting and transportation
2. e-waste recycling; it involves dismantling, recovery of valuable resource, sale of dismantled parts and export of processed waste for precious metal recovery.

The stakeholders, i.e., the people who can help in overcoming the challenges posed by e-waste, are:

- Manufacturers
- Users
- Recyclers
- Policy makers

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.

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 (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.

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.

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. 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.

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.

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.

Conclusion

Electronic equipment and therefore e-waste are everywhere in our society. They are characterized by a complex chemical composition and difficulty in quantifying their flows at a local and international level. The pollution caused by their irregular management substantially degraded the environment mostly in poorer countries, receiving them for recycling and recovery of their valuable metals. E-waste separation from the rest of solid waste and their recycling for the recovery of valuable raw materials and basic metals is essential. The management system has to be rationally designed so that the environmental benefits from the collection, transportation, management and the financial benefits from the recovery are not set-off by the required resources and energy consumptions for the system operation.

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