ABSTRACT

The hazardous content of several materials pose an environmental and health threat. Thus proper management is vital while disposing or recycling e-wastes. Disposal of e-wastes is a specific 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 e-Waste for short Electrical and Electronic Equipment is the term used to describe old, end-of-life or discarded appliances using electricity. It includes computers, consumer electronics, fridges etc which have been disposed of by their original users obtained from melting computer chips, if disposed on the ground causes acidification of soil. Producers must also take responsibility for the design and material choices that create the product in the first place. It is these choices that fundamentally determine the weight and recycling value of material waste at the end of a product’s life. The iMac is a world-class example of material efficiency, having shed 60% of its weight since its debut in 1998. In spite of the E-waste management need, the illegal export of E-waste to African and Asian countries hinder the growth of this market. However, the drastic and consistent growth of E-waste will continue to create demand.

KEY WORDS

E-waste, environment, re-cycling, Wipro, Material efficiency, Lead, Electronic goods, waste disposal, chromium, battery, etc.
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.

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. Thus proper management is necessary while disposing or recycling e-wastes.

E-Waste at the Global Level

- Due to projected increases in electronic waste (e-waste) and lax enforcement of regulations, it is likely that hazardous shipments of e-waste to China and India will increase over the next three years, while Nigeria will increasingly become a dumping ground for the hazardous material.
- Currently, companies export 80 percent of the world's electronic trash to Asia, and 90 percent of this flows into China, according to a BBC report. Environmentalists in China have begun to give opinion about the large quantities of e-waste that wealthy countries continue to dump in the developing world.
- E-waste is the electronic good that is near or at the end of its useful life. Certain components of electronic products contain materials that render them hazardous, and include heavy metals such as lead, cadmium, mercury and arsenic. Many of these elements are extremely valuable, such as gold and platinum, while the majority of them are non-renewable.

PROBLEMS DUE TO E-WASTE

- People lack the necessary skills and adequate equipment to carry out e-waste recycling, thus endangering their well-being and exposing the local environment to harmful substances.
- Some of the health effects arise from toxic e-waste chemicals include damage to the central and peripheral nervous systems, blood system and kidneys as well as serious negative effects on the endocrine system and children's brain development.
- 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.
- This is due to disposal of recycling wastes such as acids, sludges etc. in rivers.
Table I: Effects of E-Waste constituent on health.

<table>
<thead>
<tr>
<th>Source of e-Wastes</th>
<th>Constituent</th>
<th>Health effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solder in printed circuit boards, glass panels and gaskets in computer monitors</td>
<td>Lead (PB)</td>
<td>Damage to central and peripheral nervous systems, blood systems and kidney damage. Affects brain development of children.</td>
</tr>
<tr>
<td>Relays and switches, printed circuit boards</td>
<td>Mercury (Hg)</td>
<td>Chronic damage to the brain. Respiratory and skin disorders due to bioaccumulation in fishes.</td>
</tr>
<tr>
<td>Corrosion protection of untreated and galvanized steel plates, decorator or hardener for steel housings</td>
<td>Hexavalent Chromium (Cr) VI</td>
<td>Asthmatic bronchitis. DNA damage.</td>
</tr>
<tr>
<td>Cabling and computer housing</td>
<td>Plastics including PVC</td>
<td>Burning produces dioxin. It causes: Reproductive and developmental problems; Immune system damage; Interfere with regulatory hormones</td>
</tr>
<tr>
<td>Front panel of CRTs</td>
<td>Barium (Ba)</td>
<td>Short term exposure causes: Muscle weakness; Damage to heart, liver and spleen.</td>
</tr>
<tr>
<td>Motherboard</td>
<td>Beryllium (Be)</td>
<td>Carcinogenic (lung cancer) Inhalation of fumes and dust. Causes chronic beryllium disease or berylliosis. Skin diseases such as warts.</td>
</tr>
</tbody>
</table>

A set of interrelated and mutually supportive strategies are proposed to support the concrete implementation of the activities are described below:

1. 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.

3. 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.

4. To motivate selective partners among various stakeholders to bring added value to making progress in the short-term.

5. 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).

6. To undertake periodic review of activities in relation to the agreed indicators;

7. To collaborate with existing institutions and programmes to promote better use of cleaner technology and its transfer, methodology, economic instruments or policy to facilitate or support capacity-building for the environmentally sound management of hazardous and other wastes.

E-WASTE – CAUSES

All the components that comprise an electrical or electronic product when it is being discarded are termed as Electronic waste.

These products could be Computers, Televisions, Stereos, Photo Copiers, fax machines and other electronic products.

These components are recycled, resold or reused. These products comprises of elements like lead, tin, copper, aluminum, cadmium, beryllium, iron, zinc, gold, mercury, sulphur, carbon, polychlorinated biphenyls etc.

The advancement of computing and the increase in the usability of electronic gadgets have trigged the conventional disposal of electronic products widely.

The harmful components that this e-waste comprises have high lightened the issue of proper disposal of these products which is in itself a huge task.

The methods of handling this e-waste have not been standardized worldwide but different countries are following different strategies to tackle the related issues.

The mode of recycling this e-waste is difficult and costly and in many parts of the world export of this waste is not being considered illegal.

The developing nations like India, China and Kenya are among those countries that import this e-waste and earn profits.

RESTRICTION OF HAZARDOUS SUBSTANCES DIRECTIVES

Electronic products are made from valuable resources and materials, including metals, plastics, and glass, all of which require energy to mine and manufacture. Donating or recycling consumer electronics conserves our natural resources and avoids air and water pollution, as well as greenhouse gas emissions that are caused by manufacturing virgin materials.

Each European Union member state will adopt its own enforcement and implementation policies using the directive as a guide.

RoHS is often referred to (inaccurately) as the lead-free directive, but it restricts the use of the following six substances:

1. Lead (Pb)
2. Mercury (Hg)
3. Cadmium (Cd)
4. Hexavalent chromium (Cr\textsuperscript{6+})
5. Polybrominated biphenyls (PBB)
6. Polybrominateddiphenyl ether (PBDE)

PBB and PBDE are used in several plastics. Hexavalent chromium is used in chrome plating, chromate coatings and primers, and in chromic acid.

The maximum permitted concentrations in products that are not exempted are 0.1% or 1000 ppm, (except for cadmium, which is limited to 0.01% or 100 ppm) by weight. The restrictions are on each homogeneous material in the product, which means that the limits do not apply to the weight of the finished product, or even to a component, but to any single substance that could (theoretically) be separated mechanically—for example, the sheath on a cable or the tinning on a component lead.

**EXAMPLE**

1. A radio is composed of a case, screws, washers, a circuit board, speakers, etc. The screws, washers, and case may each be made of homogenous materials, but the other components comprise multiple sub-components of many different types of material.

2. A circuit board is composed of a bare resistors, capacitors, switches, etc. A switch is composed of a case, a lever, a spring, contacts, pins, etc., each of which may be made of different materials. A contact might be composed of a copper strip with a surface coating.

3. A speaker is composed of a permanent magnet, copper wire, paper, etc.

Everything that can be identified as a homogeneous material must meet the limit. So if it turns out that the case was made of plastic with 2,300 ppm (0.23%) PBB used as a flame retardant, then the entire radio would fail the requirements of the directive.

In an effort to close RoHS loopholes, in May 2006 the European Commission was asked to review two currently excluded product categories (monitoring and control equipment, and medical devices) for future inclusion in the products that must fall into RoHS compliance. In addition the commission entertains requests for deadline extensions or for exclusions by substance categories, substance location or weight. New legislation was published in the official journal in July, 2011 which supersedes this exemption.

Note that batteries are not included within the scope of RoHS. However, in Europe, batteries are under the European Commission's 1991 Battery Directive (91/157/EEC), which was recently increased in scope and approved in the form of the new battery, version 2003/0282 COD, which will be official when submitted to and published in the EU's Official Journal.

While the first Battery Directive addressed possible trade barrier issues brought about by disparate European member states' implementation, the new directive more explicitly highlights improving and protecting the environment from the negative effects of the waste contained in batteries.
It also contains a program for more ambitious recycling of industrial, automotive, and consumer batteries, gradually increasing the rate of manufacturer-provided collection sites to 45% by 2016. It also sets limits of 5 ppm mercury and 20 ppm cadmium to batteries except those used in medical, emergency, or portable power-tool devices.

Though not setting quantitative limits on quantities of lead, lead-acid, nickel, and nickel-cadmium in batteries, it cites a need to restrict these substances and provide for recycling up to 75% of batteries with these substances.

There are also provisions for marking the batteries with symbols in regard to metal content and recycling collection information.

The directive applies to the following numeric categories:

1. Large household appliances.
2. Small household appliances.
3. IT & Telecommunications equipment (although infrastructure equipment is exempt in some countries)
4. Consumer equipment.
5. Lighting equipment—including light bulbs.
6. Electronic and electrical tools.
7. Toys, leisure, and sports equipment.
8. Medical devices (exemption removed in July 2011)
9. Monitoring and control instruments (exemption removed in July 2011)
10. Automatic dispensers.
11. Semiconductor devices

It does not apply to fixed industrial plant and tools. Compliance is the responsibility of the company that puts the product on the market, as defined in the Directive; components and sub-assemblies are not responsible for product compliance. Of course, given the fact that the regulation is applied at the homogeneous material level, data on substance concentrations needs to be transferred through the supply chain to the final producer.

An IPC standard has recently been developed and published to facilitate this data exchange, IPC-1752. It is enabled through two PDF forms that are free to use.

RoHS applies to these products in the EU whether made within the EU or imported. Certain exemptions apply, and these are updated on occasion by the EU.

EXAMPLES OF PRODUCT COMPONENTS CONTAINING RESTRICTED SUBSTANCES:

RoHS restricted substances have been used in a broad array of consumer electronics products. Examples of leaded components include:

- Paints And Pigments
- PVC (Vinyl) Cables As A Stabilizer (E.G., Power Cords, USB Cables)
- Solders
- Printed Circuit Board Finishes, Leads, Internal And External Interconnects
- Glass In Television And Photographic Products (E.G., CRT Television Screens And Camera Lenses)
E-Waste Management – A Bird’s View
– Mrs. R. Sangeetha and Mr. C. Samuel

- Metal Parts
- Lamps And Bulbs
- Batteries

Cadmium

Cadmium is found in many of the above components; examples include plastic pigmentation, batteries with nickel – cadmiums and photocells (used in night lights).

Mercury is used in lighting applications and automotive switches; examples include fluorescent lights (used in laptops for backlighting) and light switches with mercury (these are rarely used nowadays).

Chromium

Hexavalent chromium is used for metal finishes to prevent corrosion. Polybrominated biphenyls and diphenyl Ethers/Oxides are used primarily as flame retardants.

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E-WASTE – APPLE CASE

THE GREENER APPLE

Apple has been criticized by some environmental organizations for not being a leader in removing toxic chemicals from its new products, and
for not aggressively or properly recycling its old products.

- Upon investigating Apple’s current practices and progress towards these goals, everyone was surprised to learn that in many cases Apple is ahead of, or will soon be ahead of, most of its competitors in these areas.
- Whatever other improvements we need to make, it is certainly clear that they have failed to communicate the things that we are doing well.
- It is generally not Apple’s policy to trumpet their plans for the future; Apple tends to talk about the things they have just accomplished.
- Unfortunately this policy has left our customers, shareholders, employees and the industry in the dark about Apple’s desires and plans to become greener.
- The stakeholders deserve and expect more from us, and they’re right to do so.

REMOVING TOXIC CHEMICAL

- Many of the dangerous chemicals all they want to eliminate from electronic products are found in very small amounts, but there’s one toxic substance that some companies still ship by the pound, and that’s the lead contained in their cathode-ray tube (CRT) displays.
- A typical CRT contains approximately 3 pounds (1.36 kg) of lead. In mid-2006, became the first company in the computer industry to completely eliminate CRTs.
- The effect has been stunning — our first CRT-based iMac contained 484 grams of lead; our current third-generation LCD-based iMac contains less than 1 gram of lead.
- The European Union is generally ahead of the U.S. in restricting toxic substances in electronic products.
- Their latest restrictions, known as RoHS, went into effect in July 2006.
- All Apple products worldwide comply with RoHS.
- The manufacturing policies had already restricted or banned most of the chemicals covered by RoHS, and Apple began introducing fully RoHS-compliant products a year before the European deadline.

RECENT TRENDS

- Some companies have made promises to phase out other toxic chemicals like polyvinyl chloride (PVC), a type of plastic primarily used in the construction industry but also found in computer parts and cables, and brominated flame retardants, or BFRs, which reduce the risk of fire.
- For the past several years, companies have been developing alternative materials that can replace these chemicals without compromising the safety or quality of our products.
- Today, they have successfully eliminated the largest applications of PVC and BFRs in our products, and we’re close to eliminating these chemicals altogether.

EXAMPLE

- More than three million iPods have already shipped with a BFR-free laminate on their logic boards.
In one environmental group’s recent scorecard, Dell, HP and Lenovo all scored higher than Apple because of their plans (or “plans for releasing plans” in the case of HP).

In reality, Apple is ahead of all of these companies in eliminating toxic chemicals from its products.

E – WASTE RECYCLING

Recycling E-waste is a complicated process; it is stripped apart by hand and put through several delicate processes in order to recover 95-98% of materials from the electronic waste.

The raw material that remains, such as glass, copper, plastics and metals, can then be put to good use instead of wasting valuable land space and contaminating the environment.

The diagram below gives a better idea of what happens once we collect electronic waste from the offices and homes.
E-Waste Management by WIPRO

The Environment Management Team at Wipro has been leading the E-waste initiatives since August 2005 and they continue this venture of making our environment a safer and greener place.

As a commitment towards IPR and EPR, Wipro has volunteered to take full responsibility - both physical and financial - towards recycling e-waste of all Wipro products.

Over the last 4 years, they have defined and redefined the process, identified suitable recycling mechanisms, created service points across the country, identified technically competent recycling agencies and setup a process for recycling of E-waste.

Wipro also actively encourages usage of environment friendly electronic products and promotes the usage of e-waste recycling services through various marketing and communication program.

They can also call Wipro representatives in respective locations for pickup. They have identified partners who will help in the recycling of e-waste.

It also provides the clarification on documentation control needed to ensure compliance to the standards prescribed by statutory pollution control authorities, if required.

E - Waste Recycling Process by WIPRO

Wipro undertakes to do the following to help in recycling.

- To collect the discarded systems from customers on behalf of the recycling agency.
- Provide the discarded computers to vendors certified by Pollution control board to recycle the parts.
- Ensure collection and transport of systems from customer to final waste recycling point. This support is limited to recycling of e-waste related to products being retired by the customer.
- Monitor the recycling of e-wastes by agency according to guidelines given by the relevant pollution control boards.
- To ensure compliance to standards set by Pollution Control Board.
- To collect documentary proof that these items have been recycled in a safe manner by the vendor as recommended by Pollution control board.
- Contact centers or delivers the e-waste to one of the 19 locations.
- To acknowledge the receipt of e-waste to customer.
- To ensure delivery of e-waste to disposal agencies certified by pollution control board.
- To monitor the disposal of e-waste by disposal agency (in eco friendly way) and shares the proof of disposal with customer.
Recycling Of Products (E-Waste)

Apple's Weight Recycled as % of Past Sales

A note of comparison — the latest figures from HP and Dell are each around 10% per year, and neither company has yet disclosed plans to grow this percentage in the future. By 2010, Apple may be recycling significantly more than either Dell or HP as a percentage of past sales weight.

Producers must also take responsibility for the design and material choices that create the product in the first place. It is these choices that fundamentally determine the weight and recycling value of material waste at the end of a product’s life. The iMac is a world-class example of material efficiency, having shed 60% of its weight since its debut in 1998. Our designs use aircraft-grade aluminum, stainless steel and high-grade plastics that are in high demand from recyclers, who recover and resell these raw materials for use in other types of products. Few of our competitors do the same.

Apple products are designed using high quality materials that are in high demand from recyclers.

E- WASTE IN FUTURE

The E-waste Management market is expected to grow at a CAGR of 9.2 percent. The environment is currently driven by the huge volumes of toxins from E-waste polluting the environment.

Toxins from disposed electronic gadgets are becoming a critical environmental issue. There has been an increasing awareness among end users about the harmful effects of these toxins. As a result there has been a growing demand
for E-waste Management, reports Technavio analyst.

CONCLUSION

In spite of the need, the illegal export of E-waste to African and Asian countries, hinder the growth of this market. However, the drastic and consistent growth of E-waste will continue to create demand.

The E-waste Management market is marked by developing countries taking stringent measures to control these toxins. This makes the study an important one for companies to fully understand the potential in the market and formulate its own strategy.

As per the Global E-waste Market Report (2010-2014), on an extensive research from inputs by industry experts, vendors and end-users. It examines the factors- including the key trends, drivers and challenges, impacting the evolution of this market.

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