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Electronics-waste Management

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Abstract

As far as e-waste is concerned, it has emerged as one of the fastest growing waste streams world-wide today. The sheer amount of electronic equipments reaching end-of-life poses a huge challenge. It is currently estimated that India produces some 3.8 lakh tonnes of e-waste annually. However, the existing management practices related to E-waste in India are reasonably poor and have the potential to risk both human health and the environment. Moreover, the policy level initiatives are not being implemented in an appropriate way. The austere problem of E-waste along with its policy level implications is looked upon in the paper. During the course of the study it has been found that there is an urgent need to address the issues related to E-waste in India in order to avoid its detrimental future consequences. We reviewed current evidence regarding the recycling conditions in communities of developing countries, and identified major environmental toxicants relevant to community exposure. We summarized the exposure levels to lead (Pb), cadmium (Cd), chromium (Cr), etc in the e-waste recycling communities compared with unexposed communities. We examined the current literature about existing technologies and methodologies in various countries which are present or can be adopted. The current study also shows the scenario of INDIA in comparison with rest of the world and the suggestions which can be implemented easily without any heavy finance or restriction to make the country green and clean.

1. Introduction

In the past decade, technological advances in electronic data management and communications have spurred economic growth and improved people's lives in countless ways. However, our growing dependence on electronic products both at home and in the workplace has given rise to a new environmental challenge: electronics waste.

A recent study by EPA shows that electronics already make up approximately 1 percent of the municipal solid waste stream. Research completed in Europe shows that electronics waste is growing at three times the rate of other municipal waste. To the extent possible, electronics waste should be prevented, and older electronics should be reused and recycled.

2. E-waste

E-waste consists of all waste from electronic and electrical appliances which have reached their end- of- life period or are no longer fit for their original intended use and are destined for recovery, recycling or disposal. It includes computer and its accessories, typewriters, mobile phones, remotes, compact discs, headphones, batteries, LCD/Plasma TVs, air conditioners, refrigerators and other household appliances [1].

2.1 E-waste in India

According to the Comptroller & Auditor-General's report, over 7.2 MT of industrial hazardous waste, 4 lakh tonnes of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medical waste, 48 MT of municipal waste are generated in the country annually. In 2005, the Central Pollution Control Board (CPCB) estimated India's e-waste at 1.47 lakh tonnes or 0.573 MT per day [2]. The CPCB has estimated that it will exceed the 8 lakh tonnes or 0.8 MT mark by 2013.

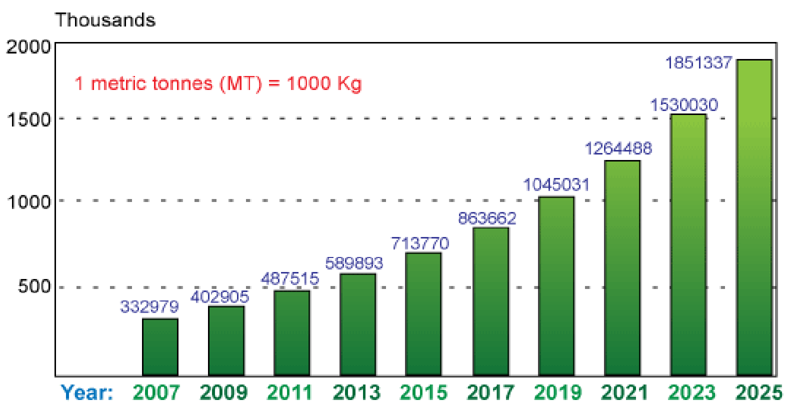

Figure 1: Growth of E-waste in India.

3. Necessity for Preventing Electronics Waste

3.1.1 Are a fast-growing waste stream

Over 20 million personal computers became obsolete in 1998. Only 13 percent were reused or recycled. Many municipalities are facing the dilemma of what to do with growing amounts of retired electronics. Rapid changes in computer technology and the emergence of new electronic gadgets exacerbate the problem.

3.1.2 Can contain hazardous materials

There are hazardous materials, such as lead, mercury, and hexavalent chromium, in circuit boards, batteries, and color cathode ray tubes (CRTs). Televisions and CRT monitors contain four pounds of lead, on average (the exact amount depends on size and make). Mercury from electronics has been cited as a leading source of mercury in municipal waste. In addition, brominated flame retardants are commonly added to plastics used in electronics. If improperly handled, these toxics can be released into the environment through incinerator ash or landfill leachate [3].

Table 1: Impact of hazardous substances on health and environment.

Element	**Effect**
Lead	A neurotoxin that affects the kidneys and the reproductive system. It affects mental development in children.
Plastics	Dioxins can harm reproductive and immune systems. Burning PVC, a component of plastics, also produces dioxins. BFR can leach into landfills.
Chromium	Inhaling hexavalent chromium or chromium 6 can damage liver and kidneys and cause bronchial maladies including asthmatic bronchitis and lung cancer.
Mercury	Affects the central nervous system, kidneys and immune system. It impairs foetus growth and harms infants through mother's milk.
Beryllium	It is carcinogenic and causes lung diseases.
Cadmium	Long-term exposure causes Itai-itai disease, which causes severe pain in the joints and spine. It affects the kidneys and softens bones.
Acid	Fumes contain chlorine and sulphur dioxide, which cause respiratory problems. They are corrosive to the eye and skin.

3.1.3 Are made with valuable materials

In 1998, over 112 million pounds of materials were recovered from electronics, including steel, glass, and plastic, as well as precious metals. Reusing and recycling the raw materials from end-of-life electronics conserves natural resources and avoids the air and water pollution, as well as greenhouse gas emissions, that are caused by manufacturing new products.

3.1.4 Data Security

3.1.4.1 Insuring all data storage devices and media in all electronics are completely sanitized as they contain critical personal, financial, legal, technical, operational, and classified information.

3.1.4.2 Insuring all data sanitation is fully documented and auditable.

4. Reduce Electronics Waste

4.1 Reusing and Donating Electronics

Preventing waste in the first place is usually preferable to any 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. Reuse, in addition to being an environmentally preferable alternative, also benefits society. As a household or a business, you may be able to take advantage of tax incentives for computer equipment donations.

4.2 Recycling Electronics

If donation for reuse is not a viable option, households and businesses can send their used electronics for recycling. Recycling electronics avoids pollution and the need to extract valuable and limited virgin resources. It also reduces the energy used in new product manufacturing.In addition, public and private organizations have emerged that accept computers and other electronics for recycling [4].

4.3 Buying Green

Environmentally responsible electronics use involves not only proper end-of-life disposition of obsolete equipment, but also purchasing new equipment that has been designed with environmental attributes.

Look for electronics 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 and have been recognized by independent certification groups as environmentally preferable.

5. Final Metal Recovery

The **final metals recovery** from output fractions after pre-treatment takes place at three main destinations. Ferrous fractions are directed to steel plants for recovery of iron, aluminium fractions are going to aluminium smelters, while copper/lead fractions, circuit boards and other precious metals containing fractions are going to e.g. integrated metal smelters, which recover precious metals, copper and other non-ferrous metals, while isolating the hazardous substances[5].

Table 2: Separation and dismantling criteria for e-waste.

	Desired treatment/ action
1. Separate before treatment	
a) Toxic/hazardous materials	
Cooling fluids and foam	Controlled removal and disposal
Mercury backlights	Controlled depot
PCB capacitors	Controlled depot
Batteries	Sort and process in specialized plants
b) High value materials	
Reusable components	Refurbish and sell
Circuit boards (high and medium grade)	Process in integrated non-ferrous/copper smelters
Circuit boards (low grade)	Upgrade (manually) and process in integrated smelters
2. Dismantle, liberate, sort	
Clean plastics	Process further with appropriate technologies
(CRT) glass	Process further with appropriate technologies; glass to glass producer, CRT glass to CRT glass producer or lead smelter
Ferrous metals	To integrated steelmaking facility or to steel scrap remelter (electric arc furnace)
Non-ferrous metals Al, Mg	To secondary aluminium or magnesium remelter or other appropriate technology
Non-ferrous metals Cu, Pb, Sn, Ni, PM	Process further with appropriate technologies
Others	Process further with appropriate technologies

6. End-processing technologies

For the end-processing of the material fractions from ICT, C&F and CRT appliances a distinction has to be made between different material streams. Each material stream has a specific set of technologies that can be used to recover the metals.

6.1 Pyrometallurgy

Which use high temperatures to chemically convert the feed materials and separate metals and impurities into different phases so valuable metals can be recovered. The high temperatures in the furnace or smelter are generated via the combustion of fuel or via electrical heating. Example electric arc furnaces etc.

6.2 Hydrometallurgy,
Which use strong acidic or caustic watery solutions to selectively dissolve and precipitate metals e.g. leaching, cementation, solvent extraction etc.

6.3 Electro-metallurgy,
Which use electrical current to recover metals, e.g. electro-winning and electro-refining of copper, zinc etc.

Smelter, blast furnace, lead refinery use pyrometallurgy unit operations; leaching, special metals and nickel refinery use hydrometallurgy unit operations and the precious metal refinery uses both hydro- and pyrometallurgy unit operations.

7. Comparative analysis and classification of countries

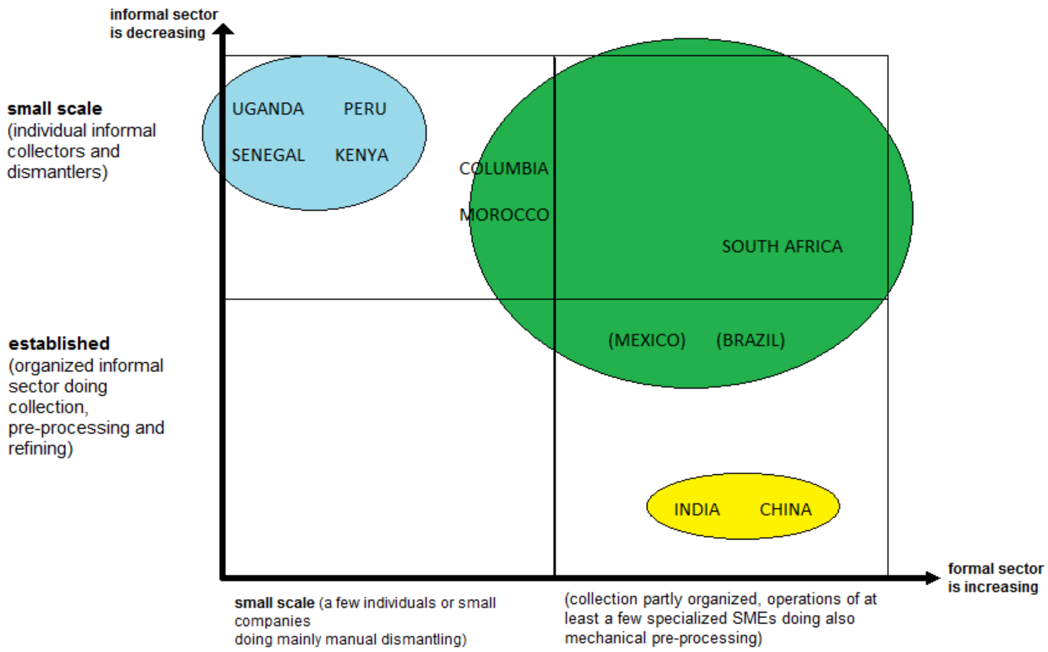

Figure 2: Comparision between different countries [6],[7].

Group A (Kenya, Uganda, Senegal, Peru)
This group includes countries featuring the formal and informal sector on a small scale. As e-waste volumes also increase over time, those countries typically could move towards more informal activities if appropriate measures are not taken. Group A is classified as promising for the introduction of pre-processing technologies with a strong support in capacity building.

Group B (India, China)
This group includes countries featuring an established informal and formal sector. E-waste volumes are large and in turn a well-organized informal sector was formed. Group B is classified as having a significant potential for the introduction of pre- and end-processing technologies with a strong support in capacity building in the informal sector.

Group C (South Africa, Morocco, Colombia, Mexico, Brazil9)
This group includes countries featuring a currently developing or already established formal recycling sector, while informal activities remain on a small or medium scale. Group C is classified as having a significant potential to adapt pre- and to some extent end-processing technologies to their own needs, following a technology and knowledge exchange.

8. Conclusion

The quantum of wastes generated over the past several years have posed an ever increasing threat to environment and public health. Over eighty-eight critically polluted industrial zones have been identified by the CPCB. Due to the early stage of awareness for e-waste recycling in emerging economies, innovation hubs and centres of excellence have not been established yet[8].

8.1 Identification of barriers for the transfer of sustainable e-waste recycling technologies (India)

8.1.1 Policy and Legislation

India currently does not have any dedicated legislation dealing with e-waste, Laws having a bearing on e-waste include topics like the environment, water, air, municipal waste and hazardous waste. E-waste handling is currently regulated under the Hazardous Waste Management and handling rules, Application procedures to obtain export licenses for the shipment of some special fractions of e-waste to state-of-the art smelters abroad are unclear, Application of the Basel Convention is unclear, High level of corruption in law enforcement, No definition of roles and responsibilities of stakeholders.

8.1.2 Technology and Skills

E-waste recycling sector dominated by the informal sector. Low technologies are applied by low-skilled workers, resulting in high health and environment risks, including open-sky incineration and wet chemical leaching of metals, No proper solution for hazardous fractions contained in e-waste.

8.1.3 Business and Financing

Logistics, especially collection and transport, are the main challenge for the formal recycling sector, Difficulties to access the materials and direct competition with the informal sector, All costs, including collection, transport, disposal of hazardous fractions at the charge of the recyclers, No secure financing of non-profitable recycling operations.

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