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Electronic Waste Management- A Challenge for Contemporary India

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Abstract
The tremendous growth and technological advancements in the electronic data and communications have spurred economic growth and improved living standards. However the dependence on electronic products has given rise to a new area of concern i.e. electronic waste. It is hazardous, complex and expensive to treat in an environmentally sound manner and there is a general lack of legislation or enforcement surrounding it. Today, mostE-waste is being discarded in the general waste stream of the e-waste in developedCountries that are sent for recycling, 80 per cent ends up being shipped (often illegally) to developing countries to be recycled by hundreds of thousands of informal workers. In India e-waste generation rate is 15% increase and to cross 800,000 tons in 2012.This paper tries to quantify the amount of E-waste generated in India, discussthe Global and Indian E-waste scenario, best available practices to find the hazardous material in e-waste and public awareness about the proper disposal of e-waste.

Introduction

What is E- Waste?

E-waste for short –or Waste Electrical and Electronic Equipment (WEEE) is any refuse created by discarded electronic devices and components as well as substances involved in their manufacture or use.

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Categories of e-waste:-

Large Household Appliances
Washing machines, Dryers, Refrigerators, Air-conditioners, etc.

Small Household Appliances
Vacuum cleaners, Coffee Machines, Irons, Toasters, etc.

Office, Information & Communication Equipment
PCs, Laptops,Mobiles, Telephones, Fax Machines, Copiers, Printers etc.

Entertainment & Consumer Electronics
Televisions, VCR/DVD/CD players, Hi-Fi sets, Radios, etc.

Electric and Electronic Tools
Drills, Electric saws, Sewing Machines, Lawn Mowers etc.

Medical Instruments and Equipment

Surveillance and Control Equipment

Automatic Issuing Machines

Possible hazardous components present in E-waste equipment

Components	*Possible Hazardous content*
Metal	
Motor/ Compressor	
Plastic	Phthalate plasticize, BFR
Cooling ODS	ODS
Insulation	Insulation ODS in foam, asbestos, refractory ceramic fibres.
Glass	
CRT	Lead, Antimony, Mercury, Phosphors
Rubber	Phthalate plasticizer, BFR
LCD	Mercury
Wiring/ Electrical	Phthalate plasticizer, Lead, BFR
Concrete	
Transformer	
Circuit Board	Lead, Beryllium, Antimony, BFR

Fluorescent lamp	Mercury, Phosphorus, Flame Retardants
Heating element	
Thermostat	Mercury
BFR- containing plastic BFR's	BFR
Batteries	Lead, Lithium, Cadmium, Mercury
CFC, HCFC, HFC, HC	Ozone depleting substances
External Electrical Cables	BFRs, plasticizers
Electrolyte Capacitors(over L/D 25mm)	Glycol, other unknown substances

E-waste generation in India

All over the world, the quantity of electrical and electronic waste generated each year, especially computers and televisions, has assumed alarming proportions. In 2006, the InternationalAssociation of Electronics Recyclers (IAER)8 projected that3 billion electronic and electrical appliances would become WEEEor e-waste by 2010. That would tantamount to an averagee-waste generation rate of 400 million units a year till 2010.Globally, about 20-50 MT (million tonnes) of e-wastes are disposedoff each year, which accounts for 5% of all municipal solid waste.

Although no definite official data exist on how much waste is generated in India or how much is disposed of, there are estimations based on independent studies conducted by the NGOs or government agencies. According to the Comptroller and Auditor- General's (CAG) 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.10 In 2005, the Central Pollution Control Board (CPCB) estimated India's e-waste at 1.47 lakh tonnes or 0.573 MT per day.11 A studyreleased by the Electronics Industry Association of India (ELCINA) at the electronics industry expo – "ComponexNepcon 2009" had estimated the total e-waste generation in India at a whopping 4.34 lakh tonnes by end 2009.12 The CPCB has estimated that it will exceed the 8 lakh tonnes or 0.8 MT mark by 2012.

There are 10 States that contribute to 70 per cent of the total e-waste generated in the country, while 65 cities generate more than 60 per cent of the total e-waste in India. Among the 10 largest e-waste generating States, Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab.

These statistics were taken in census 2012 depicts the city-wise e-waste generation in India.

It is very clear from the recent statistics that metropolitans such as Mumbai and Delhi are the largest e-waste producing cities.

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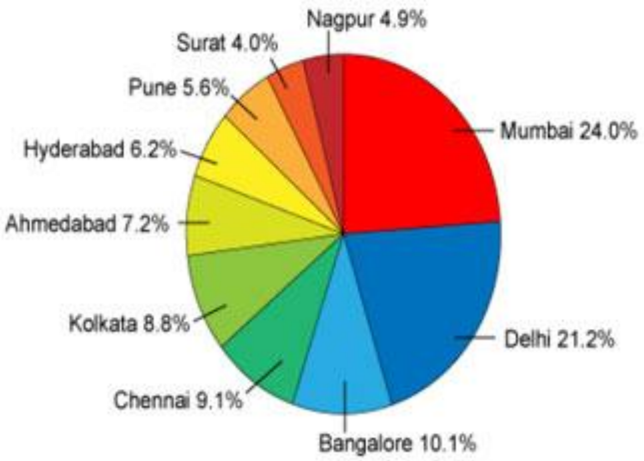

City-wise E-waste Generation in India (Tonnes/year)

Source: Department of Information Technology Chart: CopperBridge Media

Import of E-waste into India

The country has been one of the main destinations of used EEE and WEEE from OECD countries with an estimated 50 K tonnes of WEEE imported every year (Manomaivibool, 2009). Same figure was depicted by GTZ-MAIT (2007) which estimates that about 50,000 tonnes of WEEE were imported to India every single year. India is becoming a big market for imported E-waste. PCs imported to Delhi in 2003 were nearly 3,600, 000 kg per year and studies predict that the nearly 50,000 to 70,000 tonnes of E-waste is being imported annually to India (Chaterjee and Kumar, 2009). A study limited to an examination of computers, mobile phones and televisions reckoned that 382,979 tonnes (t) of E-waste were generated in 2007, 50,000 t (approximately 13%) of which were imported illegally (Skinner, 2010). Of the E-waste imported into India, it is estimated that approximately 80% is imported from the US, while the remaining 20% is predominantly imported from the EU (Skinner, 2010). Nonetheless, as the import of E-waste is illegal and E-waste is often shipped via third countries, it is unrealistic to expect these statistics to be exact. Anecdotal evidence on E-waste exported by USA to Asia reveals that substantial percentages of their E-waste moves quickly off-shore. What cannot be recycled readily or economically is sent to markets in Asia. In a report by Toxics Link (2004), at the recycling units in New Delhi (India) itself, 70% of the total electronic waste collected was actually exported or dumped by developed countries (Toxic Link, 2004). Most developed countries, find it financially profitable to send E-waste for reuse or recycling in developing countries (ibid). It is because the cost of recycling of a single computer in the United States is $ 20 while the same could be recycled in India for only US $ 2, a gross saving of US $ 18 if the computer is exported to India.

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Hence it can be easily interpreted that the import of E-waste by some of the developing countries like China and India is a major concern. Over the last few decades, India has become a major destination for E-waste exports from the developed nations. Huge quantities of E-waste like monitors, printers, keyboards, CPUs, typewriters, projectors, mobile phones, PVC wires, etc are imported to India from OECD countries in the names of charitable or reusable items.

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Are present E-waste Management techniques sufficient? And moreover are they 'Sustainable'?

What are the present methods?
In India, primarily two types of disposal options based on the composition are in practice. These are Landfilling and Incineration.

Landfilling

The environmental risks from landfilling of E-waste cannot be neglected because the conditions in a landfill site are different from a native soil, particularly concerning the leaching behaviour of metals. In addition it is known that cadmium and mercury are emitted in diffuse form or via the landfill gas combustion plant. Although the risks cannot be quantified and traced back to E-waste, landfilling does not appear to be an environmentally sound treatment method for substances, which are volatile and not biologically degradable (Cd, Hg, CFC), persistent (PCB) or with unknown behaviour in a landfill site (brominated flame retardants). As a consequence of the complex material mixture in E-waste, it is not possible to exclude environmental (long-term) risks even in secured landfilling.

Incineration

Waste destruction in a furnace by controlled burning at high temperatures. Incineration removes water from hazardous sludge, reduces its mass and/or volume, and converts it to a non-burnable ash that can be safely disposed of on land, in some waters, or in underground pits. However, it is a highly contentious method because incomplete incineration can produce carbon monoxide gas, gaseous dioxins, and or other harmful substances.

However the only advantage of incineration of E-waste is the reduction of waste volume and the utilization of the energy content of combustible materials. By incineration some environmentally hazardous organic substances are converted into less hazardous compounds. Disadvantage of incineration are the emission to air of substances escaping flue gas cleaning and the large amount of residues from gas cleaning and combustion. Waste incineration plantscontribute significantly to the annual emissions of cadmium and mercury.

Recycling of E-waste in India

The recycling system of India is basically divided into two sectors:

- *Informal Recyclers*
- *Formal Recyclers*

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Informal Recycling

In India, informal waste pickers contribute significantly to e-waste management and resource efficiency by collecting, sorting, trading and sometimes even processing waste materials. These activities also provide an income opportunity for large number of poor people. The workers here have great potential to organise door-to-door collection, cannibalise material, reduce waste destined for disposal, and generate employment potential that could be tapped by organising and formalising their activities. The informal sector, despite their marginalised position and their simple equipments, often recover a lot of material, but their recovery rates are still not very efficient.

Several studies have shown that these informal recycling activities have some positive effects on the environment by virtue of reducing the waste destined for landfills and thereby reducing the costs of waste management systems. Such activities also provide income opportunities for the poor. E-waste is one of the most critical waste streams globally, due to the burgeoning volume and the toxicity concerns. **In India, the informal sector is estimated to be handling around 95% of the e-waste recycled.** Due to its wide reach, the informal sector is able to collect e-waste from numerous sources, covering almost all segments of consumers. The operations of the sector also prevented lot of this toxic waste from being dumped into landfills at a time when the formal recycling infrastructure was non-existent in the country.

Waste hierarchy in the informal sector

Some of the challenges faced by the informal sector involved in e-waste recycling are as follows:

- Lack of education, training and professional skills
- Lack of access to technology
- Lack of government support

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- Limited access to finance
- Volatility of the waste market
- Threats/demand for bribery by local administration.

Occupational hazards in informal recycling:

End-of-life process	Occupational Risks	Environmental Risks
Collection and dismantling	Dust containing various compounds during dismantling activities, e.g., Pb and Ba-oxide from broken CRTs. Cuts from CRT glass. Volatile compounds (incl. Hg) from broken components.	Emission of dust and fumes containing various metals (e.g. Pb, Zn,Cu, Sn, Sb, Cd, Ni, Hg) and organic compounds (e.g. BFRs) to the local environments
PC-board heating	Exposure to fumes of various compounds from solder and PC-board components (e.g. Pb, Sn, BFRs and dioxins)	Leakage of various compounds from dumped PC-board residues.
Toner sweeping	Exposure to toner dust including carbon black	Leakage of various compounds from emptied and dumped toner cartridges
Acid Extraction	Exposure to acidic fumes containing various Hazardous compounds.	Leakage of various metals (e.g. Pb, Sn,Cu, Sb, Ni, Hg, Ba, Cd) and organic compounds (BFRs, phthalates, TPP,dioxins) from dumped residues of theextraction process.
Shredding	Dust and fumes of various metals and organic compounds present in the plastics (e.g. BFRs, phthalates, TPP, Cd, etc.)	Emissions of dust containing various plastics components to the local environment.
Plastic and waste burning	Exposure to a wide range of metals (incl. Cd, Cu, Pb, Zn, Sb) and organic compounds (incl. PBDEs, PAHs, PCBs, dioxins) via the smoke.	Emissions of a wide range of metals (incl. Cd, Cu, Pb, Zn, Sb) and organic compounds (incl. PBDEs, PAHs, PCBs, dioxins) to the local, regional and global environment
Dumping of Residual materials	Exposure to dust and fumes, containing various compounds from dumped materials. Secondary exposure via contaminated drinking water and food.	Leakage of various metals and organic compounds to the ground and water reservoirs in the surroundings

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Formal recycling

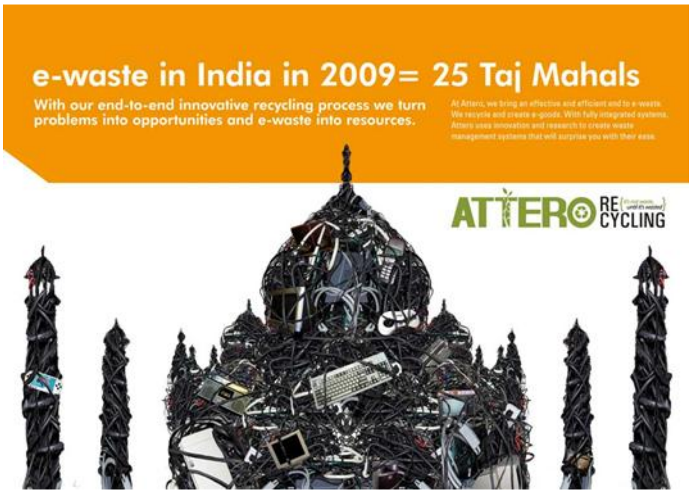
Now a days , people have started setting up companies, industrial plants where with the help of effective machinery all the e-waste or components can be used again in the production of new equipments. If the e- waste is so worn off that it can't be reused than, proper disposal of e-waste is done.With now rising e-waste quantities on one hand, and with new regulatory requirement entering into force soon on the other hand, formal recyclers increasingly enter the e-waste recycling sector. There is a widespread expectation that these formal sector recyclers would be able to manage e-waste in an environmentally sound manner by using Best Available Technologies (BAT) leading to better environmental management and enhanced resource recovery. However, it is not clear whether the advent of formal recycling would come at the expense of informal sector recyclers or would complement their activities.

Additionally, investment in machinery and increased working standards are more costintensiveand competition with informal sector recyclers is tough.

Attero factory being one of the biggest example of formal recycling.

Nitin Gupta has a penchant for garbage. The mission of his start-up company, Attero, is to recycle old computers, cellular phones, and other used electronics in a state-of-the-art industrial facility about 100 miles from New Delhi. Nearly a third of Attero's source materials come from informal collectors who earn their living by finding and selling e-scrap, . Attero pays them slightly more for used computer circuitboards than they would make from extracting gold from the boards by drenching them in cyanide — a largely unregulated process that poses risks to soils, water, and human health.

Workers in Attero's factory near New Delhi dismantle computer components



But in order to find a real success the gap between the formal and informal sector needs to be bridged.

Bridging the gap between Formal and Informal sector

As outlined, in India most of the recycling takes place in the informal sector with some formal recyclers, waste management companies and investors now entering the market. Recycling per se is considered as a secondary enterprise. For the Indian government the role of the informal sector in the value chain of e-waste continues to remain important due to its potential to generate employment. There is a need being seen to integrate the activities of the informal sector into the mainstream recycling of e-waste by dovetailing the activities of informal and formal sector. The creation of associations that comprise different informal e-waste recyclers is one possibility towards achieving a formalisation of the informal sector stakeholders. These associations would function similar to cooperatives with each having an individual institutional set-up depending on their members. The creation of an association would e.g. allow to receive formal registration and certification as e-waste recycler. Additionally, combined activities and incentives could be undertaken such as focused marketing initiatives etc.

The process of integrating the informal sector with the formal sector, however, is a challenging one. On one hand, too little is still being known on the diversity of networking amongst informal recyclers, and their distribution of tasks and financial mechanisms amongst the various stakeholders. On the other hand, the informal sector is very diverse and comprises multiple stakeholders, and hence, requires a multi-level approach to develop a path forward to their inclusion in the formal recycling market. There have been a number of reports on the identification of the clusters and the evaluation of the processes used, which reveal the need

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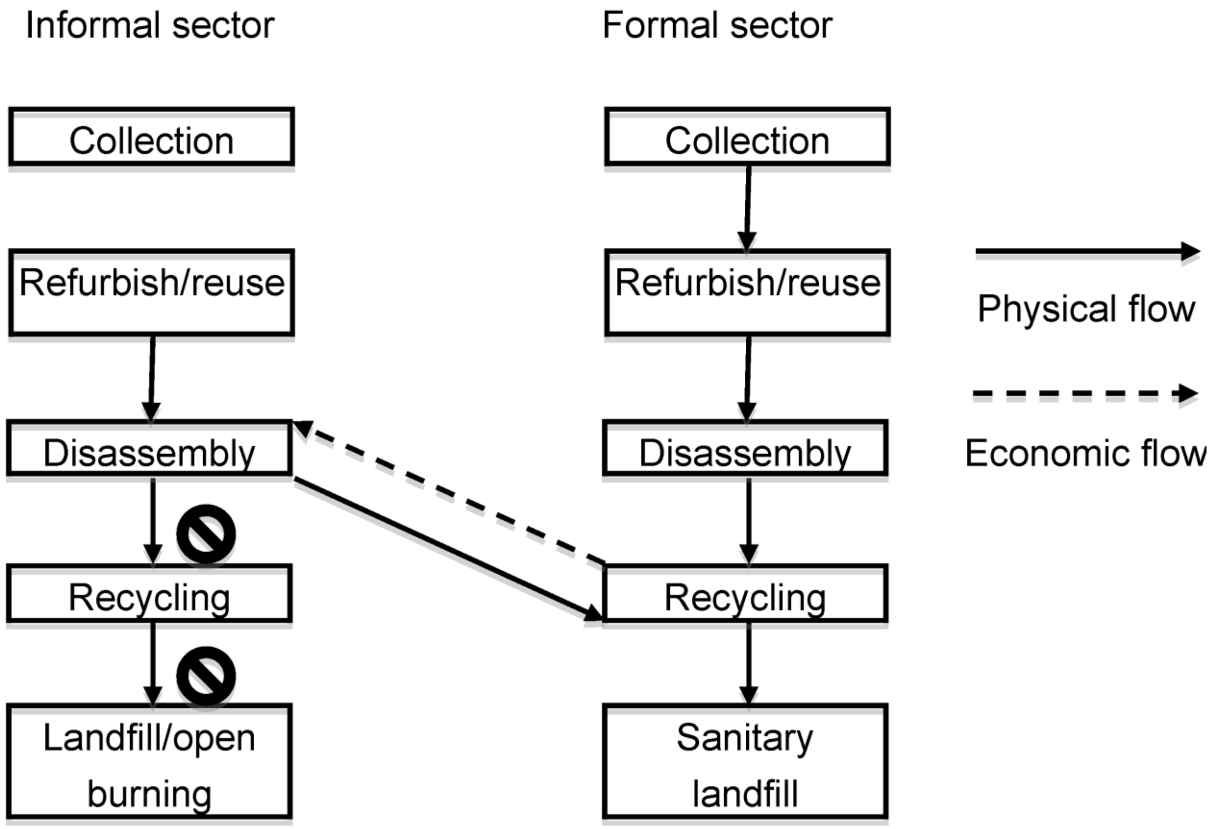
to formalize the activities, and provided a baseline understanding of how the informal sector functions in this segment. But these studies have still been sporadic and locally focused, and not yet enabled to receive a comprehensive understanding. However, they provide information on specific E-waste hubs and indicate to focusing on specific pilot regions. The EU Switch Network project on E-waste Channels, which is currently being conducted by GTZ in cooperation with MAIT, Toxics Link and adelphi, for instance, now focuses on the E-waste recycling in Delhi, Bangalore, Pune and Kolkata.



Some Successful Efforts

- **Green Computing**

Green computing is the environmentally responsible and eco-friendly use of computers and their resources. In broader terms, it is also defined as the study of designing, manufacturing/engineering, using and disposing of computing devices in a way that reduces their environmental impact.

Many IT manufacturers and vendors are continuously investing in designing energy efficient computing devices, reducing the use of dangerous materials and encouraging the recyclability

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of digital devices and paper. Green computing practices came into being in 1992, when the Environmental Protection Agency (EPA) launched the Energy Star program.

Green computing is also known as green information technology (green IT).

- **Green Disposal: An initiative taken by DELL.**

5 steps to greener disposal of e-waste

Much can be learned about the process of safe, green disposal by examining the five task forces. The five steps below can serve as your guide to greener e-waste disposal:

- **Policy** – The analysis of existing approaches and e-waste policies in order to issue recommendations for future developments in both developing and developing world.
- **ReDesign** – Efforts to support the design for better reuse, repair, refurbishment and recycling.
- **ReUse** – The development of replicable, sustainable and globally consistent reuse systems for electrical and electronic equipment.
- **ReCycle** – The enhancement of global recycling infrastructures, systems and technologies to realize sustainable e-waste recycling systems with special focus in developing countries.
- **Capacity building** – The development of infrastructures for sustainable, efficient, effective and target group-oriented capacity building to increase awareness on the growing e-waste problem.

- **Similarly, Microsoft Refurbisher Program is also a step towards reusing the laptops and cell phones by refurbishing them.**

Conclusion

As 'Prevention is better than cure' , Similarly if people start taking measures beforehand, i.e. reduction in the quantity of e-waste will itself lead to less wastage of resources and time would be needed for its management. In a densely populated country like India , it is very difficult to dispose electronic waste at such a large scale. Hence it becomes responsibility of both public as well as Government to go hand in hand and take initiative and start this electronic waste management from the root level.

In India, the amount of E-waste generated is rising rapidly. With the increasing dependence on electronic and electrical equipment, the rise of E-waste generation is well expected in the country. However, the management of the same is a major challenged faced

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by the country. As for example, in India, there are only two authorized small E-waste dismantling facilities functioning in Chennai and Bangalore. Nevertheless, the increasing generation of E-waste asks for many more such units across the country. There is no large scale organized E-waste recycling facility in India and the entire recycling exists in unorganized sector. The lack of public awareness regarding the disposal of electronic goods and inadequacy of policies to handle the issues related to E-waste enhance the problem in India. In most of the cases, the bulk of E-waste remains unattended in households and public offices. Rarely some sectors like some of the IT companies practice Extended Producer Responsibility or Take Back Policies. Due to the lack of awareness, some people discard Ewaste with regular municipal solid waste which is an extremely dicey practice. People tend not to care about the faith of the waste once these are discarded, thus satisfying the principle of “out of sight, out of mind”. Indian people are still to realize the associations between the cause of generation of E-waste and its effects including detrimental health and environmental effects. Hence a joint effort of Government and public is required in order to handle this ever growing pile of e- waste.

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