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A REVIEW ON E-WASTE

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ABSTRACT

Industrialization and extraction of natural resources have resulted in large scale environmental contamination and pollution. Large amounts of toxic waste have been dispersed in thousands of contaminated sites spread across our nation. Thus, the risk to human and environmental health is rising. These pollutants belong to two main classes: inorganic and organic. E-waste is growing exponentially recent years because the markets in which these products are produced are also growing rapidly. Developing countries are facing enormous challenges related to the generation and management of E-waste which are generated by the society 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. Thus finding a sustainable solution for handling the mass volume of e-waste generated without creating an impact to the environment and public health is the need of the hour.

Keywords- *E-waste, Scenario, E-waste legislation, Management.*

I. INTRODUCTION

E-waste is often misinterpreted as related to old computers or IT equipment in general, while the synonymous term Waste Electrical and Electronic Equipment (WEEE) is also used in the international literature. {Gaidajis et al, 2010}. Rapid economic growth in Asia and the increasing transboundary movement of secondary resources will increasingly require both 3R endeavors (reduce, reuse, recycle) in each country and appropriate control of international material cycles. To meet these needs, the prevention of environmental pollution and efficient utilization of resources will both be important.{Terazono et al, 2006} Globally the e-waste is growing by 40 million tons (MT) a year. In developed countries, e-waste constitution is 1 to 2% of the total municipal solid waste (MSW) generation and united state is 1 to 3% of the total MSW. In European Union in total amount of e-waste generation is 5-7 million tons per annum. In india e-waste generation is growing at about 15% and is expected to cross 800,000 tons per year in 2012. A central pollution control board (CPCB) report said 65 cities in india generate more then 60-70% of the total e-waste, which comes from 10 states, that's are followed by Maharashtra, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab in the list of e-waste generating states in india.{Yoheeswaran, 2013} The Environment protection Agency (EPA) refers to Electronic Waste as "electronic products that are discarded by consumers. " That is some what vague so think of E-waste as the electronics version of what you'd find in the kitchen trash can. {Borthaku1 et al, 2012} . Major issues related to E-waste in India While considering the problems related to E-waste in India, there are five major components which should be focused upon. These are Main Sources of E-waste in India, Magnitude of the Problem with respect to the Indian scenario, Health and Environmental Implications of Ewaste, Current Management practices of E-waste in India and Policy level initiatives in the country.

II. SCENARIO

- E-waste is currently growing at around 4% per year (Deng et al., 2006)
- In 2005 US generated 2.6 Million tons of e-waste out of which only 12.6% was recycled (US EPA, 2006)
- E-waste accounts for 8% of all municipal waste in Europe (Streicher-Porte, 2006)
- In china about 20 million electronic household appliances (including TV, Washing machines, PCs etc) and 70 million cell phones reach end-of-life every year (Yongguang, Qingdong et al., 2006)
- One billion PCs will be in use by the end of 2008 – two billion by 2015 with most growth in emerging Brazil, Russia, India and China (Source: Forrest Research)

Most countries lack reliable data on E-waste generation. Williams discussed E-waste generation by selected countries from a review of studies from the E-waste project based at Eidgenössische Materialprüfungs und Forschungsanstalt (EMPA) in Switzerland (Table 2). Com- parison of the figures in Table 2 is difficult because there is no standard definition of E-waste, and the methods used to estimate E-waste generation are not compatible among countries. Thus, although these figures provide an indication of the magnitude of the problem, it is important to question their reliability. {Terazono et al, 2006}

Table 2. E-waste generation in selected countries by EMPA project

Country	Total E-waste (tonnes/ year)	Categories of appliances counted as E-waste	Year Generated
Switzerland	66 042	Office and telecommunications equipment, consumer entertainment Electronics, large and 2003 small domestic appliances, refrigerators, fractions	
Germany	1 100 000	Office and telecommunications equipment, consumer entertainment electronics, large and 2005 small domestic appliances, refrigerators, fractions	
UK	915 000	Office and telecommunications equipment, consumer entertainment electronics, large and 1998 small domestic appliances, refrigerators, fractions	
USA	158 490	Video products, audio products, computers and telecommunications equipment	2000
Taiwan	4 036	Computers, home electrical appliances (TVs, washing machines, air conditioners, refrigerators)	2003
Thailand	0 000	Refrigerators, air conditioners, televisions, washing machines, computers	2003
Denmark	18 000	Electronic and electrical appliances including refrigerators	1997
Canada	7 000	Computer equipment (computers, printers, etc) and consumer electronics (TVs)	2005

Sample data on E-waste generation in Asia are shown in Table 3, which is based on the presentations by each speaker at the Workshop. Because these countries have different target items of E-waste and different urban populations, it is difficult to compare any two countries. Nonetheless, it is clear that most Asian countries are generating increasing amounts of E-waste because of their rapid economic growth. {Terazono et al, 2006}

Table 3. E-waste generation in Asia

Country	Home appliances[a]	Personal computers	Year
China	51 480 000	4 480 000	2003
India	Unknown	Unknown	
Japan	18 625 000	Approx. 80 000 tonnes	2003
Korea	Unknown	1 710 000	2003
Philippines	2 379 142	Unknown	2004
Taiwan	53 800 tonnes	21 100 tonnes	2004
Thailand	Approx. 2 400 000[b]	Approx. 300 000	2001

III. E-WASTE CATEGORIS

Thirty or forty years ago, an average family would have owned very few electronic items in their home. They might have owned a radio, television, refrigerator, vacuum cleaner and perhaps a record player. However, an average family in the modern society would own a significant number of electronic items such as computers, mobile phones, video recorders, music centers, home cinemas, as well kitchen equipment like microwave ovens, washing machines, dishwasher…. the list goes on. In offices and shops, an equally rapid electronic revolution has taken place adding items such as computer systems, telecommunication systems, photocopiers, security systems.{E-waste Research group}

E-waste means electrical waste and electronic equipment, whole or in part included in, but not confined to equipment, scraps or rejects from their manufacturing process. E-waste is divided into different categories according to Environment Protection Act, 1986 (figure-1){Pramila et al, 2012}

Figure-1
Different Categories of E-Waste

IV. E-WASTE COMPOSITION

- E-waste contains more than 1000 different substances, many of which are toxic, such as lead, mercury, arsenic, cadmium, selenium, hexavalent chromium and flame retardants (Widmer et al., 2005)
- About 70% of the heavy metals (mercury and cadmium) in US landfills come from electronic waste and 40% lead in landfills come from electrical and electronic equipment (Widmer et al., 2005)
- 22% of the yearly world consumption of mercury is used in electronics manufacture (Realff, Raymond et al., 2004)
- UN study has found that manufacturing a computer and its screen takes at least 240kg of fossil fuels, 22 kg of chemicals and 1.5 tonnes of water – more than the weight of a car (Schwarzer, et al., 2005)
- Over 90% of materials in mobile phones can be recovered such as nickel, cadmium, cobalt, gold, silver, copper, plastics and other metals (Source: AMTA)

Electrical and electronic equipment can contain a large number of hazardous substances, including heavy metals (e.g., mercury, International Science Congress Association cadmium, lead, etc.), flame retardants (e.g., pentabromophenol, polybrominated diphenyl ethers (PBDEs), tetrabromobisphenol A (TBBPA), etc.) and other substances (figure presence of these substances, e-waste is generally considered as hazardous waste, which, if improperly managed, may pose significant human and environmental health risks. {Pramila et al, 2012}

Hazardous Components of E-Waste

Americium: one of the radioactive sources, known to be carcinogenic.

Mercury: Mainly found in fluorescent tubes applications), tilt switches (mechanical doorbells, and flat screen monitors. It causes health effects such as; sensory impairment, dermatitis, memory loss, and muscle weakness. Environmental effects in animals include death, reduced fertility, slower growth and development.

Sulphur: Found in lead-acid batteries. Health effects include liver damage, kidney damage, heart damage, and eye and throat irritation. When released in to the environment, it can create sulphuric acid.

BFRs (Brominated flame retardants): Used as flame retardants in plastics in most electronics includes PBBs, OctaBDE, PentaBDE. Health effects include impaired development of the nervous system, thyroid p problems. Environmental effects: similar effects as in animals as humans. PBBs were banned from 1973-1977 on. PCBs were banned during the 1980's.

Cadmium: Found in light-sensitive resistors, corrosion alloys for marine and aviation environments and cadmium batteries. When not properly recycled it can leach into the soil, harming microorganisms and disrupting the soil ecosystem. Exposure is caused by proximity to hazardous waste sites and factories and workers in the metal refining industry. The inhalation of cadmium can cause severe damage to the lungs and is also known to cause kidney damage.

Lead: Found in CRT monitor glass,lead-acid batteries formulations of PVC. A typical 15-inch cathode ray tube may contain 1.5 pounds of lead but other CRTs have been estimated as having up to 8 pounds of lead.

Beryllium oxide: Commonly used as filler in some thermal interface materials such as thermal grease used on CPUs and power transistors,magnetrons, X ceramic windows, heat transfer fins in vacuum tubes lasers. {Pramila et al, 2012}

V. 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 of 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. {Ramachandra T.V. et al, 2004}

To mainstream and disseminate environmentally sound management of e-waste in developing countries, the work plan for the focal area on e-waste proposes to develop sustainable business plans which will include an effective take-back system, a manual dismantling facility, local pre-processing activities and sound end-processing activities. These activities will be undertaken in close cooperation with other partners working in this field. The focal area on e-waste is led by the United Nations Industrial Development Organization (UNIDO). {*www.unep.org*}

Treatment & Disposal Options

The presence of hazardous elements in e-waste offers the potential of increasing the intensity of their discharge in environment due to landfilling and incineration. The potential treatment disposal options based on the composition are given below:

Landfilling Incineration

Landfilling

The literature review reveals that degradation processes in landfills are very complicated and run over a wide time span. At present it is not possible to quantify environmental impacts from E-waste in landfills for the following reasons:

Landfills contain mixtures of various waste streams;

Emission of pollutants from landfills can be delayed for many years;

According to climatic conditions and technologies applied in landfills (e.g. leachate collection and treatment, impermeable bottom layers, gas collection), data on the concentration of substances in leachate and landfill gas from municipal waste landfill sites differs with a factor 2-3.

One of the studies on landfills reports that 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 behavior 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. {MoEF letter No. 23-23/2007-HSMD dt. March 12, 2008}

Incineration

Advantage of incineration of e-waste is the reduction of waste volume and the utilization of the energy content of combustible materials. Some plants remove iron from the slag for recycling. 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. There is no available research study or comparable data, which indicates the impact of e-waste emissions into the overall performance of municipal waste incineration plants. Waste incineration plants contribute significantly to the annual emissions of cadmium and mercury. In addition, heavy metals not emitted into the atmosphere are transferred to slag and exhaust gas residues and can reenter the environment on disposal. Therefore, e-waste incineration will increase these emissions, if no reduction measures like removal of heavy metals from are taken. {MoEF letter No. 23-23/2007-HSMD dt. March 12, 2008}

Regulatory regime for e-waste

- The Hazardous Waste (Management & Handling) Rules, 2003
- The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008
- Guidelines for Environmentally Sound Management of E-waste, 2008
- The Draft E-waste (Management and Handling) Rules, 2010
- The e-waste (Management and Handling) Rules, 2011
  {E-WASTE IN INDIA RESEARCH UNIT (LARRDIS) RAJYA SABHA SECRETARIAT NEW DELHI JUNE, 2011}

VI. CONCLUSION

Environmental sustainability and proper e-waste recycling practices go hand in hand. Without proper recycling practices in place, our ecosystem and environment are heavily impacted. Sustainability is a common term, but when applied to the environment, it can appear to have an eerie, almost frightening effect. To sustain is to maintain or keep up. We have only one Earth, one environment and one ecological system: the thought of not "keeping up or maintaining" could lead our society into an even more dire straits situation than we currently are in. environmental sustainability is a key component to the ecological cycle that keeps our Earth intact. Do you remember learning about the food chain back in elementary school? Every species has a specific purpose for the planet. Large or small, they matter. Even though our society has tried to play catch-up with the ecological cycle, our past actions already may have caused devastating consequences for the human race and wildlife. In comparison to individual recycling practices, billion-dollar corporation, some of whom make major decisions for our ecosystem and have large political influence, are charged for polluting our water systems and land. Most get a fine and/or possible incarceration. These decisions are based on what I spoke about earlier: greed and laziness.

Do your own, personal part in making proper decisions about recycling e-waste. Hold corporations and businesses responsible for their irresponsible e-waste recycling practices. Don't be afraid to call someone out or voice your opinion about how important our planet is and what it means to you.{Ferry, Jan 04, 2013}

E-Waste concerns and challenges

1. Accurate figures not available for rapidly increasing e-waste volumes—generated domestically and by imports

2. Low level of awareness among manufacturers and consumers of the hazards of incorrect e-waste disposal

3. No accurate estimates of the quantity of e-waste generated and recycled available in India

4. Major portion of e-waste is processed by the informal (unorganised) sector using rudimentary techniques such as acid leaching and open-air burning, which results in severe environmental damage

5. e-waste workers have little or no knowledge of toxins in e-waste and are exposed to health hazards

6. High-risk backyard recycling operations impact vulnerable social groups like women, children and immigrant laborers

7. Inefficient recycling processes result in substantial losses of material value and resources

8. Cherry-picking by recyclers who recover precious metals (gold, platinum, silver, copper, etc) and improperly dispose of the rest, posing environmental hazards. {http://www.globalewastemanagement.com}

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