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E-Waste-Concept, Problems and Solution Policies in India

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ABSTRACT: Electronic waste or E-waste is relatively a novel addition to the ever-growing hazardous waste stream. It includes discarded electronic and electrical equipment. Developing countries face enormous challenges which are related to the generation and management of E-waste which are either internally generated or imported illegally; India is no exception. 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 appropriately. The present paper focuses on the austere problem of E-waste along with its policy level implications. 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.

Keywords: *E-waste, Hazardous waste, Risk, Heavy metals, Management*

INTRODUCTION

Over the past few decades, enormous quantities of industrial pollutants have been released into the environment. Solid waste management, which is already a massive task in India, is becoming more complicated by the invasion of e-waste, particularly computer waste. Electronic-waste (e-waste) represents electronic products including computers, printers, photocopy machines, television sets, mobile phones, and toys, which are made of sophisticated blends of plastics, metals, and other materials. It is an emerging problem because of the volumes of e-waste being generated and the content of both toxic and valuable materials. The fraction including iron, copper, aluminium, gold and other metals in e-waste is over 60%, while plastics account for about 30% and the hazardous pollutants comprise only about 2.70%1. Electronic devices form a complex mixture of materials and components, often containing several hundreds of different substances, many of which are toxic and create serious pollution upon disposal. These include heavy metals such as mercury, lead, cadmium, chromium and flame retardants such as polybrominated biphenyls (PBB) and polybrominated diphenyethers (PBDEs). Disposal of the e-wastes is an emerging global environmental issue, as these wastes have become one of the fastest growing waste types in the world. The recent investigations of workers involved in manufacturing the chips, he drives and circuit boards are reporting health problems. Even the workers who handle even e-waste as a scrap has health problems. The recycling and disposal of computer waste in these countries becomes a serious problem since their treatment methods remain rudimentary. Such activities pose grave environmental and health hazards; for example, the deterioration of local drinking water which can result in serious illnesses. The hazardousness of e-waste is well recognized, but

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the knowledge on these hazards and the resulting risks associated with different treatment options is currently fragmented. Current article gathers the data on components and hazardous substances of e-waste that are creating environmental pollution and human exposure to these chemicals, resulting adverse effects due to recycling, incineration and landfill disposal of e-waste. Current study is based on different hazardous components present in E-waste, current scenario of E waste generation. Methods which are available and risk associated with those methods have also been mentioned.

Different Categories of E-waste

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).

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; it can create Sulphuric Acid when released in to the environment.

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 and thyroid problems. The Environmental effects are similar in the animals as human beings. 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. Cadmium, when not properly recycled, can leach into the soil; it harms microorganisms and disrupts 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.

Figure 1: Different Categories of E-Waste

RESEARCH METHOD

Data was collected from different sources and an infrastructure to manage the data of recycling processes was built. A representative substance group was chosen and its concentration in the environment was evaluated with two different models. The exposure of humans to the representative substance group was calculated and the risk assessed.

Health and Environmental Implications of E-waste

Electronic and Electrical Equipment are composed of an enormous amount of components. Many of them fall under the hazardous category. Majority of these components contain toxic substances that have adverse impacts on human health and the environment if not handled properly. Often, these hazards arise due to the improper recycling and disposal processes that are in practice in most of the developing countries including India. Such offensive practices can have serious aftermath for those staying in proximity to the places where E-waste is recycled or burnt. Disposal of E-wastes is an unembellished problem faced by many regions across the globe. Electronic 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 flourishing 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, sludge, etc., in the rivers. Mercury leaches when certain electronic devices, such as circuit breakers are destroyed. The same is true for polychlorinated biphenyls (PCBs) from condensers. When brominated flame retardant plastic or cadmium containing plastics are landfilled, both polybrominated diphenyl ethers (PBDE) and cadmium may leach into the soil and groundwater. It has been found that significant amounts of lead ion are dissolved from broken lead ontaining glass, such as the cone glass of cathode ray tubes, gets mixed with acid waters and are a common occurrence in landfills. In addition, uncontrolled fires may arise at landfills and this could be a frequent occurrence in many countries. When exposed to fire, metals and other chemical substances, such as the extremely toxic dioxins and furans (TCDD tetrachloro dibenzo-dioxin, PCDDs polychlorinated dibenzodioxins.

PBDDs-polybrominated dibenzo-dioxin and PCDFs-poly chlorinated dibenzo furans) from halogenated flame retardant products can be emitted1. 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 the local environment and broader global air currents, depositing highly toxic byproducts in many places throughout the world. Incineration of E-waste possesses another threat. It can emit toxic fumes and gases, thereby polluting the surrounding air. Moreover, shipping of hazardous waste to developing countries is a major alarm. It happens because of cheap labor and lack of environmental legislations in developing countries (table 1).

Table 1: E-waste toxins and affected body parts

Components	Constituents	Affected body parts
Printed circuit Board	Lead and Cadmium Benllium	Nervous system, Kydney, lever
Moterboards	Lead oxide,barium and cadmium	Lung and skin
Cathode Ray Tube(CRT)	Mercury	Heart, lever, muscles
Switches and Flat screen Monitors	Cadmium	Brain, Skin
Computer Batteries	Polychlorinated biphenyls(PCBs)	Kidney lever
Capacitors and Transformers	Brominated Flame-retardent casing cable	-
Plastic	Polyviny Chloride	-
Cable insulating coating Plastic housing	Bromine	Immune System

Management of E-waste in Indian Context

In India, it has been observed that in most of the cases, electronic items are stored unattended because of lack of knowledge about their management. Such electronic junks lie in houses, offices, warehouses etc. Generally, these wastes are mixed with household wastes, which are finally disposed of at landfills. This necessitates implementation of appropriate management measures including stringent regulations. The management practices currently in operation in India have severe health and environmental implications. The composition of E-waste consists of diverse items many of which contain hazardous elements. Therefore, the major approach to treat E-waste is to reduce the concentration of these hazardous chemicals and elements through recycle and recovery. In the process of recycling or recovery, certain E-waste fractions act as secondary raw material for recovery of valuable items. In Indian context, primarily recycling, reuse and recovery are done as measures to treat E-waste. The recycle and recovery includes the unit operations like dismantling, segregation of ferrous metal, non-ferrous metal and plastic by shredder process, refurbishment and reuse, recycling / recovery of valuable materials and treatment/disposal of dangerous materials and waste. Dismantling includes removal of parts of the electrical and electronic equipment containing perilous substances (CFCs, Hg switches, PCB); removal of easily accessible parts containing valuable substances (cable containing copper, steel, iron, precious metal containing parts etc.). Refurbishment and reuse of E-waste has potential for those used electrical and electronic equipment which can be easily renovate to put to its original use. Recycling / recovery of valuable materials includes recycling and recovery of valuable materials from the E-waste stream like non-ferrous metals in smelting plants, precious metals in separating works. As most of the electrical and electronic equipment contain many precious metals, this process is an important step in the management of E waste. The materials of potential hazard are disposed of in landfill sites or sometimes incinerated. However, the process of incineration is quite expensive. CFCs are treated thermally, PCB and Mercury is often recycled or disposed of in underground landfill sites. In India, primarily two types of disposal options based on the composition are in practice. These are Landfilling and Incineration. However, 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 behavior 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 (Guidelines for Environmentally Sound Management of E-waste, 2008). 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 (Guidelines for Environmentally Sound Management of E-waste, 2008). Waste incineration plants contribute significantly to the annual emissions of cadmium and mercury. The assessment of E-waste recycling sector in India indicates that E-waste trade starts from formal dismantling sector and moves to informal recycling sector (Guidelines for Environmentally Sound Management of E-waste, 2008). The entire E-waste treatment is being carried out in an unregulated environment, where there is no control on emissions. There are two E-waste dismantling facilities in formal sector in India. These facilities are M/s. Trishiraya Recycling facilities, Chennai and M/s E-Parisara, Bangalore.

Policy Level Initiatives in India

In view of the ill-effects of hazardous wastes to both environment and health, several countries exhorted the need for a global

agreement to address the problems and challenges posed by hazardous waste. However, the policy level initiatives regarding E-waste in India is quite rudimentary and needs immediate attention. Following are some of the policy level initiatives in India regarding E-waste.

- ✓ **The Hazardous Wastes (Management and Handling) Amendment Rules, 2003**

Under Schedule 3, E-waste is be defined as "Waste Electrical and Electronic Equipment including all components, sub-assemblies and their fractions except batteries falling under these rules". The definition provided here is similar to that of Basal Convention. E-waste is only briefly included in the rules with no detail description.

- ✓ **Guidelines for Environmentally Sound Management of E-waste, 2008**

This guideline was a Government of India initiative and was approved by Ministry of Environment and Forest and Central Pollution Control Board. It classified the E-waste according to its various components and compositions and mainly emphasizes on the management and treatment practices of E-waste. The guideline incorporated concepts such as "Extended Producer Responsibility".

- ✓ **The E-waste (Management and Handling) Rules, 2011**

This is the very recent initiative and the only attempt in India meant solely for addressing the issues related to E-waste. These rules are not implemented in India as yet and will only come into practice from 1st May, 2012. According to this regulation, 'electrical and electronic equipment' means equipment which is dependent on electric currents or electro-magnetic fields to be fully functional and 'e-waste' means waste electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded. These rules are meant to be applied to every producer, consumer or bulk consumer involved in manufacturing, sale purchase and processing of electrical and electronic equipment, collection centers, dismantlers and recyclers of e-waste. Responsibilities of producers, collection centers, consumers, dismantlers, recyclers and other related entities are defined and incorporated in these rules.

CONCLUSION

The current article summarizes that e-waste contains a number of hazardous substances. Heavy metals and halogenated compounds are of particular concern. Improper handling and management of e-waste during recycling and other end-of-life treatment options may develop potentially significant risks to both human health and the environment. Current simple recycling carried out in many developing countries is causing risks that could to a large extent, be avoided through the use of improved treatment methods. Biohydrometallurgical techniques allow metal cycling by processes similar to natural biogeochemical cycles. There is no large scale organized E-waste recycling facility in India and the entire recycling exists in unorganized sector. Moreover, the management practices are often poorly designed and have a lot of health and environmental repercussions. Involvement of urban poor, especially women and children and illegally imported E-waste from developed countries further exaggerate the problem of E-waste in India. 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 E-waste with regular municipal solid waste which is an extremely dicey practice. Another important factor in Indian context is that although the information technology revolution started in India way back in early 1990s, the first rule exclusively dealing with E-waste came up only recently after almost 20 years in the form of "e-waste (Management and Handling) Rules, 2011". Proper implementation of the "e-waste (Management and Handling) Rules, 2011" is exceedingly essential to address the ever growing pile of E-waste in the country.

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