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GLOBAL CHALLENGES IN E- WASTE MANAGEMENT IN INDIA

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ABSTRACT

Electronic waste or E-waste comprises of old, end-of-life electronic appliances such as computers, laptops, TVs, DVD players, refrigerators, freezers, mobile phones, MP3 players, etc., which have been disposed of by their original users. E-waste contains many hazardous constituents that may negatively impact the environment and affect human health if not properly managed. Various organizations, bodies, and governments of many countries have adopted and/or developed the environmentally sound options and strategies for E-waste management to tackle the ever growing threat of E-waste to the environment and human health. This paper presents E-waste composition, categorization, Global and Indian E-waste scenarios, prospects of recoverable, recyclable, and hazardous materials found in the E-waste, Best Available Practices, recycling, and recovery processes followed, and their environmental and occupational hazards. Public awareness of the health and environmental threat posed by e-waste is virtually non-existent. If we continue to do nothing, these problems will become more serious. In our previous studies, cytogenetic damage effects have been found among the residents who live in the polluted area. In order to best protect public health and the environment without unfairly burdening the people of developing countries, policy makers of all developed and developing nations must be willing to fundamentally redesign the approach to e-waste management and to create awareness among them.

KEYWORDS: *Waste, Hazardous Waste, Electronic Scraps, E – Waste Management*

1.INTRODUCTION

Electronic waste, or e-waste for short, refers to discarded computers, televisions, cell phones, printers, PDAs and the thousands of other electronic devices commonly used in offices, homes and on-the-go. A more technical definition would refer to obsolete or discarded products that have their primary functions provided by electronic circuitry and components. Electronic products are complicated assemblies. Containing dozens of compounds that are known to have adverse impacts on human health and the environment, including lead, mercury, arsenic, cadmium, polyvinyl chloride, and several classes of brominated flame retardants. Improperly disposing of these products in landfills or incinerators at the end of their useful life creates serious health and environmental threats. The growth of e-waste has significant economic and social impacts. The increase of electrical and electronic products, consumption rates and higher obsolescence rate leads to higher generation of e-waste. The increasing obsolescence rate of electronic products also adds to the huge import of used electronics products.

There is no large scale organized e-waste recycling facility in India and there are two small e-waste dismantling facilities are functioning in Chennai and Bangalore, while most of the e-waste recycling units are operating in un-organized sector.

1.2CATEGORIZATION OF THE E-WASTE

Composition of the E-waste is very diverse and complex. E-waste contains more than 1,000 substances, which can be classified as hazardous and non-hazardous substances. Electrical and electronic equipment can be broadly categorized into following categories

- Large household appliances (refrigerator, washing machine, cooking appliances, etc.)
- Small household appliances (vacuum cleaners, watches, grinders, etc.)
- IT and telecommunication equipment (PCs, telephones, etc.)
- Consumer equipment (TV, radio, video camera, amplifiers, etc.)
- Lighting equipment (CFL, high intensity sodium lamp, etc.)
- Electrical and electronic tools (drills, saws, sewing machine, etc.)
- Toys, leisure, and sport equipment (computer, electric trains, etc.)
- Medical devices (with the exception of all implanted and infected products radiotherapy equipment, cardiology, dialysis, nuclear medicine, etc.)
- Automatic dispensers (for hot drinks, hot and cold bottles, etc.)

2. PRESENT E-WASTE MANAGEMENT SYSTEM IN INDIA

Most of the activities right from the collection, transportation, segregation, dismantling, etc., is done by unorganized sectors manually. Being a rich source of reusable and precious material, E waste is also a good source of revenue generation for many people in India. The big portion (rag pickers) of the Indian population earned their livelihood by collecting and selling the inorganic waste-like plastics, polythene bags, glass bottles, cardboards, paper, other ferrous metals, etc. In India, most of the operations related to E-waste such as collections, segregation, dismantling, recycling, and disposals are performed manually. In absence of the adequate technologies and equipment, most of the techniques used for the recycling/treatments of E-waste are very raw and dangerous. Improper recycling and disposal operations found in different cities of India often involve the open burning of plastic waste, exposure to toxic solders, dumping of acids, and widespread general dumping. As a result, pollutants are dumped into the land, air, and water, which are the cause of serious environmental problems in India. Also, the labors and workers employed in the dismantling and recycling units are poorly literate and uneducated.

Lacking the basic knowledge about the serious occupational and health risks associated with the operations. Most of the time, dismantling and recycling operations are performed by the workers without proper Personnel Protection Equipment

[1]. Mostly hammers, chisels, hand drills, cutters, electric torch/burners, and some time electric drills were used for dismantling the Waste Electrical and Electronic Equipment WEEE.

TABLE 1: QUANTITY OF WEEE (WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT) GENERATED IN INDIAN STATE

S.NO	STATES	WEEEE (Tones)	S.NO	STATES	WEEEE (Tones)
1	Andaman and Nicobar	92.2	17	Karnataka	9,118.7
2	Andhra Pradesh	2,780.3	18	Kerala	6,171.8
3	Arunachal Pradesh	131.7	19	Lakshadweep	7.8
4	Assam	2,176.7	20	Madhya Pradesh	7,800.6
5	Bihar	3,055.6	21	Maharashtra	20,270.9
6	Chandigarh	401.01	22	Manipur	231.7
7	Chhattisgarh	2150.6	23	Meghalaya	211.6
8	Dadra and Nagar Haveli	30.6	24	Mizoram	80.6
9	Daman and Diu	42.9	25	Nagaland	145.1
10	Delhi	9,729.9	26	Orissa	2,937.7
11	Goa	427.4	27	Puduchery	284.2
12	Gujarat	8,994.3	28	Punjab	6,986.3
13	Haryana	4,506.3	29	Rajasthan	6,.326.9
14	Himachal Pradesh	15,950.2	30	Sikkim	80.3
15	Jammu and Kashmir	1,521.3	31	Tamilnadu	13,487.9
16	Jharkhand		32	Uttar Pradesh	10,381.1

(Courtesy Level WEEE assessment study by IRGSSA)

Table 1 shows the amount of wastes generated by each state in India. Mostly, the dismantling and recycling areas are without any proper lighting and ventilation. In absence of suitable techniques and infrastructure, the workers and labourers working in such areas are prone to serious occupational health hazards Thus; there is no organized or formal E-waste management system in INDIA

3. E-WASTE MANAGEMENT RECYCLING, REUSE AND RECOVERY OPTIONS

The composition of e-waste consists of diverse items like ferrous and nonferrous metals, glass, plastic, electronic components and other items and it is also revealed that e-waste consists of 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 [2]. The recycle and recovery includes the following unit operations.

(i) Dismantling: Removal of parts containing dangerous substances (CFCs, Hg switches, PCB); removal of easily accessible parts containing valuable substances (cable containing copper, steel, iron, precious metal containing parts.).

(ii)Segregation: Separating of ferrous metal, non-ferrous metal and plastic, this separation is normally done in a shredder process.

(iii) Refurbishment and reuse: Refurbishment and reuse of e-waste has potential for those used electrical and electronic equipment which can be easily refurbished to put to its original use.

(iv) Recycling of valuable materials: Ferrous metals in electrical furnaces, non-ferrous metals in smelting plants, precious metals in separating works

(v) Treatment/disposal of dangerous materials and waste: Shredder light fraction is disposed of in landfill sites or sometimes incinerated (expensive), Chloro Fluro Carbons (CFCs) are treated thermally, Printed Circuit Board (PCB) is incinerated or disposed of in underground storages, and mercury is often recycled or disposed of in underground landfill sites. The value of recovery from the elements would be much higher if appropriate technologies are used.

4. TREATMENT & DISPOSAL OPTIONS

5The 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 [5]:

- Landfilling
- Incineration
- Recycling
- Reuse

4.1 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 forthe 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 differ with a factor 2-3. One of the studies on landfills reports that the environmental risks from land filling 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, land filling 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 and filling.

4.2 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 emissio

ns 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 intothe atmosphere are transferred to slag and exhaust gas residues and can re-enter the environment on disposal. Therefore, e-waste incineration will increase these emissions, if no reduction measures like removal of heavy metals e-waste are taken.

4.3 RECYCLING OF E-WASTE

Monitors & CRT, keyboards, laptops, modems, telephone boards, hard drives, floppy drives, Compact disks, and mobiles, fax machines, printers, CPUs, memory chips, connecting wires & cables can be recycled [4]. Recycling involves dismantling i.e. removal of different parts of e-waste containing dangerous substances like PCB, Hg, separation of plastic, removal of CRT, segregation of ferrous and non-ferrous metals and printed circuit boards. Recyclers use strong acids to remove precious metals such as copper, lead, gold. The value of recycling from the element could be much higher if appropriate technologies are used. The recyclers are working in poorly–ventilated enclosed areas without mask and technical expertise results in exposure to dangerous and slow poisoning chemicals

[6]. The existing dumping grounds in India are full and overflowing beyond capacity and it is difficult to get new dumping sites due to scarcity of land. Therefore recycling is the best possible option for the management of e-waste.

4.3.1 BENEFITS OF RECYCLING

Recycling raw materials from end-of-life electronics is the most effective solution to the growing e-waste problem. Most electronic devices contain a variety of materials, including metals that can be recovered for future uses. By dismantling and providing reuse possibilities, intact natural resources are conserved and air and water pollution caused by hazardous disposal is avoided. Additionally, recycling reduces the amount of greenhouse gas emissions caused by the manufacturing of new products. It simply makes good sense and is efficient to recycle and to do our part to keep the environment green.

4.4 RE-USE

It constitutes direct second hand use or use after slight modifications to the original functioning equipment. It is commonly used for electronic equipment like computers, cell phones etc. Inkjet cartridge is also used after refilling. This method also reduces the volume of e-waste generation. We can use above mentioned methods for treatment and disposal of e-waste. The better option is to avoid its generation. To achieve this, buy back of old electronic equipment's shall be made mandatory [3]. Large companies should purchase the used equipment's back from the customers and ensure proper treatment and disposal of e-waste by authorized processes. This can considerably reduce the volume of e- waste generation.

5. PROCESSING TECHNIQUES

In developed countries, electronic waste processing usually first involves dismantling the equipment into various parts (metal frames, power supplies, circuit boards, plastics), often by hand. The advantages of this process are the human's ability to recognize and save working and repairable parts, including chips, transistors, RAM, etc. The disadvantage is that the labour is cheapest in countries with the lowest health and safety standards [5]. In an alternative bulk system, a hopper conveys material for shredding into an unsophisticated mechanical separator, with screening and granulating machines to separate constituent metal and plastic fractions, which are sold to smelters or plastics recyclers. Such recycling machinery is enclosed and employs a dust collection system. Some of the emissions are caught by scrubbers and screens. Magnets, eddy currents, and trommel screens are employed to separate glass, plastic, and ferrous and nonferrous metals, which can then be further separated at a smelter. Leaded glass from CRTs is reused in car batteries, ammunition, and lead wheel weights, or sold to foundries as a fluxing agent in processing raw lead ore. Copper, gold, palladium, silver, and tin are valuable metals sold to smelters for recycling. Hazardous smoke and gases are captured, contained, and treated to mitigate environmental threat. These

Methods allow for safe reclamation of all valuable computer construction materials [2]. Hewlett-Packard product recycling solutions manager Renee St. Denis describes its process as: "We move them through giant shredders about 30 feet tall and it shreds everything into pieces about the size of a quarter. Once your disk drive is shredded into pieces about this big, it's hard to get the data off." An ideal electronic waste recycling plant combines dismantling for component recovery with increased cost-effective processing of bulk electronic waste. Reuse is an alternative option to recycling because it extends the lifespan of a device. Devices still need eventual recycling, but by allowing others to purchase used electronics, recycling can be postponed and value gained from device use.

6. ELECTRONIC WASTE SUBSTANCES

Some computer components can be reused in assembling new computer products, while others are reduced to metals that can be reused in applications as varied as construction, flatware, and jewellery. Substances found in large quantities include epoxy resins, fiberglass, PCBs, PVC (polyvinyl chlorides), thermosetting plastics, lead, tin, copper, silicon, beryllium, carbon, iron and aluminum. Elements found in small amounts include cadmium, mercury, and thallium [3]. Elements found in trace amounts include americium, antimony, arsenic, barium, bismuth, boron, cobalt, europium, gallium, germanium, gold, indium, lithium, manganese, nickel, niobium, palladium, platinum, rhodium, ruthenium, selenium, silver, tantalum, terbium, thorium, titanium, vanadium, and yttrium. Almost all electronics contain lead and tin (as solder) and copper (as wire and printed circuit board tracks), though the use of lead-free solder is now spreading rapidly [4]. The following are ordinary applications:

6.1 HAZARDOUS

- Mercury: fluorescent tubes (numerous applications), tilt switches (mechanical doorbells, thermostats).
- Sulfur: lead-acid batteries.
- PBBs: Predecessor of PCBs. Also used as flame retardant.
- PCBs: prior to ban, almost all 1930s–1970s equipment, including capacitors, transformers, wiring insulation, paints, inks, and flexible sealants. Banned during the 1980s.
- Cadmium: light-sensitive resistors, corrosion-resistant alloys for marine and aviation environments, nickel-cadmium batteries.
- Lead: solder, CRT monitor glass, lead-acid batteries, some 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: filler in some thermal interface materials such as thermal grease used on heat sinksfor CPUs and power transistors, magnetrons, X-ray-transparent ceramic windows, heat transfer finsin vacuum tubes as stated
- Polyvinyl chloride third most widely produced plastic, contains additional chemicals to change the chemical consistency of the product. Some of these additional chemicals called additives can leach outof vinyl products. Plasticizers that must be added to make PVC flexible have been additives of particular concern. Burning PVC in connection with humidity in the air creates Hydrogen Chloride (HCl), an acid.

6.2 GENERALLY NON-HAZARDOUS

- Tin: solder, coatings on component leads.
- Copper: copper wire, printed circuit board tracks, component leads. ➢ Aluminum: nearly all electronic goods using more than a few watts of power (heat sinks), electrolytic capacitors.
- Iron: steel chassis, cases, and fixings.
- Germanium: 1950s–1960s transistorized electronics (bipolar junction transistors).
- Silicon: glass, transistors, ICs, printed circuit boards.
- Nickel: nickel-cadmium batteries.

7. CONCLUSIONS

Solid waste management, which is already a mammoth task in India, is becoming more complicated by the invasion of e-waste, particularly computer waste. There exists an urgent need for a detailed assessment of the current and future scenario including quantification, characteristics, existing disposal practices, environmental impacts etc. Institutional infrastructures, including e-waste collection, transportation, treatment, storage, recovery and disposal, need to be established, at national and/or regional levels for the environmentally sound management of e-wastes.

Establishment of e-waste collection, exchange and recycling centers should be encouraged in partnership with private entrepreneurs and manufacturers.

Effective take-back program providing incentivesfor producers to design products that are less wasteful, contain fewer toxic components, and are easier to disassemble, reuse, and recycle may help in reducing the wastes. Hence creating awareness among the e-waste generating sectors is the important task now. Technical audit and Life cycle analysis are also recommended before releasing the electronic consumer product.

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