Review Article

E-waste - Management Practices in India

Archana Thakur[1], Tapas Kumar Ray[2], Manish Kumar Goel[3]

[1]Post Graduate, [2]Professor, [3]Associate Professor, Dept. of Community Medicine, Lady Hardinge Medical College, New Delhi.

Correspondence to:
Dr. Archana Thakur, Post Graduate, Dept. of Community Medicine, Lady Hardinge Medical College, New Delhi.

E-mail Id: archanat786@gmail.com

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Background

With the usage of electrical and electronic equipment (EEE) on the rise, the amount of electrical and electronic waste (e-waste) produced each day is equally growing enormously around the globe. Recycling of valuable elements contained in e-waste such as copper and gold has become a source of income mostly in the informal sector of developing or emerging industrialized countries. However, primitive recycling techniques such as burning cables for retaining the inherent copper expose both adult and child workers as well as their families to a range of hazardous substances.[1] By definition, e-waste or "waste electrical and electronic products" is a term used to cover all items of electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of reuse.[2] Such wastes encompass wide range of electrical and electronic devices such as computers, handheld cellular phones, personal stereos, including large household appliances such as refrigerators, air conditioners, etc.[3] E-waste consists hazardous and non-hazardous waste. It consists of ferrous and non-ferrous metals, plastics, glass, wood and plywood, printed circuit boards, concrete, ceramics, rubber and other items. Iron and steel constitute about 50% of the-waste, followed by plastics (21%), non-ferrous metals (13%) and other constituents. Non-ferrous metals consist of metals like copper, aluminum and precious metals like silver, gold, platinum, palladium and so on. The presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants beyond threshold quantities make e-waste toxic (Table 1).[4] Rapid product innovation, miniaturization and replacement, especially for information and communication technology (ICT) products and consumer equipment, are fueling the increase of e-waste and resulting in immediate and long-term concern[5] because of unregulated accumulation, improper collection and treatment approaches that can lead to major environmental problems endangering human health.

Table 1.Source of E-waste, Component, Toxic Substances in E-waste

PC, Laptop, TV	Printed circuit boards	Lead and cadmium
	Cathode ray tubes (CRTs)	Lead oxide and Cd
	Switches & flat screen monitors	Mercury
	Computer batteries	Cadmium
	Plastic casings cable	Brominated flame retardant
Refrigerator	Capacitors and transformers	PCB

Non-hazardous subs-Fe, Steel, Cu, Al and precious metals like Ag, Au, platinum, palladium, etc.

The Scale of Problem - Global and India

It was estimated that the total amount of e-waste generated in 2014 was 41.8 million metric tons (Mt). It is forecasted to increase to 50 Mt of e-waste in 2018. Asia (16 Mt) was the largest e-waste generator followed by America (11.7 Mt), Europe (11.6 Mt), Africa (1.9 Mt) and Oceania (0.6 Mt). Per-inhabitant e-waste generation was maximum for Europe (15.6 kg/Inh) and Oceania (15.2 kg/Inh).[5]

In 2005, Central Pollution Control Board estimated e-waste generation in India as approximately 1.46 lac tons.[4] In 2007, a study conducted by GTZ for e-waste

assessment revealed that approximately 3.8 lac tons of e-waste was generated in India and 50,000 tons was imported.[6] Recently, United Nations University reported that around 1.7 Mt of e-waste was generated in India in the year 2014.[5] Besides this, e-waste is also imported from various developed countries of Europe and America.[7] According to a recent ASSOCHAM-KPMG joint study, India has become the fifth-largest e-waste producer in the world with whopping amount of 1.85 Mt.[8]

IT sector boom has resulted in mammoth growth of e-waste and to halt this, many countries have adopted e-waste legislation to promote official take back system by producers that means producer or manufacturer will be responsible to manage a streamlined system of 4-waste collection/take back and channelizing it to a registered dismantler/recycler for safe disposal of his product.[9]

In 2014, out of total world population, only 4 billion people were covered by national legislation of e-waste handling rule, but the more devastating fact is 6.5 million tons, i.e., only 15% of total e-waste was collected by official take back systems.[4] According to a report generated by United Nation Environment Programme (UNEP) in 2015, 60-90% of annual e-waste generated in year 2014 was handled informally including illegally traded and dumped in landfills. Developed countries, which are major generators of e-waste, are illegally exporting e-waste to poor developing countries of Asia like India, China, Pakistan, etc.[10] Most developed countries find it financially profitable to send e-waste for re-use/recycling in developing countries. The cost of recycling of a single computer in the United States is US$ 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.

E-waste Management in India

In the year 2008, guidelines for environmentally sound management of e-waste was given by the Ministry of Environment and Forests to address sustainable development concerns, by facilitating the recovery and/or reuse of useful materials and reducing the wastes destined for final disposal and to ensure the environmentally sound management e-waste.[3]

Environmentally sound e-waste treatment technologies are used at three levels as described below:

First-level treatment

1. Decontamination: Removal of all liquids and gases
2. Dismantling: Manual/ mechanized breaking
3. Segregation

Output of first-level treatment

- Segregated hazardous wastes like CFC, Hg switches, batteries and capacitors
- Decontaminated e-waste consisting of segregated non-hazardous e-waste like plastic, CRT, circuit boards and cables

Second-level treatment

1. Hammering
2. Shredding
3. Special treatment processes comprising of (i) CRT treatment consisting of separation of funnels and screen glass; (ii) electromagnetic separation; (iii) eddy current separation; (iv) density separation using water.

The major objective of these two unit operations is size reduction. The third unit operation consists of special treatment processes. Electromagnetic and eddy current separation utilizes properties of different elements like electrical conductivity, magnetic properties and density to separate ferrous, non-ferrous metal and precious metal fractions. Plastic fractions consisting of sorted plastic after the first-level treatment, plastic mixture and plastic with flame retardants after second-level treatment, glass and lead are separated during this treatment. The efficiency of this treatment determines the recovery rate of metal and segregated e-waste fractions for third-level treatment

Third-level Treatment

The third-level e-waste treatment is carried out mainly to recover ferrous, nonferrous metals, plastics and other items of economic value. The major recovery operations are focused on ferrous and non-ferrous metal recovery, which is either geographically carried out at different places or at one place in an integrated facility.

In India, consumers are naturally keen on recovering economic value from waste, creating a thriving informal recycling sector. According to the ASSOCHAM-KPMG study, 95% of e-waste is managed by unorganized sectors leading to various environmental and health hazards which does not

have adequate means for environment friendly disposal of huge amount of such waste.[8] It is estimated that more than 2000 unorganized recyclers along with 270 medium and big scrap dealers are involved in the recycling business in India. Nearly 20,000 to 25,000 numbers of unskilled laborers are involved in the unorganized sector in Delhi alone.[11]

Under informal sectors, e- waste is either being stored in landfills, resulting in leaching of toxic substances, or incinerated or burnt in open areas, releasing toxic gases in the environment. Electronic wastes after being discarded are taken to small towns and villages for further reuse either directly or after some modifications and finally used for recycling, i.e., extracting useful substance like gold, silver, copper from e-waste by rudimentary and unsophisticated processes.[5]

The secondary market of refurbished old electronics products, old components, modules and the metals recycling in unorganized sectors is growing steadily due to substantial demand in rural consumers. One study shows that after spending US$ 12.5-19 per piece for a single computer with color monitor, a trader can earn around US$ 50-60 by selling its disassembled components, modules to different recyclers or re-users and by recovering precious metals and other valuables.[11]

The unorganized sector consists of an assortment of small and informal businesses not governed by any stringent health and environmental regulations. Workers face dangerous working conditions as they may be without protection like gloves or masks. Released gases, acid solutions, toxic smoke and contaminated ashes are some of the most dangerous threats for the workers and for the local environment.[5] Some of the workers work in homes to reprocess waste, further exposing themselves, their families and the environment to dangerous toxins. Delhi, Meerut, Ferozabad, Chennai, Bangalore and Mumbai are the few cities where scrap yards exist.[12] Experts claim that as many as 5 million people who are involved in scraping work often do not have minimal personal protection making them vulnerable to various health problems. It has also been found that 94% of the organizations in IT industries dealing with electronic items did not have any policy on disposal of obsolete IT products and/or wastes. Studies further showed that there is serious lack of awareness in several corporates about environmental and health hazards on account of unsafe disposal of e-waste resulting in casual dumping of hazardous materials in the landfills.[13]

In India, there were 138 e-waste dismantlers and recyclers in the year 2014, registered with Government of India, Ministry of Environment and Forests/Central Pollution Control Board, for handling, recycling and reusing of waste electrical and electronic equipment (WEEE) in an eco-friendly way. The total capacity of these recycling units is 0.35 Mt per annum which is only 21% of total e-waste generation in the country.14

Hazards of E-waste

The toxic substances present in e-waste like heavy metal, acids, plastics, etc., pose a great risk to our environment and therefore to human health and in case sound management practices of e-waste are not implemented, it can make informal sectors workers engaged in e-waste recycling, will remain vulnerable to various health problem making e-waste a health hazard. This can also hinder our progress to sustainable development goals. Various environmental problems are soil pollution due to acidification and heavy metal poisoning, water pollution due to leaching of heavy metals and air pollution due to emission of toxic fumes and gases and vaporization of Hg. Various health problems that can occur are given in Table 2.

Toxic Substance	Health Problems
Lead	CNS, PNS, blood system and kidney damage.
Plastics	Reproductive and developmental problems Immune system damage Interfere with regulatory hormones
Chromium	liver and kidney
Mercury	CNS, kidney , immune system and liver Also secreted in mother's milk
Beryllium	Carcinogenic, lung disease
Cadmium	Carcinogenic, Itai-itai disease, kidney and bones
Acids	Respiratory failure, eyes and skin

E-waste Legislations and Their Impact - Global and India

With a rapid stream of e-waste in the country, the issue of import of e-waste and its handling and disposal has assumed significance. The issue was first time brought to the notice of the government in December 2005.[5] And it took almost half a decade to bring a law for sound and environment friendly management and disposal of e-waste, i.e., E-Waste

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(Management and Handling) Rules 2011. However several Acts and rules are in place for decades for safe handling and disposal of hazardous waste as a whole under the umbrella framework of the Ministry of Environment and Forests. Examples of such rules and guidelines are: Hazardous waste (Management and Handling) Rules enacted in 1989, further amended in 2000 and 2003; Municipal Solid Waste Rules (Management and Handling) in the year 2000.

E-waste has been defined by Hazardous Waste (Management and Handling) Rules and classified under Schedule 2 of this Act, and some of the guidelines for handling municipal solid wastes provided in the Schedules are relevant for the management of e-waste and can be used as a model in the e-waste recycling and disposal scheme. None of the existing environmental laws has any direct reference to the electronic waste or its handling as hazardous in nature.[5]

E-waste rules were implemented in 2011 but there has been very slow progress. Now E-waste (Management) Rules 2016 that shall be implemented from October 2016 provide several options to manufacturers such as collection of a refundable deposit and paying for the return of goods to meet the requirements of law. They classify mercury-laden light bulbs as e-waste, which will keep them out of municipal landfills. Bulk consumers have to file annual returns, another welcome move. An awareness campaign on e-waste will make it easier to implement the rules. Also this new law has come up with targets for extended producer responsibility to be achieved in a phased manner. During first two years, e-waste collection target has been set as 30% of e-waste generation and after 7 years onwards, it has been set as 70% of e-waste generation.[15]

Challenges Ahead in India

1. Lack of data on WEEE: The amount of e-waste generated and disposed of is seriously underestimated. The exact amount may be much higher than what is projected to be. More study and strong reporting system probably may fill the gap.

2. Import of waste materials: India is one of the countries where waste equipment of developed countries has been traditionally exported so far. With shorter life span these materials find their way to the dumping grounds very soon posing a threat to the environmental health. Though Basel convention is in action to restrict trans-boundary shipment of e-wastes across the countries, illegal transportation through hidden route remains a real challenge in India.

3. Dual government stand: Though India is a signatory to Basel convention the government policy does not have strong stand to entirely uproot the importation of e-waste. In contrary, government has given license to each producer to import fixed amount of e-waste every year. This dual government policy may prove detrimental to environment security.[16]

4. Accountability of all stakeholders: There is serious lack of knowledge on the health impact of e-waste. The scrap dealers who are the main sources behind disposal of e-waste in India lack in self-precautionary measures. All the stakeholders starting right from the consumers to the manufacturers should be made aware about the adverse effect and the safe environment-friendly disposal of hazardous waste. A safe and sound environment cannot be ensured unless all the stakeholders in the field of electronic goods realize the noble message, “with great power comes great responsibility.”

Suggestion

Unfortunately, India is lagging far behind as far as the control and management of e-waste is concerned. The gap between growing volume of e-waste and adequate recycling infrastructure is very large and is still continuously increasing. So, the new rules proposed by the Ministry of Environment and Forests to manage electronic waste must be implemented with firm political will to close this gap. Increasing awareness at consumer level by mass media, on product packaging, by hoardings in outlets of electronic equipment and leaflets, pamphlets by these retailers can improve the disposal of electronic waste in a streamlined channel to male it reach the organized sector for sound management of e-waste.

This will decrease the vulnerability of informal sector workers for health problems. Landfill is still being used as a disposal method of e-waste; that should be banned due to non-biodegradable substances present in it. Attracting investment in formal sectors and incorporating informal recyclers in formal sectors will be an enchanting move to curb this problem.

Conflict of Interest: None

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