The health impact of E-waste: Addressing the challenge

Mrs. Amandeep Kaur

Abstract— Electronics waste is currently the large growing waste stream. E- Waste is being discarded in the general waste stream. The paper explores the sources and flow of E-Waste, the risk it poses to the environment and health issues of the workers involved. It is hazardous, complex and expensive to treat in environmentally sound manner and there is a general lack of legislation or enforcement surrounding it. Today most of the E Waste is being discarded in the general waste stream. The paper explores the sources and flow of E-Waste, the risk it poses to the environment and health issues of the workers involved.

Index Terms— E-waste,EEE, WEEE, CRTs, EPR, PVCs, PBBS.

1 INTRODUCTION

India generates about 1,46,180 tons of E-waste every year. This is contributed by households and corporate houses as well as illegal dumping from developed countries. Electronic products often contain hazardous and toxic materials that pose environmental risks if they are land filled or incinerated [1]. Televisions, video and computer monitor use cathode ray tubes (CRTs), which have significant amounts of lead. Printed circuit boards contain primarily plastic and copper, and most have small amounts of chromium, lead solder, nickel, and zinc. Large number of women and children are employed in this sector involved in high risk backyard operations poses to Occupational and environmental health hazards [3]. Industrial revolution followed by the advances in information technology during the last century has radically changed people's lifestyle. Although this development has helped the human race, mismanagement has led to new problems of contamination and pollution. The technical prowess acquired during the last century has posed a new challenge in the management of wastes. For example, personal computers (PCs) contain certain components, which are highly toxic, such as chlorinated and brominated substances, toxic gases, toxic metals, biologically active materials, acids, plastics and plastic additives.

2 FLOW OF E-WASTE IN SOCIETY

2.1 Material flow analysis

WEEE collection and recycling activity basically consists of the dismantling and recovery of metals/scrap. Generally, an income hierarchy exists within this sector, where those at the bottom of the collection chain are the most numerous and earn the least in terms of quantities of waste and numbers of people involved, the bulk of WEEE collection and recycling is performed by the informal sector [9].

During the survey, an agreement regarding the price per kilo was reached between the representative of a new formal recycling company and the informal manager (wholesale intermediary) of the dump wandering waste collectors also called rag pickers; they scour the city with a cart and collect recyclable waste from public rubbish bins, factories and dumps. There are no wandering waste collectors that specialize in WEEE as, according to them, the product is difficult to sell on. Some go from house to house, offering to buy EEE (old models sold at very low prices, or sometimes given away) [9].The lfe cycle flow of e-waste with in India is shown in figure 1.

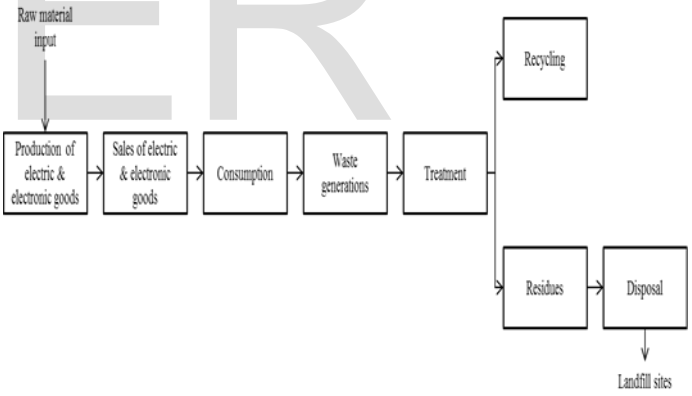

Fig. 1 Life cycle of E-Waste

The complexity of the e-waste flow within India is shown in figure 2. Not only does thee-waste originate from a number of different sources, but the different stakeholders involved in the value chain are also interlinked with each other. Consequently, the e-waste does not follow one set path [2].

Most e-waste ends up with scrap traders and dealers who, for economic reasons, commonly transfer it on to the informal sector. The flow of e-waste follows a path involving preliminary, secondary and tertiary stages. Preliminary e-waste workers obtain e-waste from the formal organized market composed of manufacturers, importers, offices and so on. These stakeholders are mainly scrap dealers and dismantlers who have the ability to bid for and store large amounts of e-waste [4].

• *Mrs Amandeep Kaur is currently working as Assistant Professor in Dept. of Civil and Environmental Engg. at ITM University Gurgaon, Haryana, India, PH-00918010735434. E-mail: aman_sandhu_83@yahoo.co.in*

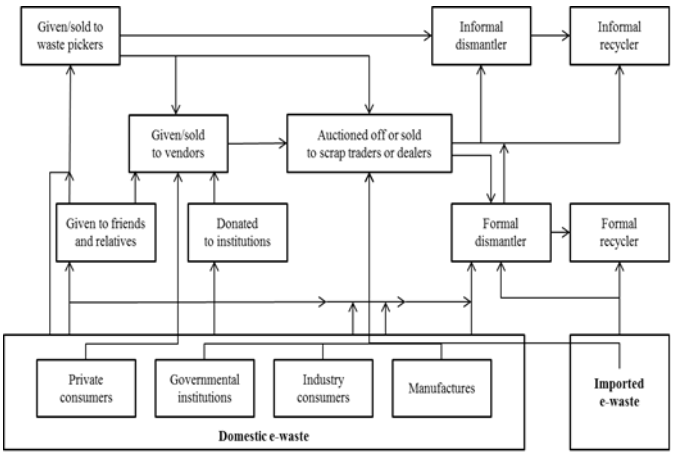

Fig 2.Simplified diagram of flow of E-Waste in India

The main issues posed by e-waste are as follows:

High volumes – High volumes are generated due to the rapid obsolescence of gadgets combined with the high demand for new technology [14].

Toxic design – E-waste is classified as hazardous waste) having adverse health and environmental implications. Approximately 40 per cent of the heavy metals found in landfills come from electronic waste [6].

Poor design and complexity – E-waste imposes many challenges on the recycling industry as it contains many different materials that are mixed, bolted, screwed, snapped, glued or soldered together. Toxic materials are attached to non-toxic materials, which makes separation of materials for reclamation difficult. Hence, responsible recycling requires intensive labour and/or sophisticated and costly technologies that safely separate materials [14].

Labour issues – These include occupational exposures, informal sector domination causing health and environmental problems, lack of labour standards and rights [15].

Financial incentives – In general, there is not enough value in most e-waste to cover the costs of managing it in a responsible way. However, in line with EPR policies, new opportunities can be realized with the rise in the price of many of the materials in electronics, such as gold and copper. Furthermore, with rising e-waste quantities, formal recyclers are increasingly entering the e-waste recycling sector [15].

Lack of regulation – Many nations either lack adequate regulations applying to this relatively new waste stream, or lack effective enforcement of new e-waste regulations [14].

A great deal of attention has been given to the impact that e-waste has on human health, especially on the health of the informal recycling workers in India. The lack of monitoring and regulation by the government can mean that little-to-no safety precautions (such as wearing protective gear and air filtering) are taken to protect workers while they carry out their job [9].

The health hazards that people who dismantle or recycle e-waste are exposed to are devastating, and often render them incapable of working once they reach the age of 40. Recyclers and dismantlers have recorded dangerously high levels of lead, mercury and chromium in their bodies. It is estimated that 95 percent of e-waste in India is recycled via the non-formal sector which often entails child labour. Most of these children are unaware of the long term effects but have no alternatives. It is difficult to concretely say how much e-waste currently exists in India, however according to a 2007 study, it was estimated that e-waste could increase by 500 percent by 2020. While e-waste poses immediate threats to the health and welfare of informal laborers across India, it also harbours substantial environmental risks [3].

2.2 E-waste: It's implications

Electronic products often contain hazardous and toxic materials. Televisions, video and computer monitor use cathode ray tubes (CRTs), which have significant amounts of lead.

Printed circuit boards contain primarily plastic and copper, and most have small amounts of chromium, lead solder, nickel, and zinc. In addition, many electronic products have batteries that often contain nickel, cadmium and other heavy metals. Relays and switches in electronics, especially older ones, may contain mercury. Also, capacitors in some types of older and larger equipment that is now entering the waste stream may contain polychlorinated biphenyls (PCBs).Environment leakage through emission and leaching (ground water, air, surface) [6]

The main risks to human health and the environment arise from the presence in e-waste of heavy metals, POPs, flame retardants and other potentially hazardous substances. There are three main groups of substances that may be released during recycling and material recovery, and which are of concern: original constituents of equipment, such as lead and mercury; substances that may be added during some recovery processes, such as cyanide; and substances that may be formed by recycling processes, such as dioxins. If improperly managed, such substances may pose significant human and environmental health risks.

Toxic substances can be found within the following types of emissions or outputs [8]:

- leachates from dumping activities
- particulate matter (coarse and fine particles) from dismantling activities
- fly and bottom ashes from burning activities
- fumes from mercury amalgamate "cooking", desoldering and other burning activities
- wastewater from dismantling and shredding facilities
- Effluents from cyanide leaching and other leaching Activities [12].

An environmentally sound e-waste recycling chain contains the following steps:

- Demanufacturing into subassemblies and components-this involves the manual disassembly of a device or component

to recover value.
- Depollution – the removal and separation of certain materials to allow them to be handled separately to minimize impacts, including batteries, fluorescent lamps and cathode ray tubes (CRTs water, soil) [3].
- Materials separation – manually separating and Preparing material for further processing
- Mechanical processing- of similar materials this involves processing compatible plastic resins, metals or glass from CRTs to generate market-grade commodities
- Mechanical processing of mixed materials this involves processing whole units followed by a series of separation technologies
- Metal refining/smelting – after being sorted into components or into shredded streams, metals are sent to refiners or smelters. At this stage, thermal and chemical management processes are used to extract metals [12].

The potentially hazardous elements found in E-Waste are:
- Lead (Pb)
- Cadmium (Cd)
- Mercury (Hg)
- Hexavalent Chromium (Cr)
- PVC (Polyvinyl Chloride Plastics)
- Brominated Flame Retardants (Pb)

a) Lead
- Lead accumulates in the environment and has high acute and chronic toxic effects on plants, animals and microorganisms.
- Lead is known to cause damage to the central and peripheral nervous systems, blood system and kidneys in humans.
- Effects on the endocrine system have been observed, and serious negative effects on children's brain development are well documented.
- Lead existing in land filled products has the potential to leach and contaminate drinking water supplies.
- Lead is found in soldering of printed circuit boards and other electronic components.
- Lead is also found in glass panels in computer monitors (CRTs) [4].

b) Cadmium
- Cadmium compounds are classified as toxic with a possible risk of irreversible effects on human health.
- Cadmium and cadmium compounds accumulate in the human body, in particular in the kidneys.
- Cadmium shows a danger of cumulative effects in the environment due to its acute and chronic toxicity [2].
- It is found in certain components such as SMD chip resistors, infrared detectors and semiconductors.
- Cadmium is also found in older models of cathode ray tubes (glass panels in computer monitors) and in plastics as a stabilizer [5].

c) Mercury
- Mercury has been shown to accumulate in living organisms and concentrate through the food chain, particularly in fish.
- Negative effects on brain functioning and development have been attributed to mercury [13].
- Mercury is found in:
  i. Thermostats
  ii. Position censors
  iii. Relays and switches
  iv. Discharge lamps
  v. Batteries
  vi. Printed wiring boards

d) Hexavalent Chromium
- Chromium can cause strong allergic reactions, even in small concentrations.
- It is found in untreated and galvanized steel plates [1].

e) PVC (Polyvinyl Chloride Plastics)
- The production and burning of PVC products generates dioxins and furans, which contribute to air pollution and respiratory ailments.
- PVC is found in cabling and computer housing [5].

f) Brominated Flame Retardants
- Research has concluded that exposure to these chemicals in early life could induce neurotoxin effects similar to those caused by other toxic substances such as some pesticides.
- Exposure to Polybrominated Biphenyls (PBBs) is believed to cause an increased risk of cancer of the digestive and lymph systems.
- PBBs are found in:
  i. Printed circuit boards
  ii. Components such as connectors, plastic covers and cables
  iii. Plastic covers of TV sets [5]

2.3 E-waste: It's solution

Reuse is the environmentally preferable option by extending the life of old equipments that defers the pollution and resource consumption associated with in making new products.

Reuse provides opportunity, to the underprivileged that cannot afford or have no access to electronic equipment, at reduced or no cost.

Electronic equipments which commercially & practically not good for reuse or is broken beyond repair, may be sent for disassembly i.e. salvaging parts, and selling reclaimed materials like ferrous, non ferrous, plastic, glass.

Several electronic equipments, such as computers, monitors, printers, and scanners, contain materials suitable for reclamation and use in new products. These may include plastic, glass, steel, aluminum, copper, gold, silver, and other metals.

3 CONCLUSION

The health impact of e-waste is evident. There is no doubt that it has been linked to the growing incidence of several lethal or severely debilitating health conditions, including cancer, neurological and respiratory disorders, and birth defects. This impact is found to be worse in developing countries like India where people engaged in recycling e-waste are mostly in the unorganized sector, living in close proximity to dumps or landfills of untreated e-waste and working without any protection or safeguards. Many workers engaged in these recycling operations are the urban poor and unaware of the hazards associated with them. For instance, such recycling activities lead to the deterioration of local drinking water which can result in serious illnesses. Now, more than ever, the proper treatment of e-waste needs to start taking place, so that not only human suffering is averted now and in the foreseeable future, but so that the long-term degradation of our environment, ecosystem and health is averted as well.

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