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E-WASTE:HAZARDS AND ITS PROBABLE SOLUTIONS

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ABSTRACT

Electronics industry is one of the fastest growing industries over worldwide. With this development we are also increasing the size of electronic waste or e-waste. The rapid growth of electronics and IT industry increases the consumption rate of electronic items and has led to disastrous environmental consequences. The varieties of the toxic substances present in these goods contaminate the environment and threaten human health. The consequences and toxicity is due to discharge of lead, mercury, cadmium, beryllium and other toxic substances. Developing countries are the main hubs of e-wastes as they developed countries export there wastes in the form of donation to these countries. This paper gives a general idea of venomous substances present in e-waste, their possible impacts on environment and human health. To overcome this and to manage e-waste we have to design devices which are eco friendly, proper collection and recycling of materials by safe methods, raise the awareness of the impacts of e-waste and to stop the transfer or e-wastes from developed countries to developing countries in the name of donation.

Keywords—*Electronic waste, electronic goods, hazards, human health.*

I. INTRODUCTION

In today's scenario managing electronic waste or e-waste is one of the most hastily emerging pollution problems all over the world. Each and every day new technologies are being come into existence, which surpasses the older technologies. This leads the older technology based electronic devices to come under the category of wastes. Although they are hazardous not only to health but also to the environment still they have to be buried under land or to left as it is. The lifetime of many electronic commodities has been shortened to a very large extent due to advancements in technologies, eye-catching end user designs and marketing and compatibility issues. We can say so because the average life of a new computer was 4.5 years in 1992 which has now decreased to a projected 2 years in 2005 and is still decreasing in a much faster rate [1], consequentially in much greater volumes of computers for either export to developing countries or for disposal. [2] gave an overview of the volume of e-wastes generated in countries like in China, Japan and US.

This report estimates that over 130 million computers, monitors and televisions become outdated annually and that the annual number is growing faster in the United States. approximately 500 million computers became archaic between 1997 and 2007 in the United States only and 610 million computers had been useless in Japan by the end of December 2010. In China 5 million new computers and 10 million new televisions have been purchased every year from 2003 [3] and every year approximately 1.11 million tonnes of e-waste is generated. It is logical to presume that comparable amounts of e-waste are being generated in other parts of the globe. Generation of e-waste generation in developing countries is not such a cause of concern at this point because in these countries electronic goods are in smaller number and also have a longer half-life of in those developed countries. This is due to the financial constraints of developing countries, on both local community and national scales. Nevertheless 80% of all the e-wastes which are less eco friendly and older are being imported from western countries, which are the major concern for developing countries [3].

Restricted legislation, safeguards, policies and enforcement of the safe disposal of imported electronic goods and e-waste have led to serious human and ecological tribulations in these developing countries. [4][5][6][7][8][9][10] has already noted some case studies from China where e-waste disposal creates a colossal negative impacts on human health.

The developing countries not only has to deal with such big volume of e-wastes but also suffers critical environmental and health issues to its people, which is a major concern. It was already been demonstrated by a number of researchers that e-waste generates toxic metals and polyhalogenated organics including polychlorinated biphenyls (PCBs) and polybrominated
diphenyl ethers (PBDEs) which can create serious risks to humans and the environment. [11][12] [13].

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II. DEFINITION OF ELECTRONIC WASTE OR E-WASTE

Puckett et al. [14] define e-waste as "a broad and growing range of electronic devices ranging from large household devices such as refrigerators, air conditions, cell phones, personal stereos, and consumer electronics to computers which have been discarded by their users". According to [15], "e-Waste can be classified as any electrical powered appliance that has reached its end-of-life". In the meantime, a file of customary definitions has been provided by [16]. In [17] and [16] the terms "E- Waste" and "WEEE" synonymously used. Any white goods, consumer and business electronics, and information technology hardware that is in the end of its useful life. Electronic waste may be defined as discarded computers, office electronic equipment, entertainment device electronics, mobile phones, television sets and refrigerators. E-wastes are considered dangerous, as certain components of some electronic products contain materials that are hazardous, depending on their condition and density. The hazardous content of these materials pose a threat to human health and environment. Discarded computers, televisions, VCRs, stereos, copiers, fax machines, electric lamps, cell phones, audio equipment and batteries if improperly disposed can leach lead and other substances into soil and groundwater.

III. SOURCES OF E-WASTE

E-waste consists of every squander from electrical and electronic appliances which have reached their end- of-life period or are no more fit for their novel future use and are ordained for recovery, re-cycling or disposal. It includes computer and its associated accessories like monitors, keyboards, printers, CPUs; typewriters, mobile phones and chargers, remotes, headphones, compact discs, batteries, LCD/Plasma TVs, air conditioners, microwave ovens, refrigerators and other household appliances [18]. The composition of e-waste is varied and falls under two categories 'hazardous' and 'non-hazardous'. Mostly, it consists of ferrous and non-ferrous metals, glass, plastics, wood and plywood, concrete, rubber, ceramics, printed circuit boards, and other items. Iron and steel comprises about 50% of the total wastes, followed by plastics (21%), non-ferrous metals (13%) and other constituents. Non-ferrous metals consist of metals like aluminium, copper, and expensive metals also like gold, silver, platinum, palladium and so on [19]. The presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants beyond verge quantities make e-waste hazardous in nature. It contains over 1000 dissimilar substances, many of which are toxic, and creates severe pollution upon disposal [20]. Obsolete computers pose the most significant environmental and health hazard among all the e-wastes.

I. Places where E-Waste ends up.

- *Landfill:* According to the US EPA, more than 4.6 million tons of e-Waste ended up in landfills in 2009. Toxic chemicals in electronics products can leach into the land over time or be released into the atmosphere, impacting nearby communities and the environment.
- *Incineration:* In this process heavy metals like lead, cadmium, and mercury are released into the atmosphere, which can bio accumulate in the food chain, particularly in fish, which is the major source of exposure for the general public.
- *Reuse:* This increases the product's lifespan. Many older products are exported to the developing countries. Although there are benefits of reusing electronics still the practice is causing serious troubles and so hazardous waste are generated.
- *Recycle:* Although recycling can be a good way to reuse the raw materials in a product, the hazardous chemicals in E-waste mean that electronics can harm workers in the recycling areas, as well as their neighboring communities and the environment.
- *Export:* E-Waste is regularly exported by developed countries, repeatedly in violation of the international law. Developing countries are becoming a dumping place.

IV. EFFECTS OF E-WASTE ON HIMAN HEALTH AND ENVIRONMENT

E-waste consists of a large range of materials [21], some of which contain a range of toxic substances and if they are not managed appropriately they can be the possible threats to human health and a basic environment pollution ingredient. E-waste disposal methods include incineration and landfill, both of which cause substantial contagion risks. Incineration in an incinerator can emit toxic gases into the air whereas land filling potentially transports toxic substances into groundwater. Recycling of e-waste also give out hazardous substances into the atmosphere and may influence human health. There are more than 1000 toxic substances [22] associated with e-waste. The more frequently reported substances include: toxic metals (like barium (Ba), cobalt (Co), beryllium

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(Be), cadmium (Cd), copper (Cu), chromium (Cr), nickel (Ni), iron (Fe), mercury (Hg), lead (Pb), lithium (Li), lanthanum (La), manganese (Mn), molybdenum (Mo), silver (Ag), hexavalent chromium (Cr(VI)) and persistent organic pollutants (POPs) such as dioxin, brominated flame retardants (BFRs), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs), polybrominated
dibenzo-p-dioxins and dibenzofurans (PBDD/Fs), and polyvinyl chloride (PVC).
E-waste disposals impact human health in two ways:
(1) Food chain: contamination by toxic substances from disposal and primitive recycling processes that result in byproducts entering the food chain and thus transferring to humans; and
(2) Direct impact on workers who labor in primitive recycling areas from their occupational exposure to toxic substances. Along with this, numerous researchers have demonstrated a direct impact of backyard recycling on workers. The danger of e-waste toxicity to human health, both in terms of chronic and acute conditions, has become a serious societal problem .Blood, serum, hair, scalp hair, human milk and urine from people who lived in the areas where e-wastes are being recycled showed the presence of significant concentrations of toxic substances.

Table I: Effects of E-Waste Constituents on Health

Source of e-wastes	**Constituent**	**Health effects**
Solder in printed circuit boards, glass panels and gaskets in computer monitors	Lead (Pb)	Damage to central and peripheral nervous systems, blood systems and kidney damage. Affects development of brain in children.
Chip resistors and Semi-conductors	Cadmium (Cd)	Toxic irreversible effects on human health, Accumulates in kidney and liver, Causes neural damage, Teratogenic.
Relays and switches, printed circuit boards	Mercury (Hg)	Chronic damage to the brain, Respiratory and skin disorders due to Bio-accumulation in fishes
Corrosion protection of untreated and galvanized steel plates, hardner for steel housings	Hexavalent chromium (Cr) VI	Asthmatic bronchitis, DNA damage

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Cabling and computer housing	Plastics including PVC	Burning produces dioxin, causes reproductive and developmental problems; Immune system damage; Interfere with regulatory hormones
Plastic housing of electronic equipments and circuit boards	Brominated flame retardants (BFR)	Disrupts endocrine system functions
Front panel of CRTs	Barium (Ba)	Short term exposure causes: Muscle weakness; Damage to heart, liver and spleen.
Motherboard	Beryllium (Be)	Carcinogenic (lung cancer) Inhalation of fumes and dust. Causes chronic beryllium disease or beryllicosis. Skin diseases such as warts

Breathing of released fire emissions can elicit asthma attacks, respiratory infections, and can cause other severe and irritating problems like chest pain, wheezing, coughing, and eye irritation [23].
For instance, burning of PVCs releases hydrogen chloride which when inhaled mixes with water in our lungs and structures hydrochloric acid (HCl). This can direct to corrosion of the lung tissues, and numerous respiratory complications. Table I gives a brief overview of health risks because of e-waste.

V. PROBABLE SOLUTIONS

There is actually no exceptional or ultimate model for the management e-waste in developing countries like India, and where each type of e-waste has its own explicit social, environmental, economic technological, and cultural conditions.
Environmentally sound management of electronic wastes recognizes three R's i.e. reduce, reuse and recycle. The aim would be to reduce the generation of e-waste through well-groomed manufacturing and maintenance, reuse till the functioning of the electronic equipments by some needy person and recycle those components that by any means cannot be repaired. A smart and efficient e-waste management system has to be framed for developing countries and which can be formulated in a large scale.
The main aspects to be taken into account when framing e-waste management strategies for developing countries are:

- Defining responsibilities of prime stake holders at the government level, supply chain, end users of electronic equipments and entities for waste disposal.
- Extended producer responsibility (EPR) where the manufacturer's responsibility for its electronic equipment extends throughout the diverse stages of the equipment's life cycle.
- Responsible information system to have data on electronic equipment in market, disused electronic management and to have power over the monitoring and future planning.
- Policy and regulations covering import and export of e-wastes in agreement with the rules of each developing country and with the international legislation.

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- Promoting employment, awareness and training for the informal sector engaged in the recycling and recovery of the electronic materials.

But out of all these us as consumers and responsible citizens of our country should also involve ourselves actively in e-waste management. Because at the end it is us, the human being who will adversely get affected by these wastes, which will lead serious health and environmental issues. So we have to follow some of the below mentioned rules while buying electronic goods:

- Buy those goods which are made up with fewer toxic constituents, and for this you need to use internet.
- Try to use recycled materials.
- See if they are energy efficient or not.
- Check if they are designed for easy advancement or disassembly.
- Equipment should utilize minimal packaging.
- Companies offer leasing or take back options which have been certified by the regulatory authorities.

Some concern organizations already helping the cause are: www.USGS.gov, www.retroworks.com, www.ban.org, www.mineralpolicy.org, www.mpi.org.au, www.moles.org, www.copper.org, www.antigraymarket.org. Over 200 international restore shops like www.exporters.com.sg, www.recycle.net, www.exporters.com/sg, www.alibaba.com, www.globalrecycle.net, etc. Sales of parts and restoration on www.ebay.com Scrap alum, copper, plastic sold directly to end users at www.globalrecycle.net

The government of developing countries should consider the following points for an efficient management of e-waste:

- Total ban on imports of electronic waste.
- Formulate strict legal agendas to tackle these gaps in import of electronic waste.
- Need to aware safe disposal of domestic e-waste.
- Tie recycling with take-back product.
- Focus on reuse and recycling of E waste.
- Policies that can attract investors in this sector.
- Devise activities which can bridge the gap between informal and formal sectors.
- Recyling and disposal industries should be subsidized.
- Incentive schemes for garbage collectors and general public.
- Awareness program on recycling.
- Promote recycling units and to encourage generators to have proper e-waste disposal.
- Promote plenty of ESM technologies for recycling.
- Incorporate precautionary principles and polluter pays.
- Impart training on e-waste handling.
- Fix duties and responsibilities to recyclers.
- Tax incentives for scrap dealers.
- Reward and reprimand schemes for performance and non-conformity of e-waste management

VI. CONCLUSION

E-waste is a severe setback at both scales, locally and globally. The problems of e-waste was initially developed in developed countries and later spread to the whole world. The level of e-wastes are increasing surprisingly in a higher rate, on a per day basis. Because of the rapid changes and advancements in technology the e-goods are very quickly comes under the category of e-wastes that to within a span of 3 to 4 years generating substantial amounts of e-waste. E-waste constitutes many sources of toxic materials that contaminates our environment and if they are not managed intelligently they can possess a threat to human life and their well being. So we all not only the governments or the nonprofit organizations, we the common people should also have to join hands for this issue also. Such electronic goods should be produced that can have long life span, which can be reused and recycled. Government should impart license to those industries which have e-waste management policies and produces eco friendly e-goods. Last but not the least it is us from where we have to start working.

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