

E-Waste: An Emerging Problem of Innovative Society

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Abstract– In the past few years there is a revolution in electronic industry, which increases the volume and varieties of both solid and hazardous wastes. Urbanization Industrialization, fast changes in technologies leave a negative impact on health of human beings. Also increases the pollution in air, land and water. A growing municipal waste contains hazardous electrical and electronics products. When dumped in landfill will pollute the environment badly. This waste is usually named as E-waste (Electrical and Electronics Waste). In the absence of suitable techniques and protective measures, recycling e-waste can result in toxic emissions to the air, water and soil and pose a serious health and environmental hazard-waste is assuming serious proportions in developing countries and urgent steps need to be taken to mitigate this problem. This paper highlights the problem posed by e-waste and its hazards on environment and health

Keywords– E-waste (Electrical & Electronic waste), carcinogen, landfills

I. INTRODUCTION

During the last few years, there is an increasing acknowledgment of our impact on the environment due to our lifestyle, while the need to adopt a more sustainable approach concerning our consumption habits emerges as of particular significance. This trend regards industrial sector affecting the consumption habits and especially electronic industry where the short life cycles and the rapidly developing technology have led to increased E-waste volume [3]

Electrical and Electronics waste, also known as Electronic waste or waste electrical & electronics equipment (WEEE), or in short called E-waste, is used to describe obsolete or end of life electrical & electronics equipment [4]. There is no generally accepted definition of E-waste around the world[2]. According to the European Union directive WEEE means Electrical or Electronic Equipment which is waste within the meaning of article 1(a) of directive 75/442/EEC, including all components, subassemblies and consumables which are part of the product at the time of discarding. However E-waste most often misunderstood as comprising only computers related IT equipment or email spam[5]. It is universally understood as electronic waste disposed of by end users and a wide range of products, from simple devices to complex goods. Therefore E-waste comprises both white

goods such as refrigerators, washing machines and microwaves, and brown goods which consists of TV, Radios and Computers that have reached their ends for their current holder[6].

E-waste mainly comes from several sources:

- Residue or leftover materials from electronic products manufacturing process
- Leftover parts or materials or discarded EEE generated from a repair shop
- Obsolete EEE coming from all sector of society like government offices, Companies, Education institutes, Household etc
- Obsolete electrical or electronic products brought in by smuggling [7].

The production of electrical & electronic equipment (EEE) is one of the fastest growing global manufacturing activities. Rapid economic growth, coupled with urbanization and a growing demand for consumer goods has greatly increased both the consumption and the production of EEE [8][9][10]

II. MAGNITUDE OF PROBLEM

The magnitude of the problem is really huge and scary. According to UNEP, global E-waste generation is growing by about 40 million tons a year, and predicts that by 2020 in South Africa & china E-waste from old computers will jump by 200 to 400% from 2007 levels and by 500% in India [2]. Developing countries are the major dumping grounds for E-waste. By 2020 there will be increase by 400 to 500%. The spectrum of hazardous E-waste Mountain looms large especially for developing countries with serious consequences for the environment and public health[11]. The global E-waste production is accessed at 20-50 million ton/year, equal to 1-3% of the estimated global urban waste production. Personal computers, Cell phones and TV will contribute 5.5 Mt in 2010 and will increase to 9.8Mt in 2015. In developed countries E-waste will stand for 8% of the urban waste volume[3]. Each

item's participation in the annual E-waste production(kg/year),depends on each electronics' item's mass M(Kg),its quantity (number) in the market and consumption(N) and its Average life cycle L (year).

$$\text{Estimated Life } E = MN/L$$

For computers with an average 3 years life cycle contributes to a greater extent to the total E-waste flow compared to refrigerators and electric stoves, having an average of 10-12 years [12].Certain electrical & electronics equipment's which form the major part of the E-waste generation along with their mass and estimated life cycle are summarized in Table 1.

TABLE 1

ELECTRICAL & ELECTRONICS EQUIPMENTS & THEIR ESTIMATED LIFE

Items	Mass(Kg)	Estimated Life(Yrs)
Personal Computer	25	3
Cell Phones	0.1	2
Television	30	5
Fax Machines	3	5
AC	55	10
Photo copier	60	8
Washing Machine	65	8
Refrigerator	35	10
Microwave	15	7
Vacuum Cleaner	10	10

III. IMPACT ON HEALTH & ENVIRONMENT

E-waste cannot be considered or treated like any kind of waste, because it contains hazardous and toxic substances such as heavy metals or others such as dioxins and furans (produced when E-waste is incinerated).For instance, lead represent 6% of the total weight of a computer monitor. It is been reported that nearly 36 chemical elements are incorporated in electronic equipment's [13].Electronic wastes can cause widespread environmental damage due to the use of toxic materials in the manufacture of electronics goods. Hazardous metals such as lead (Pb) ,Mercury(Hg) and hexavalent chromium[Cr(VI)],in one form or the other are present in such wastes primarily consisting of cathode ray tubes(CRTs),PCB, capacitors, mercury switches ,relays

.batteries etc. Liquid Cr tetardants on PCB, LCD, cartridges from photocopying machines, selenium drums etc. Land filling of E-waste can lead to the leaching of lead (Pb) into the groundwater and leads to un-portability of water. If the CRT is crushed and burned, it emits toxic fumes into the air cause air pollution, which are very hazardous to human being as well as animals. A rechargeable battery which contains toxic substances that can contaminate when burned in incinerators or disposed of in landfills .E-waste is much more hazardous than many other municipal wastes. Long term exposure to these substances damages the nervous system, kidney, reproductive system, endocrine system and bones. It also leads to carcinogen (cancer).Workers in E-waste recycling or disposal sector are poorly protected against the risk of it. They dismantle E-waste, often by hand in very unhealthy conditions. The hazardous substances found in the E-waste are considered dangerous to health. Inhaling or handling such substances and being in contact with them on a regular basis can damage the main organs of the human body. Working in poorly-ventilated enclosed areas without masks and technical expertise result in exposure to dangerous and slow poisoning chemicals. Due to lack of awareness, workers are risking their health [15][14].Scientist who examined Guiyu, China(one of the popular destinations of E-waste recycling activities) have determined that because of waste, the location has the highest level of cancer causing dioxins in the world. Pregnant women are six times more likely to suffer a miscarriage, and seven out of ten kids have too much lead (Pb) in their blood [17]. E-waste is not alone factor in causation of environmental and health problems but its inadequate management which plays as a catalyst in the magnitude of the problem.

IV. STRATEGIES FOR REDUCTION OF E- WASTE

The best option for dealing with E-waste is to reduce the volume. Designers should ensure that the product is built for re-use and/or upgradability. Stress should be laid on use of less toxic, easily recoverable and recyclable materials which can be taken back for refurbishment, remanufacturing, disassembly and reuse. Recycling and reuse of material are the next level of potential options to reduce E-waste. Recovery of metals, plastic, glass and other materials reduces the magnitude of E-waste. These options have a potential to conserve the energy and keep the environment free of toxic materials that would otherwise have been released. It is high time the manufactures, consumers, regulators, municipal authorities and policy makers take up the matter seriously so that the different critical elements are addressed in an integrated manner. It is need of the hour to have an "E-waste policy "and national regulatory framework for promotion of such activities. An E-waste policy is best created but those who understand the issues. So it is best for industry to initiate policy formation collectively, but user involvement. Sustainability of E-waste management system has to be ensured by improving the effectiveness of collection and recycling system (e.g: public-private partnership in setting up buy back or drop off center) and by designing in advance funding [1][15].The E-waste generated every year globally is

40-50 million ton out of which 15 to 20 % is recycled and remaining is dumped in landfills/incinerators. If we have a good and effective recycling system and good policies to carry recycling process than we can sustain our natural resources which is depleting very fast

V. E-WASTE MANAGEMENT

To have a better management of E-waste the end user should be aware of the hazardous affects of E-waste. Proper awareness should be given and in turn survey should be conducted to find what people are doing with their E-waste. Is they are just dumping in the store room or selling to scrap people or they are giving back to the company .Find the amount of E-waste generated, by surveys from all sector of society, awareness program to educate the people how to reuse the existing Electrical & Electronics products. Next step will be the design of a proper E-waste management system to reduce and to recycle the E-waste generated. The first in the process is to collect the E-waste from all sector of the society i.e from companies, institution, residential, hospitals etc.

The second step involved to manage the E-waste is to apply the principle of three R i.e. Reduce, Reuse and Recycle. As the duty of the user is that try to minimize the E-waste generation by up grading the system or repair it. If those things will not give the expected output then try to resale or recycle it. Many companies have take back schemes. Segregation & dismantling of the various equipment or components is the third step where under proper environment this process is carried out. In the recycling process we can recovery many valuable materials and metals. Which can be reused? The last part is the hazardous materials disposal that has to be done with at most cares.[1][2][16]

VI.NEED FOR E-WASTE POLICY AND REGULATION

The policy should address all issues ranging from production and trade to final disposal, including technology transfer for the recycling of electronics waste. Clear regulatory instruments, adequate to control both legal or illegal exports and imports of E-waste and ensuring their environmentally sound management should be in place. According to the EU the designers and the manufactures have to obey the RoHS directive which bans or restrict the use of certain hazardous substances like lead and its compound, Cadmium and ,its compound, Mercury, hexavalent chromium, polybrominated biphenyls[1].The regulations should prohibit the disposal of E-waste in municipal landfills and encourage owners and generators of E-waste to properly recycle the waste. Manufactures of products must be financially, physically and legally responsible for their products. Better management of hazardous substances may be implemented through measures such as

- Specific product take back obligations for industry.
- Financial responsibility for actions and schemes
- Greater attention to the role of new product design. Follow RoHS directives.

- Greater scrutiny of cross border movements of electrical & electronic products and E-waste
- Increasing public awareness by labeling products as “Environmental Hazard”
- Personal protection measures (masks, Gloves, shields, protective glasses etc) should be made available to all the workers who are engaged with E-waste management.

The key questions about the effectiveness of legislation would includes

- What is to be covered by the Term Electronic Waste
- Who pays for disposal is the producer responsibility the answer.
- What would be the benefits of voluntary commitments
- How can sufficient recovery of materials be achieved to guarantee recycling firms a reliable and adequate flow of secondary materials [18].

A. *Benefits of E-Waste*

- Conservation of natural resources
- Preventing soil, water and air contamination by toxic chemicals.
- By back offers for consumers
- Creates new jobs in the market
- Creates new markets for secondary materials and components

B. *Energy Efficiency [19][16]*

Reduction of energy requirement, cost involved in E-waste recycling is comparatively less than the cost involved in mining and processing of new materials from scratch. Recycling of Aluminum can save 95% of energy than production from basic ore. Recycling of plastic can save 70% of energy and glass up to 40%.Recovering of metals from recycling process generates only a fraction amount of CO₂ emission compared from natural process. Innovation in E-waste treatment should focus on the major needs to improve overall sustainability [1][18].Some of the policies in place globally for effectively managing E-waste are mention in table 2.

TABLE 2
REGULATORY MODEL

	Producers Responsibility	Government Responsibility
Model	Commonly known as EPR Manufacturers financially responsible beyond point of sale. Take back Schemes & recycle them up to a defined percentage by the manufacturers Funding model for this activity varies from company to company	End consumer taxed a recycling fee on the purchased product. This Tax/Fees is used to fund the E-waste collection & recycling activity Government is responsible to monitor & collect the E-waste
Current Examples	European Union Japan, South Korea, Taiwan	Switzerland California(USA)
Likely Implications	Pressure on manufacturers to follow RoHS directive	No incentives for manufacturer to create cleaner design.E-waste not likely to reduce as manufacturers do not have any liability

VII. CONCLUSION

The Electronic market has revolutionized the whole world over last decades as Electrical & Electronics products increasingly capture the major part of our lifestyle. While no one can give the exact figures how much E-waste is presently generated or how much of this is hazardous, what is definite is that if we the people living in the innovative society don't try to manage the E-waste properly then E-waste have the potential of threatening human health and its environment. Initiatives are been taken to reduce the volume of generation and to have an effective recycling techniques, which can sustain the natural resources as well as conserve the energy. E-waste in developing countries is a menace. There is lack of awareness among the people about E-waste. This paper highlights some of the problems, their impact on human health and environment, briefly explains how to have an effective E-waste management system with examples

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