CHALLENGES AND WAY TO THE SOLUTION OF E-WASTE

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Abstract— Computers, electrical and electronic toys, household appliances, laptops, mobile phones, printers, fax machines etc. are intended to make our lives easier and happier. Technology advances at such a high rate that many such items and electronic devices become "junk" after a few short years (months, days or so) of use. The replacement of VCRs by DVD players, DVD players by blu-ray players and so are some of the examples in this concern. Such products that have become unwanted, non-working or obsolete, and have essentially reached the end of their useful life can be called as waste or better it can be known as electronic waste, or e-waste. It is created from anything electronic: TVs, monitors, cell phones, PDAs, CD players, and other devices mentioned as above. It contains both valuable materials as well as hazardous materials.Such materials require special handling and recycling methods. The landfills of the globe are rapidly filling by such obsolete electronic devices. Many form of harmful materials such as beryllium, cadmium, mercury and lead are the prime constituent of these electronics which are improperly thrown away. The threat to the environment is significant when such materials are added up in the volume. **This** work makes an attempt to provide a concise insight into this concept of e-waste, its generation especially in India and health concerns involved to it. It also looks into the global trade in e-waste and the international experience in this regard. Getting a solution for this e-waste problem starts with education, and habit changes as a result of knowledge.

Keywords— Computers, electrical and electronic toys, household appliances, laptops, mobile phones, printers, fax machines, electronic waste, e-waste, TVs, monitors, cell phones, PDAs, CD players, valuable materials, hazardous materials, recycling, landfills, harmful materials, , environment, health concerns, education.

I. INTRODUCTION

Society today revolves around technology and by the constant need for the newest and most high tech products we are contributing to mass amount of e-waste. Since the invention of the iPhone, cell phones have become the top source of e-waste products because they are not made to last more than two years. Electrical waste contains hazardous but also valuable and scarce materials.

Almost all electronic waste contains some form of recyclable material, including plastic, glass and metals. Most of us are trained to recycle a newspaper, bottles, and cans. Almost anything electronic in nature can be recycled properly with effort.

It is important that any e-waste processor is fully certified in safe destruction and follow certified documented procedures to safely dispose of electronic waste.

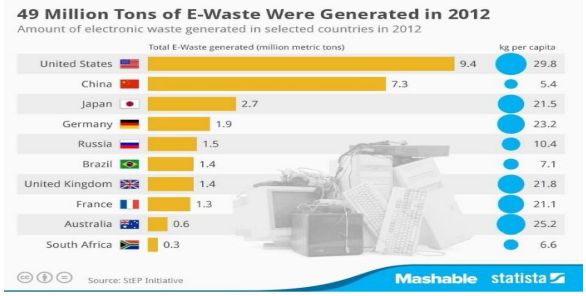
In addition to its damaging effect on the environment and its illegal smuggling into developing countries, researchers have now linked e-waste to adverse effects on human health, such as inflammation and oxidative stress -- precursors to cardiovascular disease, DNA damage and possibly cancer.

Besides adding harmful elements to the environment, improper disposal of e-waste is a recycling opportunity lost.

In the US alone, more than 100 million computers are thrown away with less than 20% being recycled properly. The EPA estimates as much as 60 million metric tons enter landfills every year.

E-WASTE: UNIVERSAL SCENARIO

Electronic waste has raised concerns because many components in these products are toxic and are not biodegradable. Based on these concerns, many European countries banned E-waste from landfills long before in the 1990s. Alarming levels of dioxin compounds, linked to cancer, developmental defects, and other health problems in the samples of breast milk, placenta, and hair, these compounds are linked to improper disposal of electronic products. Furthermore, surveys have indicated that much exported, E-waste is disposed of unsafely in developing countries, leaving an environmental and health problem in these regions. Impacts from those countries, especially Asia, have already been reported. Meanwhile, recycling and disposal of E-waste are also grown in the regions beyond Asia, particularly in certain African countries. Today's paradigm is one of disposable electronics, and as a result we now stand at the forefront of a growing environmental catastrophe.



E-WASTE: INDIAN SCENARIO

Countries like India are facing an imminent danger. E-waste of developed countries, such as the US, dispose their wastes to India and other Asian countries. A recent investigation revealed that much of the electronics turned over for recycling in the United States ends up in Asia, where they are either disposed of or recycled with little or no regard for environmental or worker health and safety. Major reasons for exports are cheap labour and lack of environmental and occupational standards in Asia and in this way the toxic effluent of the developed nations' would flood towards the world's poorest nations. Penetration of personal computers in India has increased drastically in the recent years

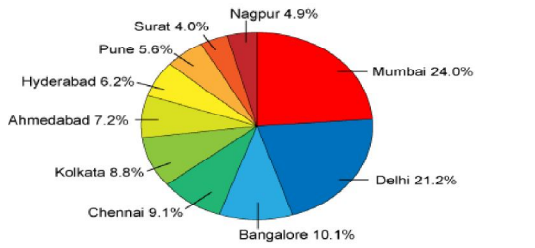


Table.1 The total WEEE generation in the State of Maharashtra**.**

S. no	Place	Quantity of generation (tonnes)
1	Navi Mumbai	4636.96
2	Greater Mumbai	11,017.06
3	Pune	3584.21
4	Pimpri-Chinchwad	1032.37
	Total	**20,270.60**

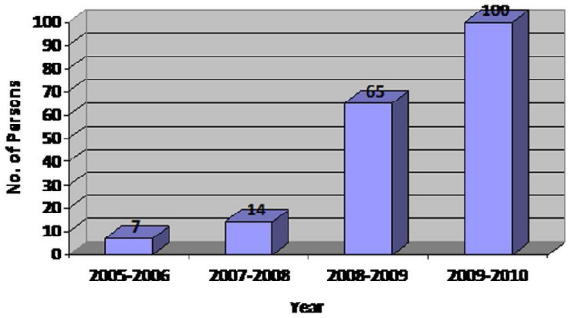


Figure.2 Usage of PCs for every 1000 persons

The magnitude of these problems is yet to be documented. However, groups like Toxic Links India are already working on collating data that could be a step towards controlling this hazardous trade. It is imperative that developing countries and India in particular wake up to the monopoly of the developed countries and set up appropriate management measures to prevent the hazards and mishaps due to mismanagement of e-wastes. Central Pollution Control Board (CPCB) estimated India's e-waste at 9 lakh tonnes per day .There are 10 States that contribute to 70 per cent of the total e-waste generated in the country, while 65 cities generate more than 60 per cent of the total e-waste in India. Among the 10 largest e-waste generating States, Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab.Among the top ten cities generating e-waste, Mumbai ranks first followed by Delhi, Bengaluru, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur.

HAZARDOUS TECHNOLOGIES

Incineration

Incineration is the process of destroying waste through burning. Because of the variety of substances found in e-waste, incineration is associated with a major risk of generating and dispersing contaminants and toxic substances. The gases released during the burning and the residue ash is often toxic. This is especially true for incineration or co-incineration of e-waste with neither prior treatment nor sophisticated flue gas purification. Studies of municipal solid waste incineration plants have shown that copper, which is present in printed circuit boards and cables, acts a catalyst for dioxin formation when flame-retardants are incinerated. These brominated flame retardants when exposed to low temperature (600-800°C) can lead to the generation of extremely toxic polybrominated dioxins (PBDDs) and furans (PBDFs). PVC, which can be found in e-waste in significant amounts, is highly corrosive when burnt and also induces the formation of dioxins.

Incineration also leads to the loss valuable of trace elements which could have been recovered had they been sorted and processed separately.

Open Burning

Since open fires burn at relatively low temperatures, they release many more pollutants than in a controlled incineration process at an MSWI-plant. Inhalation of open fire emissions can trigger asthma attacks, respiratory infections, and cause other problems such as coughing, wheezing, chest pain, and eye irritation. Chronic exposure to open fire emissions may lead to diseases such as emphysema and cancer. For example, burning PVC releases hydrogen chloride, which on inhalation mixes with water in the lungs to form hydrochloric acid. This can lead to corrosion of the lung tissues, and several respiratory complications. Often open fires burn with a lack of oxygen, forming carbon monoxide, which poisons the blood when inhaled. The residual particulate matter in the form of ash is prone to fly around in the vicinity and can also be dangerous when inhaled.

Landfilling

Landfilling is one of the most widely used methods of waste disposal. However, it is common knowledge

that all landfills leak. The leachate often contains heavy metals and other toxic substances which can contaminate ground and water resources. Even state-of-the-art landfills which are sealed to prevent toxins from entering the ground are not completely tight in the long-term. Older landfill sites and uncontrolled dumps pose a much greater danger of releasing hazardous emissions.

Mercury, Cadmium and Lead are among the most toxic leachates. Mercury, for example, will leach when certain electronic devices such as circuit breakers are destroyed. Lead has been found to leach from broken lead-containing glass, such as the cone glass of cathode ray tubes from TVs and monitors. When brominated flame retarded plastics or plastics containing cadmium are landfilled, both PBDE and cadmium may leach into soil and groundwater. Similarly, landfilled condensers emit hazardous PCB's.

Besides leaching, vaporisation is also of concern in landfills. For example, volatile compounds such as mercury or a frequent modification of it, dimethylene mercury can be released. In addition, landfills are also prone to uncontrolled fires which can release toxic fumes.

Significant impacts from landfilling could be avoided by conditioning hazardous materials from e-waste separately and by landfilling only those fractions for which there are no further recycling possibilities and ensure that they are in state-of-the-art landfills that respect environmentally sound technical standards.

EFFECT OF E-WASTE ON ENVIRONMENT AND HEALTH

Electronic waste can cause the environmental damage throughout the world (Skinner et al., 2011). Every electrical and electronic product are a complex mixture of thousands compounds out of which many compound contains toxic chemicals and elements such as lead, mercury, cadmium, chromium, copper and some precious metal such as silver and gold. In general the electronic appliances are classified as:

1) White goods: common household appliances
2) Brown goods: camera, camcorder, TVs
3) Grey goods: computers, calculators, printers, fax machines, scanners

Grey goods contain most toxic elements as compare to white and brown goods. In most of the developing country like India, electronic and electric waste are dismantled and sorted manually. These processes raise the risk of many health problems to workers as well as damage the environment. Some common ways by which toxic elements and chemicals can enter into the environment are:

1) Soil: open dumping and land fillings is the most common to dispose the wastes including E-waste. It is one of the most dangerous methods to discard the E-waste because toxic elements from E- waste can easily leach out into the soil and pollute it. Elements like, mercury and cadmium have the tendency to bio magnify. Once these element uptakes by plants from soil than they can bio magnify up to the highest tropical level.

2) Air: when e-waste burns large amount toxicants enters into the environment. Fugitive emissions and slag contain heavy metals. When we burn Circuits boards, plastic casings, cables and polyvinyl chlorides cable insulation can release dioxins and furans these are highly toxic. Brominated flame retardants are found in circuit boards and plastics.

3) Water: wastewater from e-waste recycling units is also a main source from which heavy metals enter into environment. And heavy metals present in E-waste dumped into the landfills can easily migrate into the groundwater especially in acidic conditions.

Table 1: Effects of E-Waste on human health and environment

Toxicant from E-waste	Sources	Effects on human health	Effect on environment
Mercury	thermostats, position censors, relays, switchs, discharge lamps, batteries	affects the human brain	biomagnifications
Lead	Cathode ray tubes (CRTs), glass of computer monitors and printed circuit boards	damage to the central nervous system and kidneys	
dioxin and furans	When inorganic material introduce to high temperature	respiratory problems, Reproductive and developmental problems Immune system damage; Interfere with regulatory hormones	bioconcentrate in organisms
Polychlorinated biphenyls (PCBs)	older capacitors, transformers and condensers	alter the sex hormone systems	biomagnifications
Cadmium	cathode ray tubes, plastic	Kidneys damage	biomagnifications
Brominated flame	Burning plastic	neurological system	
Barium(Ba)	panel of CRTs	Muscle weakness; Damageto heart, liver and spleen	
Beryllium (Be)	Motherboard	Carcinogenic, skin diseases	

Dioxin and furans also shows the bio concentration phenomenon as they and long life time once they released into the environment. Brominated flame can cause harmful effect on neurological system. Beryllium is also a toxic element which can cause the cancer. It is present in motherboard of computers.

There is a need to search and find out the easy and cheap way to recycle and reuse the E-waste. It will help in reduction the amount of e-waste which goes to dumping site and burned opening and ultimately poses a great threat to human health and environment by the several numbers of ways.

HEALTH IMPACTS

The physiological and health impacts on humans and animals of many of the toxic substances contained in e-Waste are

1.Reproduction: damage to both male and female reproductive systems, including interfering with development of the testes; reduction in semen production and quality; abnormal morphology of Source of e-wastes Constituent Health effects rates.

2.DNA: damage in lymphocytes, fatal and developmental toxicity; growth retardation; abnormal brain development, which can result in intellectual impairment; and possible long-term impacts on memory, learning and behaviour.

3.Nervous system: damage to the central nervous system (CNS) and blood system, including CNS depression and neurotoxicity; immune system suppression, including inhibition of a key blood cell enzyme.

4. Organs: damage to the brain, including swelling; liver, including liver necrosis; kidney, including renal toxicity; thyroid; pancreas; lymph nodes; spleen; and bone, including bone toxicity.

5. Skin: contact dermatitis; skin lesions; carcinogenic, including tumour promotion and lung cancer; anaemia; CBD (a Currently-Incurable, Debilitating Disease that can Sometimes be Fatal); and mortality.

6. Hormonal system: Disruption to endocrine systems including the oestrogen, androgen, thyroid hormone, retinoid and corticosteroid systems; inhibition of human and organ hormone reception; and ability to mimic natural oestrogen hormones, leading to altered sexual development in some organisms.

7. Other: hypertension (high blood pressure); cardiovascular and heart disease; respiratory tract irritation, including irritation of the nose, mouth and eye

E-Waste Policy and Regulation:

The environmentally sound management of e-waste is a challenge for India. The challenge relates not only to disposal of e-waste, but also to the increasing amounts of WEEE day by day. The Environment (Protection) Act (EPA), enacted in 1986 following the Bhopal gas tragedy, was the first comprehensive law related to environment. The Act only defined hazardous waste in very broad terms and did not address e-waste at all. However, what it did do was confer the power to enact regulations related environmental issues on the executive. Since then, the precautionary and the "polluter pays" principle have become part of Indian environmental policy. Although no e-waste laws exist till 2000, two regulations established under the provisions of the EPA – the Hazardous Waste (Management and Handling) Rules and the Batteries (Management and Handling) Rules – are applicable to some extent. The Indian Municipal Solid Wastes (Management and Handling) Rules of 2000 do not cover e-waste at all, although some e-waste could potentially be regulated on a municipal level. The HWM Rules require any company or individual receiving, treating, transporting or storing hazardous waste to first obtain permission from the relevant State Pollution Control Board (SPCB). In 2008, the Central Pollution Control Board (CPCB) released guidelines on e-waste management.

CONCLUSION

Environment friendly methods to dispose of and recycle IT and electronic equipment must be promoted and provided is the best solution for the problem of e-waste is the extract of this paper. This work confers that the assessments of the e-waste scenario, if performed accurately, results in the expression of proper views; thus the system based on the any systematic model could generate an overall improvement to the environment. The awareness that please don't throw away your computer or old monitor in the junk, it may be illegal should be spread. Solving the e-waste problem starts with education. Such good habit changes as a result of knowledge. Almost all of us are trained to recycle a newspaper, bottles, and cans. Almost anything electronic in nature can be recycled properly with effort. It is important that any e-waste processor is fully certified in safe destruction and follow certified documented procedures to safely dispose of electronic waste. Ask questions before you recycle.

FUTURE SCOPE

Subsequent from this initial work, a number of research questions arise. For a more complex environment, how much illustration would be required to train the system to a satisfactory level? To what degree should outlier decisions be identified and included in the system? The aim of future research will be to investigate these questions, the next stage being to develop a model of a real system.

REFERENCES

[1] Alastair, I., (2004). Mapping environmental justice in technology flows: computer waste impacts in Asia, Massachusetts Institute of Technology. Glob. Environ. Pol., 4(4): 76-107.

[2] CPCB.,(2007). Draft guidelines for environmentally sound management of electronic waste.:10–25.
[3] Cui, J. and E. Forssberg.,(2003).Mechanical recycling of waste electric and electronic equipment: a review. J. Hazard. Mater., 99(3): 243-263.
[4] CII.,(2006). E-Waste Management, Green Business Opportunities, Vol.12,Issue 1, Confederation of Indian Industry, Delhi
[5] E-Waste in India system failure imminent-take action, toxics link for a Toxics-Free World.
[6] E-Waste: The Next Hazard Wave Consumer Voice., (2007); 3:6.
[7] Johri N, Jacquillet G, Unwin R.,(2010). Heavy metal poisoning: the effects of cadmium on the kidney. BioMetals 23(5):783–792.
[8] Jomova K, Jenisova Z, Feszterova M, Baros S, Liska J, Hudecova D, RhodesCJ, Valko M., (2011).,Arsenic: toxicity, oxidative stress and human disease. J ApplToxicol, 31(2):95–107
[9] MOEF., (2011). Implementation of E-Waste Rules.
[10] Mutter, J.,(2004). Amalgam studies: disregarding basic principles of mercury toxicity. Int J Hyg Environ Health. (27); 391-397
[11] Niu, X. and Y. Li.,(2007). Treatment of waste printed wire boards in electronic waste for safe disposal. J. Hazard. Mater., 145(3): 410-416
[12] Skinner, A., Dinter, Y., Lloyd, A., Strothmann, P., (2010). 'The Challenges of E-Waste Management in India: Can India draw lessons from the EU and the USA?' ASIEN 2010, 117, S7-26
[13] Sinha, D.; Kraeuchi, P; Schwaninger, M.,(2005). A Comparison of Electronic Waste Recycling in Switzerland and in India. Environmental Impact Assessment Review 25, 492-504.
[14] Third World Network.,(1991). 'Toxic Terror: Dumping of Hazardous Wastes in the Third World', Third World Network 1991, Malaysia
[15] Weisglas-Kuperus, N., Vreugdenhil, HJ., Mulder, PG.,(2004). Immunological effects of environmental exposure to polychlorinated biphenyls and dioxins in Dutch school children. Toxicol. Lett. 149(1-3): 281–5.

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