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E-waste: Generation, recycling and management

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Abstract
In the world, from last two decades the technology growing up rapidly. The electronics industry is the world's largest and fastest growing manufacturing industry. But the electronic and electrical waste is becoming a major problem for every country. Each and every people replace their household items (televisions, computers, refrigerators, air conditioners, and hand held cellular phones) with new one. As a result, wide range of e waste is produced in the world every year and these devices contain various types of toxic materials, which is very hazardous to the environment. The aim of this paper to aware the people about the e wastage. In this research paper we only focus on the generation and management of e-waste.

Keywords: e-waste, generation, environmental impact, recycling and management

Introduction
In the 20th century, life changes very fast with the revolution in the field of information and communication technology. With this regime change, huge amount of waste and other wastes generated from electrical/electronic products. It consists of faulty components of electrical/ electronic goods frequently used at each home. Items falls in the category of e-waste is cellular phones, TV's, Computers, Laptops, Monitors, Printers, CD's, DVDs, Memory Cards, and Pen Drives etc. Faster technological innovation and consequently a high obsolete rate poses a direct challenge for its proper disposal or recycling. This problem has assumed a global dimension, of which India is an integral and affected part. Management of solid waste has become a critical issue for almost all the major cities in India. Increase in population coupled with the rapid urbanization of Indian cities, has lead to new consumption patterns, which typically affect the waste stream through the successive addition of new kinds of waste.

Electronic products contain hazardous and toxic material, it should be properly dispose off. Television and monitor uses cathode ray tube which contains huge amount of lead. Printed circuit board contains copper, lead solder, zinc etc. Toxic materials can cause serious health effects in an exposed individual. The degree of hazard associated with any toxic material is related to the exact material you are exposed to, concentration of the material, the route into the body and the amount absorbed by the body. Moreover, in the unit of electronic factories the workers face dangerous health problems. So it is very big issue for the every country, it is time to manage the e waste. It will be very beneficially for the future of everyone.

Fig 1

Generation
A discarded electronic item (e waste) is growing rapidly with increasing demands of people to use electronic and digital items. In the society bulk of e waste is produced by the government, public and private sectors.

E-waste sources can be numerous. Electronic appliances which are used personally and in households are the most common sources of e-waste. Such appliances are usually personal computers, DVD players, laptops, television sets, mobile phones, mp3 players and so on. Many people think

that e-wastes are only comprised of IT products, but electrical and other household appliances also form e-waste when they are discarded. Such items consist of washing machines, vacuum cleaners, toasters, drying machines, refrigerators, irons, air conditioners, coffee machines and related items.

E-Waste Environmental Impact and Recycling

The processes of dismantling and disposing of electronic waste in developing countries led to a number of environmental impacts as illustrated in the graphic. Liquid and atmospheric releases end up in bodies of water, groundwater, soil, and air and therefore in land and sea animals both domesticated and wild, in crops eaten by both animals and human, and in drinking water.

One study of environmental effects in Guiyu, China found the following:

- Airborne dioxins – one type found at 100 times levels previously measured
- Levels of carcinogens in duck ponds and rice paddies exceeded international standards for agricultural areas and cadmium, copper, nickel, and lead levels in rice paddies were above international standards
- Heavy metals found in road dust – lead over 300 times that of a control village's road dust and copper over 100 times

The environmental impact of the processing of different electronic waste components

Table 1

E-Waste Component	Process Used	Potential Environmental Hazard
Cathode ray tubes (used in TVs, computer monitors, ATM, video cameras, and more)	Breaking and removal of yoke, then dumping	Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphor
Printed circuit board (image behind table – a thin plate on which chips and other electronic components are placed)	De-soldering and removal of computer chips; open burning and acid baths to remove metals after chips are removed.	Air emissions and discharge into rivers of glass dust, tin, lead, brominated dioxin, beryllium cadmium, and mercury
Chips and other gold plated components	Chemical stripping using nitric and hydrochloric acid and burning of chips	PAHs, heavy metals, brominated flame retardants discharged directly into rivers acidifying fish and flora. Tin and lead contamination of surface and groundwater. Air emissions of brominated dioxins, heavy metals, and PAHs
Plastics from printers, keyboards, monitors, etc.	Shredding and low temp melting to be reused	Emissions of brominated dioxins, heavy metals, and hydrocarbons
Computer wires	Open burning and stripping to remove copper	PAHs released into air, water, and soil.

This table shows environmental impact of the processing of different electronic waste components [1].

Let's have a look at some useful facts and figures about e-waste recycling:

- In 2014, approximately 41.8 million tons of e-waste was generated worldwide. The quantity included 12.8 million tons of small equipment, 11.8 million tons of large equipment, 7.0 million tons of temperature exchange equipment (freezing and cooling equipment), 6.3 million tons of screens and monitors, 3.0 million tons of Small IT and 1.0 million tons of lamps. The amount of worldwide e-waste generation is expected to be 49.8 million tons in 2018 with an annual 4-5 percent growth.
- Only 6.5 million tons of total global e-waste generation in 2014 was treated by national electronic take-back systems.
- The United States generated 11.7 million tons of e-waste in 2014. The data for 2015 and 2016 are not available yet. According to EPA, only about 1 million tons of over 3.4 million tons of e-waste generated in the U.S. in 2012 was recycled, resulting in a recycling rate of 29 percent. The e-waste recycling rate in 2011 was 24.9 percent, and 19.6 percent in 2010.
- According to United Nations reports, only 16 percent of total global e-waste generation in 2014 was recycled by government agencies and companies sanctioned by industry regulators.
- Currently, only 15-20 percent of all e-waste is recycled.
- According to a recent report by EPA, every day, we are to get rid of over 416,000 mobile devices and 142,000 computers either by recycling or disposing of them in landfills and incinerators.
- A BBC Panorama program says that every year 20 to 50 million tons of e-waste is generated worldwide. This amount accounts for more than 5 percent of the municipal solid waste stream. However, the U.S. EPA report says, e-waste represents only 2 percent of the solid waste stream, but the amount accounts for 70 percent of the hazardous waste which is deposited in landfills.
- EPA report says, in 2007, approximately 26.9 million television sets, weighing 910,600 tons, were scrapped in the U.S.
- In 2009, as reported by EPA, only 8 percent of mobile phones, 17 percent of TVs and 38 percent of computers were recycled.
- Another EPA report reveals that by recycling one million cell phones, we can recover more than 20,000 lbs of copper, 20 lbs of palladium, 550 lbs of silver, and 50 lbs of gold.
- According to a study conducted by the Consumer Electronics Association (CEA), an average U.S. household in 2012 spent $1,312 on consumer electronics. The survey found the average family owns 24 discrete consumer electronic products. CEA estimated, in 2012, sales of Smartphones and tablet computers would make global annual consumer electronic sales to more than $206 billion.

- A market research firm namely "iSupply" said, in 2010, around 1.56 billion consumer electronics were bought globally by customers. The number reached1.6 billion units in the very next year.
- A study identified that producing a computer along with its monitor takes at least 1.5 tons of water, 48 lbs of chemicals and 530 lbs of fossil fuels.
- Compared to disposal in landfills or by incinerators, reusing or recycling computers can create 296 more jobs per year for every 10,000 tons of computer waste processed.
- Recycling one million laptop computers can save enough energy to run 3,657 U.S. homes for a year.
- Cell phones contain very high amount of precious metals such as silver and gold. Americans throw away approximately $60 million worth of silver and gold per year.
- According to EPA, the excessive amount of lead in e-waste, if released into the environment, could cause severe damage to human blood and kidneys, as well as central and peripheral nervous systems.
- Each year, globally, around 1 billion cell phones and 300 million computers are put into production.
- Roughly 80 percent of e-waste generated in the U.S. is exported to Asia, a trade flow that is a source of considerable controversy [2].

Management

Today E-Waste management is a challenge for every country to handle these hazardous discarded items which greatly affected the each and every people as well as environment. I think any electronic equipment can be easily upgraded, so users will keep it for a long time. Here are two benefits: one is e waste will not be produced and second there is no need to spend money to purchase new equipment.

The electronic devices must be designed to ensure a clean, safe and efficient mechanism for recovering raw material. Raw material must be suitable for safe reconstitution and recycling. Equipment components must be properly labeled to identify plastic and metal types. Warning must be placed for any possible hazards in dismantling or recycling. Manufacturers of electronic products should end the use of chemicals that are dangerous to human health or the environment including lead, mercury, cadmium, brominated flame retardant, chlorinated solvents and other hazardous materials. Use of renewable materials like, biodegradable plastics and plastics made with plant based chemicals must be practised. Bio based plastics exist but they are not commonly used because of lack of market demand and low price of petrochemical based plastics. Some alternative solutions are proposed as follows for improvement in e-product design for waste and to minimize impact on health and environment [3].

Recycling plays an important role in reducing the e-waste crisis but can hardly be seen as only solution particularly when hazardous inputs are involved. The electronics industry should design products to be easily repaired and upgraded to extend their useful life, incorporate recycled content and remanufacture components into new products. The proper practices for disposal of non-recyclable components must be developed. The electronics industry should apply stringent health and safety standards to manufacturing and recycling facilities throughout the product chain. Exploitation of workers within manufacturing facilities should be eliminated. The electronics industry should institute livable wages for all workers throughout the product chain [4].

Conclusion

The rate of generating electrical/electronics discarded items is being greater than other types of waste materials. Although number of attempts to be made for the management of e waste. Electronic equipment is one of the largest known sources of heavy metals and organic pollutants in the waste stream. Without effective collection, reuse, and recycling systems, highly toxic chemicals are found in electronic appliances like, lead, beryllium, mercury, cadmium, chromium, brominated flame retardant, etc will continue to contaminate soil and groundwater as well as pollute the air, posing a threat to wildlife and people.

In India, domestic generation and illegal imports are the two main sources of e-waste. It is impossible to determine how much e-waste is generated in India and how much is imported. But the growing quantities at a disastrous proportion and uncontrolled disposal practices are alarming the situation from an environmental point of view. Reuse and recycling of electronic equipment is a beneficial alternative than disposal as it reduces the amount of toxic and hazardous substances that may enter the environment through disposal.

Considering the future scenario, it is imperative that the safe management of waste is done in an organized manner with sufficient resources and sustainable recycling technologies on the one hand and effective legislations and monitoring mechanisms on the other. In Delhi, in the wake of the Mayapuri radiation leak incident, the government had issued guidelines and advisories to all heads of hospitals, medical centres, diagnostic centres and medical labs using radioactive equipment and consumables for their safe disposal, as per the directives of the Atomic Energy Regulatory Board (AERB) under the Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987, and the Atomic Energy (Radiation Protection) Rules, 2004. Ironically, under the AERB directives, the rules prescribing detailed guidelines regarding medical exposure, potential exposure, personal monitoring, quality control and even appointing radiation workers and radiological safety officers already exist. The incident highlights the need to have a clear cut disaster protocol and to implement effective regulation and monitoring mechanism to ensure that the rules are adhered to. It also calls for the regulatory infrastructure to allow for the protection of workers and community rights. There has to be sufficient rights for citizens to take legal recourse for damages caused to their health, environment and property [5].

It is very big challenge for the country for its proper management of the e waste. Safe raw material should be used by the working units of the industries. E-wastes should never be disposed with garbage and other household wastes. This should be segregated at, the site and sold or donated to various organizations. If we will make the effort collectively then the environment will more secure for the human lives.

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