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Electronic waste: It's impact on health and environment

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Abstract
Electronic waste (E-Waste) refers to the waste which is generated out of the old, obsolete and discarded technology. With the growing range of electronic devices such as air conditioners, computers, cell phones and many new products the need for old ones has decreased as a result they are thrown away into thrash without even properly destroying them. Improper recycling of worn out electronics results into the release of toxic metals in the environment which enters the food chain and ultimately harms the human health and indirectly the environment by causing air, soil and water pollution.
Generation and accumulation of E-Waste is a serious threat if not recycled and managed properly. The present study is an attempt to study the concept of electronic waste and also to highlight its effect on human health as well as on environment. For this purpose extensive literature survey has been done and help of websites, journals and government portals have been taken.

Keywords: Electronic waste, recycling, toxic metals, landfills

1. Introduction
The innovation, dynamic environment and globalisation has led to many changes in the technological market and brought forth different kinds of new innovations by the manufacturers so as to compete with the ever growing market. New advanced technology is hitting the market with more additions and inventions to already existing market. This innovation and inventions has added up to the comfort level of individuals but has also bundled up the waste of old and obsolete electronic products. The replacement of the equipments has led to an increase in electronic waste in the country.
The waste generated out of the old, obsolete, discarded technology is termed as E-Waste or electronic waste or WEEE (Waste from Electrical and Electronics Equipments). According to the Basel Convention, wastes are substances or objects, which are disposed off or are intended to be disposed off, or are required to be disposed off by the provisions of national laws [1]. Puckett *et al.* 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" [2].
According to Sinha-Khetriwal, "E-waste can be classified as any electrical powered appliance that has reached its end-of-life" [3]. Electronic gadgets has eased our lives but has also led to old technology being converted into thrash. The generation of E- Waste has become an emerging problem throughout India. Mumbai, the financial nerve-centre of India, alone throws away 19,000 to 20,000 tons of electronic waste a month, excluding the large e-waste it imports from developing nations through its port [4]. In Asia around 40-50 million tons of E- waste is generated per year. In India approximately 4-5 Lac tones of e-waste is generated per year and Recycled only 7-10% and its growth rate is 35-40% per year [5].

2. Objectives
Following are the objectives of the study:
1. To briefly study the concept of E-Waste.
2. To highlight the effect of E-Waste on human health.
3. To study the adverse effect of E-Waste on environment.

3. Research Methodology
The present paper is a result of extensive literature survey and secondary data has been collected from various websites, journals, research paper so as to get exact statistics regarding the generation of E- Waste and its impact on human health.

4. E-waste Generation
The use of electronics and electronic equipments in increasing day by day by individuals, households, industries, manufacturing units etc. As new electronic goods are consumed, simultaneously more and more waste is generated from the old and obsolete equipments.
The waste generated depends upon the demographic, geographical, socio-economic perimeters etc. [6].

Table 1: Top 5 Countries generating E-Waste as on 2014

S. No	Country	Production (million tons)
1.	The United States	7.07
2.	China	6.03
3.	Japan	2.2
4.	Germany	1.77
5.	India	1.64

(Source: www.chinadaily.com)

Table 1 highlights the top 5 Nations involved in generating E-Waste as on 2014. India is ranked 5th by generating 1.64 million tons of e-waste annually. The maximum production is by the US that is 7.07 million tons.
In India, the current estimate projects 2.7 million tons of E-waste generation annually. The IT sector accounts for 34% of this, household appliances 42% and consumer electronics 14%.[7] As per the ASSOCHAM study 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 eight largest e-waste

generating states, Maharashtra ranks first followed by Tamil Nadu (2nd), Andhra Pradesh (3rd), Uttar Pradesh (4th), Delhi (5th), Gujarat (6th), Karnataka (7th) and West Bengal (8th). E-waste typically includes discarded computer monitors, motherboards, Cathode Ray Tubes (CRT), Printed Circuit Board (PCB), mobile phones and chargers, compact discs, headphones, white goods such as Liquid Crystal Displays (LCD)/ Plasma televisions, air conditioners, refrigerators and soon [8].

5. E- waste Sources

E-waste consists of all waste from electronic and electrical appliances which have reached their end- of- life period or are no longer fit for their original intended use and are destined for recovery, recycling or disposal. It includes computer and its accessories, monitors, printers, keyboards, central processing units; typewriters, mobile phones and chargers, remotes, compact discs, headphones, batteries, LCD/Plasma TVs, air conditioners, refrigerators and other household appliances [9].

The composition of e-waste is diverse and falls under 'hazardous' and 'non-hazardous' categories. Broadly, it consists of ferrous and non-ferrous metals, plastics, glass, wood and plywood, printed circuit boards, concrete, ceramics, rubber and other items. Iron and steel constitute about 50% of the waste, followed by plastics (21%), non-ferrous metals (13%) and other constituents. Non-ferrous metals consist of metals like copper, aluminium and precious metals like silver, gold, platinum, palladium and so on [10].

The main sources of electronic waste in India are the government, public and private (industrial) sectors, which account for almost 70 per cent of total waste generation. The contribution of individual households is relatively small at about 15 per cent; the rest being contributed by manufacturers. Though individual households are not large contributors to waste generated by computers, they consume large quantities of consumer durables and are, therefore, potential creators of waste [11].

6. Effect of E-waste on Human Health

Electronic goods are considered as a boon to the human entity as it has eased the human life in all aspects and the new innovation to the technology has helped the overall economy grow. The growth of the technological market has flooded the market with new and advanced technology but simultaneously it has also added up to the pile of old and obsolete electronics. With advanced features in technology the already existing electronics are converted into old and obsolete thrash which if not disposed-off properly will adversely affect human health.

Disposing off the electronics is an important part as the emissions that are thrown out in the environment harms the human health as well as the environment. Most of the components in electronic devices contain lead, cadmium, mercury, polyvinyl chloride (PVC), brominated flame retardants (BFRs), chromium, beryllium etc., TVs, video and computer monitors use CRTs, which have significant amounts of lead and the long term exposure to these substances can damage the nervous system, kidney and bones and the reproductive and endocrine systems and some of them are carcinogenic [12].

Table 2: List of pollutants and their occurrence

Pollutant	Occurrence
Liquid crystal	Displays
Lithium	Mobile telephones, Photographic equipments, video equipments, batteries
Mercury	Components of Copper machines and steam irons, batteries in clocks and pocket calculators, switches, LCDs
Nickel	Alloys, batteries, relays, semiconductors, pigments
PCBs (poly chlorinated biphenyls)	Transformers, capacitors, softening agents for paints, glue, plastic
Selenium	Photoelectric cells, pigments, photo copiers, fax machines
Silver	Capacitors, Switches (contacts) batteries, resistors
Zinc	Steel, brass, alloys, disposable and rechargable batteries, luminous substances
Arsenic	Semiconductors, diodes, microwaves, LEDs (light emitting diodes), solar cells
Barium	Electron tubes, filler of plastic and rubber, lubricant additives
Brominated flame proofing agent	Casings, circuit boards (plastic), cables and PVC cables
Cadmium	Batteries, pigments, solders, alloys, circuit boards, computer batteries, monitor, cathode ray tubes (CRTs)
Chrome	Dyes/ Pigments, Switches, Solar
Lead	Lead reachable batteries, solar, transistors, lithium batteries, PVC (polyvinyl chloride), stabilizers, lasers, LEDs, thermo electrical elements, circuit boards

(*Source*:https://www.epa.gov/sites/production/files/2014-05/documents/india.pdf)

Table 2 represents some of the major pollutants which might be harmful to the human health and also highlights where they are found mostly. It can be seen that displays carry most of the liquid crystal in them whereas high amount of mercury can be found in batteries, LCD's and switches. It can also be noticed that computer batteries, cathode ray tubes and monitor contains high amount of cadmium in them. The effect of some of more toxic metals is explained in table 3.

Table 3: Toxic metals present in various types of E-waste and their effects on humans

Materials	Weight (%)	Recycling (%)	Location	Effects
Lead	6.2988	5	Acid battery, CRT	Kidney failure, nervous system failure, damage to the reproductive system
Cadmium	0.0094	0	Battery, CRT, Housing	Bone disease, long term cumulative poison

Mercury	0.0022	0	Batteries, Switches	Chronic damage to brain, liver damage, causes damage to the central and peripheral nervous systems as well as the fetus
Chromium VI	0.0063	0	Decorative hardener, Corrosion protection	DNA damage, lung cancer
Plastic	22.99	20	Computer mouldings	Generates dioxins and furans

Table 3 highlights various types of toxic metals present in the e-waste and their effect on human health. Toxic metals adversely affect the nervous as well as respiratory system of the humans. Lead can cause damage to the kidney whereas chromium can harm the DNA as well as lungs.

7. Effect of E-waste on Environment

With the advent of advanced technology consumers now treat electronics as disposable items without even realising that what they throw away is converted into a harmful toxic for them as well as for the environment. In order to avoid the electronics to harm the environment their proper recycling is required. Every electronic item which is now obsolete and is no more in proper condition to be used contains certain harmful toxic metals that can harm the humans and environment if not disposed-off properly.

Cell phones for example contain harmful toxins including lead, mercury, arsenic, cadmium, chlorine and bromine which if not recycled properly leads to creation of landfills which will affect human health and ultimately the environment at large. If in case these toxins leak into the groundwater due to some reasons can accumulate in the food chain and can cause deep damage to the soil, water supply, vegetation, animals and humans.

Computers if thrown as thrash can pile up as landfills with time resulting into the toxic metals reach groundwater which reaches the supply chain and prove harmful for the entire chain. Also when e-waste is warmed up it releases harmful toxic chemicals in the air, thus damaging the atmosphere. E-waste is not a problem that is going away any time soon. In fact it is only going to get worse. By 2017, the volume of our thrown away e-products throughout the world is expected to rise by 33 percent from 2012, and we can expect the weight of this garbage to equal eight of the Great Pyramids of Egypt. The amount of e-waste that we produce, including computers, DVD players, cell-phones and global positioning products, could rise by a whopping 500% over the next decade in countries such as India [13].

8. Conclusion

The present study comes to the conclusion that electronic waste is a major threat to the entire nation and the entire world at large. E-waste refers to the waste and old electronics that are no more in use either due to obsolescence or introduction of new technology in the market. Every electronic item contains some toxic material in it which if not disposed-off properly will result into harmful damage to the human life as well as environment at large. In India, the current estimate projects 2.7 million tons of E-waste generation annually.

The main sources of electronic waste in India are the government, public and private (industrial) sectors, which account for almost 70 per cent of total waste generation. The contribution of individual households is relatively small at about 15 per cent; the rest being contributed by manufacturers. It can be pointed out that recycling e-waste is an important work which needs to be fulfilled with due care and in a proper manner as improper disposing-off of the electronics would lead to many ill effects both to individuals as well as environment.

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