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E-Waste Management in India

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Abstract: Electronic waste (e-waste) is one of the fastest growing waste streams in the country. Growth of Information and Communication Technology sector has enhanced the usage of the electronic equipment exponentially. Faster obsolescence and subsequent up-gradation of electronics product, are forcing consumers to discard old products, which in turn accumulate huge e-waste to the solid waste stream. Major recycling of e-waste is carried out in the non-formal sector using primitive and hazardous methods. Adequate legislative measures and cost-effective, environmental friendly, technological solution would be needed to address the issue.
Keywords: E-waste, Basel convention, hazardous components, recycling, recovery, reuse.

1. Introduction:

The information and communication technologies (ICT) have revolutionized the way we live, work and communicate bringing countless benefits to all its users. The creation of innovative and new technologies and the globalization of the economy have made a whole range of products available and affordable to the people changing their lifestyles significantly. New electronic products have become an integral part of our daily lives providing us with more comfort, security, easy and faster acquisition and exchange of information. But on the other hand, it has also led to unrestrained resource consumption and an alarming waste generation. Both developed countries and developing countries like India face the problem of e-waste management.

The problem of e-waste has become an immediate and long term concern as its unregulated accumulation and recycling can lead to major environmental problems endangering human health. It is a hard fact that with the voluminous increase in use of these devices to ridge the digital divide, there is also an alarming growth of e-waste worldwide.

"Electronic Waste" may be defined as discarded computers, office electronic equipment, entertainment device electronics, mobile phones, television sets and refrigerators etc. This definition includes used electronics which are destined for reuse, resale, salvage, recycling, or disposal. Others define the reusable (working and repairable electronics) and secondary scrap (copper, steel, plastic, etc.) to be "commodities", and reserve the term "waste" for residue or material which is dumped by the buyer rather than recycled, including residue from reuse and recycling operations. Because loads of surplus electronics are frequently commingled (good, recyclable, and non-recyclable), several public policy advocates apply the term "e-waste" broadly to all surplus electronics. Cathode Ray Tubes (CRT) are considered one of the hardest types to recycle. CRTs have relatively high concentration of lead and phosphors (not phosphorus), both of which are necessary for the display.

The rapid growth of technology, upgradation of technical innovations and a high rate of obsolescence in the electronics industry have led to one of the fastest growing waste streams in the world which consist of end of life electrical and electronic equipment products. It comprises a whole range of electrical and electronic items such as refrigerators, washing machines, computers and printers, televisions, mobiles, i-pods, etc., many of which contain toxic materials. Many of the trends in consumption and production processes are unsustainable and pose serious challenge to environment and human health. Optimal and efficient use of natural resources, minimization of waste, development of cleaner products and environmentally sustainable recycling and disposal of waste are some of the issues which need to be addressed by all concerned while ensuring the economic growth and enhancing the quality of life.

There is a need for e-waste management as e-waste components may cause severe health risks and environmental damage, when crude, unscientific methods are applied for recovery of useful components. There is a need to encourage recycling of all useful and valuable material from e-wastes to preserve the natural resources.

2. Composition of E-waste:

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.

The composition of e-waste is diverse and falls under 'hazardous' and 'non-hazardous' categories. The various parts / materials / composition of e-waste may be divided broadly into six categories such as

(i) Iron and steel, used for casings and frames
(ii) Non-ferrous metals, especially copper used in cables, and aluminium
(iii) Glass used for screens, windows
(iv) Plastic used as casing, in cables and for circuit boards
(v) Electronic components
(vi) Others (rubber, wood, ceramic etc.).

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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. The presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants beyond threshold quantities make e-waste hazardous in nature. It contains over 1000 different substances, many of which are toxic, and creates serious pollution upon disposal. Obsolete computers pose the most significant environmental and health hazard among the e-wastes.

3. E-waste scenario in India

The Indian information technology industry has a prominent global presence today largely due to the software sector. More recently, policy changes have led to a tremendous influx of leading multinational companies into India to set up manufacturing facilities, R&D centres and software development facilities. The domestic market is getting revived due to buoyant economic growth and changing consumption patterns. This growth has significant economic and social impacts. The increase of electronic products, consumption rates and higher obsolescence rate leads to higher generation of electronic waste (e-waste). The increasing obsolescence rates of electronic products added to the huge import of junk electronics from abroad create complex scenario for solid waste management in India.

As there is no separate collection of e-waste in India, there is no clear data on the quantity generated and disposed of each year and the resulting extent of environmental risk. The preferred practice to get rid of obsolete electronic items in India is to get them in exchange from retailers when purchasing a new item. The business sector is estimated to account for 78% of all installed computers in India. Obsolete computers from the business sector are sold by auctions. Sometimes educational institutes or charitable institutions receive old computers for reuse. It is estimated that the total number of obsolete personal computers emanating each year from business and individual households in India will be around 1.38 million.
There are 10 States that contribute to 70 % of the total e-waste generated in the country, while 65 cities generate more than 60% 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.

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.

4. Effects of e-waste on human health and environment:
E-waste is highly complex to handle because of its composition. It is made up of multiple components some of which contain toxic substances that have an adverse impact on human health and environment if not handled properly that is if improper recycling and disposal methods are deployed. So there is a need for appropriate technology for handling and disposal of these chemicals.
Basel Convention characterizes e-waste as hazardous when they contain and are contaminated with mercury, lead, cadmium, polychlorinated biphenyl etc. Wastes containing insulation or metal cables coated with plastics contaminated with or containing lead, coal tar, cadmium, Polychlorinated Biphenyl (PCB) etc are also characterized as hazardous wastes. Also precious metal ash from printed circuit boards, glass waste from cathode-ray tubes, LCD screens and other activated glasses are classified as hazardous wastes.

Effects of some of the prime hazardous components in of e-waste are mentioned below:

5. Waste Management Strategies:
The best option for dealing with e-wastes is to reduce the volume. Designers should ensure that the product is built for reuse, repair and/or upgradeability.

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 material that would otherwise have been released.

It is high time the manufactures, consumers, regulators, municipal authorities, state governments, and policy makers take up the matter seriously so that the different critical elements depicted in Figure 1 are addressed in an integrated manner. It is the need of the hour to have an “e waste-policy” and national regulatory frame work for promotion of such activities.

An e-waste policy is best created by those who understand the issues. So it is best for industry to initiate policy formation collectively, but with user involvement. Sustainability of e-waste management systems has to be ensured by improving the effectiveness of collection and recycling systems (e.g., public–private-partnerships in setting up buy-back or drop-off centers) and by designing-in additional funding e.g., advance recycling fees.

Environmentally sound management of recognizes three **Rs** i.e. reduce, reuse and recycle. The aim would be to **reduce** the generation of e-waste through smart manufacturing and maintenance, **reuse** till functioning of electronic equipment by someone else and **recycle** those components that cannot be repaired.

A smart e-waste management system for developing countries have to assess the e-waste situation, recognize that e-wastes are a complex mixture of hazardous and nonhazardous substances and materials and need to define the integral e-waste management system taking into consideration the market pe-

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netration, life cycle of ICT equipment, financing mechanisms etc.

The main aspects to be taken into account when framing ICT waste management guidelines for developing countries are:

(i) Policy and regulations covering import and export in accordance with the rules of each country and with international legislation.
(ii) Defining responsibilities of prime stake holders at the level of government, supply chain, consumers of ICT equipment and entities for disposal of waste.
(iii) Extended producer responsibility (EPR) where the manufacturer's responsibility for its ICT equipment extends throughout the various stages of that equipment's life cycle with internalizing the cost of managing the equipment at end of life.
(iv) Responsible information system to have data on ICT equipment in market, and to have control on the monitoring and future planning.
(v) Promoting employment and training for the informal sector engaged in recycling and recovery of the materials.

6. Challenges in e -waste management:

Following are the some of the major issues that need attention while handling e-waste:

(i) The data for information on e-waste is estimation and there is a problem in finding information on imports of e-waste. Most studies have concentrated on devices like mobile, computer and TVs while the domestic appliances also contribute to a considerable proportion of e-waste. There is a need to have credible data covering wide range of products across sectors.
(ii) Waste collection, transportation, processing and recycling is dominated by the informal sector. The sector is well networked and unregulated. There are serious issues regarding leakage of toxins into the environment hampering workers' safety/health.
(iii) There is a need for establishment of collection channels for e-waste from the generator to the recycler. Presently as the standards are not followed by the collectors (mainly the informal sector), the environmental, health and safety norms are hampered. The formal sector having large infrastructure and high operational cost finds difficulty in competing with the informal sector.
(iv) The informal sector needs specific attention to be handled properly considering the socio economic condition so that the solutions for environment friendly management of e-waste are found to be rational for the stake holders.
(v) There is a lack of fund and capacity in Government for monitoring and enforcement of the regulations.
(vi) Awareness regarding the hazards of e-waste is low because of structural deficiency in implementation of policies, poor literacy and poverty of an important major stake holder (informal sector).
(vii) The e-waste management system is mostly manual and low tech and the 'take back' by producers is limited to few IT equipment and few formal collection centres. There is lack of effort from producers that result in limited implementation of EPR. In absence of accountability and penalty criteria in the regulation, it is difficult to monitor the EPR activities.

7. Conclusion

Most of the e-waste is recycled in India in unorganized units, which engage significant number of manpower. There exists an urgent need for a detailed assessment of the current and future scenario including quantification, characteristics, existing disposal practices, environmental impacts etc. Institutional infrastructures, including e-waste collection, transportation, treatment, storage, recovery and disposal, need to be established, at national and/or regional levels for the environmentally sound management of e-wastes. Recovery of metals from PCBs by primitive means is a most hazardous act. Proper education, awareness and most importantly alternative cost effective technology need to be provided so that better means can be provided to those who earn the livelihood from this. A holistic approach is needed to address the challenges faced by India in e-waste management. A suitable mechanism needs to be evolved to include small units in unorganized sector and large units in organized sector into a single value chain. One approach could be for units in unorganized sector to concentrate on collection, dismantling, segregation, whereas, the metal extraction, recycling and disposal could be done by the organized sector. There is an urgent need of generating awareness among the people about the best practices for collection mechanism of e-waste, to be followed to avoid dumping of waste in landfills, and to channelize the waste through standard methods of e-waste disposal management.

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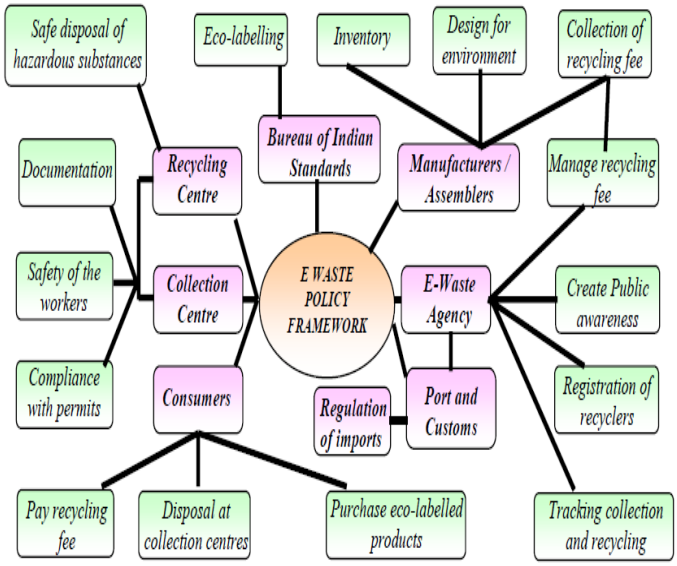
S.No.	Hazardous components	Effect of Hazardous components of e-waste
1	**Arsenic**	Can affect skin and can decrease nerve conduction velocity. Chronic exposure to arsenic may cause lung cancer and sometimes be fatal.
2	**Lead**	May affect kidneys, reproductive systems, nervous connections. May cause blood and brain disorders, sometimes may be fatal.
3	**Barium**	Can affect heart muscle.
4	**Chromium**	Can damage liver, kidneys and may cause asthmatic bronchitis and lung cancer.
5	**Beryllium**	May cause lung diseases.
6	**Mercury**	Affects the central nervous system, kidneys and immune system, it impairs foetus growth. May cause brain or liver damage
7	**Cadmium**	May cause severe pain in the joints and spine. It affects the kidneys and softens bones.
8	**BFR (Brominates flame retardants)**	Can harm reproductive and immune systems, may cause hormonal disorder.
9	**Chlorofluorocarbon (CFC)**	May affect the ozone layer. It may cause skin cancer in human and genetic damage in organisms.
10	**Polychlorinated Biphenyl (PCB)**	May cause cancer in animals, can affect the immune system, reproductive system, nervous system, endocrine system . PCBs persistently contaminate in the environment and cause severe damage.
11	**Polyvinyl Chloride (PVC)**	PVC contains upto 56% chlorine and when burnt, produces Hydrogen chloride gas which in turn produces hydrochloric acid that is dangerous to respiratory system.
12	**Dioxin**	These are highly toxic to animals and can lead to malfunction of foetus, decreased reproduction and growth rates, affect immune system.



"Figure 1 Elements of e-waste management system for India"