An Approach for E-waste Management under Make in India Initiative

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ABSTRACT
Electronic industry is a sector which focuses mainly on designing, fabrication and manufacturing of small components (ICs and Chips) used in the making of bigger Electronic equipments. The reason of including Electronic systems as a part of Make In India initiative is that India has the third largest number of scientists in the world, this industry is growing with a rate of almost 10% since 2011 and this sector is focusing on having a USD 29 Billion consumer electronic market by 2020. With such a large number of electronic devices manufacturing, the amount of electronic and electrical waste (E-waste) will also increase.

E-waste is defined as "waste of electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded" is one of the most important area one need to focus on. The annual E-waste generation in India was estimated to be 0.8 million tonnes in 2012 and it is increasing exponentially since then. Thus, a nation-wide awareness needs to be initiated which will take care of E-waste management as there might be adverse effects on environment if not properly disposed and the recycling of this waste on a large scale need to be done as it can be further used in manufacturing of electronic equipments.

Keywords
Electronics Industry, Make In India, E-waste, Environmental and Social Effects, Disposal, Management and Recycling of E-waste.

1. INTRODUCTION
The rapid growth of technology due to Industrial and Communication Revolution accompanied with up-gradation in technical innovation and high rate of obsolescence in electronic industry has made E-waste as one of the fastest growing waste streams in the world. E-waste includes diverse range of electronic and electrical equipment's many of which contain toxic materials which can create an irreversible impact to human health and environment if improperly disposed. It constitutes a serious challenge to the modern societies and requires coordinated effects to address it for achieving sustainable development. Used electronics which are destined for reuse, resale, salvage, recycling or disposal are considered as E-waste.

Electronic scrap components, such as CRTs, may contain contaminants such as lead, cadmium, & beryllium, and other heavy metals makes E-waste more hazardous and toxic[1]. Since E-Waste contains both valuable as well as hazardous materials it requires special handling and proper recycling methods.

Make In India initiative has opened a wide scope for the establishment of Electronics Industries in India as 65% of the current demand for electronic products is met by imports and there is a continuous rise in manufacturing price in alternate markets. With the growth in this market, the generation of E-waste will also increase. A report of the United Nations predicted that by 2020, E-Waste from old computers would jump by 500% in India. Additionally E-Waste from discarded mobile phones would be about 18 times higher than 2007 in India by 2020.

On the other hand, E-waste can also be considered as a resource, as it contains many valuable components that actually may be beneficial to recover. For example, it usually contains substantial amounts of copper (often 5-20% by weight), and also relatively high levels of several precious metals, such as gold (0.1%), silver (0.2%) and palladium (0.005%) [2]. These metals together make up the major economical incentive for recycling of E-waste, as they may constitute over 95% of its total value. However, also other metals and materials may be worth recycling from an economical point of view, e.g. lead, nickel and various plastics. Recycling of E-waste is thus important, not only from a waste management point of view but also from the view of material and recycling [3].

Thus, a proper checking and regulation has to be implemented for a clean environment and better society.

2. COMPOSITION OF E-WASTE
Electronic appliances are composed of hundreds of different materials that can be both toxic and equally of high value. While majority materials such as iron, aluminium, plastics and glass account for over 80 weight % of E-waste, whereas valuable and toxic materials are found in smaller quantities but are still of high importance[3]. The material composition of different appliances is often similar, but the percentage of different components can vary a lot. The precious metals such as Gold, silver, copper, platinum etc., turns recycling of E-waste into a lucrative business opportunity. On the other hand, the recycling of hazardous E-waste which possesses carcinogens such as lead and arsenic is critical and cause serious health risks and environment dangers if not properly handled.

As the figure-1 indicates that the E-waste consists of a larger amount of iron and steel along with aluminium, rubber, ceramic, copper and other chemically composed materials, the methods to extract them out and recycle will also be different. Heavy materials will be taken out separately as they are easy to pick up while the tiny one needs special attention. Also the chemically harmful substances need to be taken care by using chemical deposition techniques to avoid any harmful effect on human body and environment. Most electronic waste goes

through a recycling system called a WEEE (Waste Electrical and Electronic Equipment), which not only recycles 95-98%, by weight, of all E-waste passed through it, but ensures that any data left on hard drives and memories are thoroughly destroyed too.

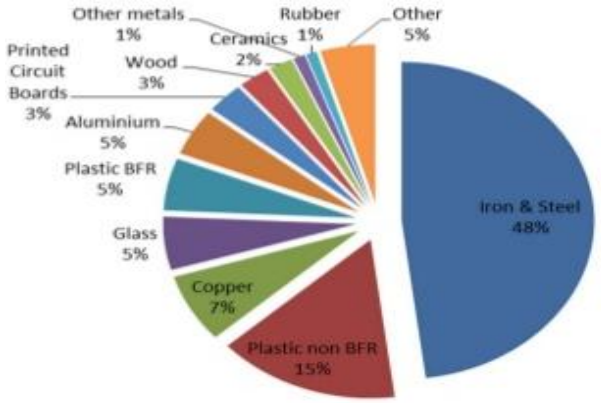

Figure 1: Composition of E-waste on a broad level.

3. E-WASTE MANAGEMENT- A GROWING BUSINESS

E-waste management has turned out to be a huge market in India in past few years but most of it is illegal. India has over 100 registered recycling companies but the overall output is quite low as compared to their efficiency. A number of new companies along with public-private partnership are setting up their recycle centers [4].

In terms of E-waste generation, 6 states alone generate the 70% of overall waste in India. Maharashtra leads the country for generating the highest E-waste, followed by Tamil Nadu and Telangana. Recently, The Brihanmumbai Municipal Corporation (BMC), along with the waste management company Eco Recycling Limited or Ecoreco, has set up an e-waste collection centre at the junction of Mithibai College in Vile Parle (W). It is the first in a series of 24 such centers across the city. The project has been undertaken on Public-Private Partnership (PPP) basis. In all over India, companies for E-waste management are getting set-up, all one required is to do it ina proper manner [5].

In India, the major collectors of E–waste are the 'Kabadiis', they collect wastes from house to house and every sort of places one can think of. But the major amount of this collected waste does not get disposed properly which leads to more severe health and environmental problems.

According to the report of United Nation Environment Programme up to 90% of the world's electronic waste, worth nearly $19bn (£12bn), is illegally traded or dumped each year. Some of the African and Asian countries such as Ghana, Nigeria, China, Pakistan, India and Vietnam are turning into illegal E-waste hubs, bypassing the legitimate global waste and recycling market that is thought to be worth $410bn a year. It is quite evident now that a mount of business is flourishing from this E-waste [6].

4. E-WASTE EFFECTS ON HEALTH, ENVIRONMENT AND SOCIETY

E-waste consists of both Hazardous and non-hazardous materials. Electronic waste affects nearly every system in the human body because they contain a plethora of toxic components including Mercury, Lead, Cadmium, Poly Brominated Flame Retardants, Barium and Lithium. Even the plastic casings of electronics products contain Polyvinyl Chloride. The health effects of these toxins on humans include birth defects, brain, heart, liver, kidney and skeletal system damage. They will also significantly affect the nervous and reproductive systems of the human body [6].

Hazardous material, its sources and effects are given below:

- Americium: The radioactive source in smoke alarms. It is known to be carcinogenic.
- Mercury: Found in fluorescent tubes (numerous applications), tilt switches (mechanical doorbells, thermostats), and flat screen monitors. Health effects include sensory impairment, dermatitis, memory loss, and muscle weakness. Environmental effects in animals include death, reduced fertility, and slower growth and development.
- Sulphur: Found in lead-acid batteries. Health effects include liver damage, kidney damage, heart damage, eye and throat irritation. When released into the environment, it can create sulphuric acid.
- Brominated Flame Retardant (BFRs): Used as flame retardants in plastics in most electronics. Includes PBBs, PBDE, DecaBDE, OctaBDE, PentaBDE. Health effects include impaired development of the nervous system, thyroid problems, liver problems. Environmental effects: similar effects as in animals as humans. PBBs were banned from 1973 to 1977 on. PCBs were banned during the 1980s.
- Cadmium: Found in light-sensitive resistors, corrosion-resistant alloys for marine and aviation environments, and nickel-cadmium batteries. The most common form of cadmium is found in Nickel-cadmium rechargeable batteries. These batteries tend to contain between 6 and 18% cadmium. The sale of Nickel-Cadmium batteries has been banned in the European Union except for medical use. When not properly recycled it can leach into the soil, harming microorganisms and disrupting the soil ecosystem. Exposure is caused by proximity to hazardous waste sites and factories and workers in the metal refining industry. The inhalation of cadmium can cause severe damage to the lungs and is also known to cause kidney damage. Cadmium is also associated with deficits in cognition, learning, behavior and Neuromotor skills in children.
- Lead: Solder, CRT monitor glass, lead-acid batteries, some formulations of PVC. A typical 15-inch cathode ray tube may contain 1.5 pounds of lead but other CRTs have been estimated as having up to 8 pounds of lead. Adverse effects of lead exposure include impaired cognitive function, behavioural disturbances, attention deficits, hyperactivity, conduct problems and lower IQ.
- Beryllium oxide: Filler in some thermal interface materials such as thermal grease used on heat sinks for CPUs and power transistors, magnetrons, X-ray-transparent ceramic windows, heat transfer fins in vacuum tubes, and gas lasers.
- Perfluorooctanoic acid (PFOA): Found in Non-stick cookware (PTFE), used as an antistatic additive in industrial applications, and found in electronics. PFOAs are formed synthetically through

environmental degradation and, in mice, after oral uptake. Studies in mice have found the following health effects: developmental toxicity, immune-toxicity, hormonal effects and carcinogenic effects. Studies have found increased maternal PFOA levels to be associated with an increased risk of spontaneous abortion (miscarriage) and stillbirth. Increased maternal levels of PFOA are also associated with decreases in mean gestational age (preterm birth), mean birth weight (low birth weight), mean birth length (small for gestational age), and mean APGAR score.

- Hexavalent chromium: A known carcinogen after occupational inhalation exposure.

Figure 2 shows a flow chart that how all the sections of society including Manufacture, Government and Consumer needs to work together to reduce the E-waste and handle it properly through Re-use and Re-cycling.

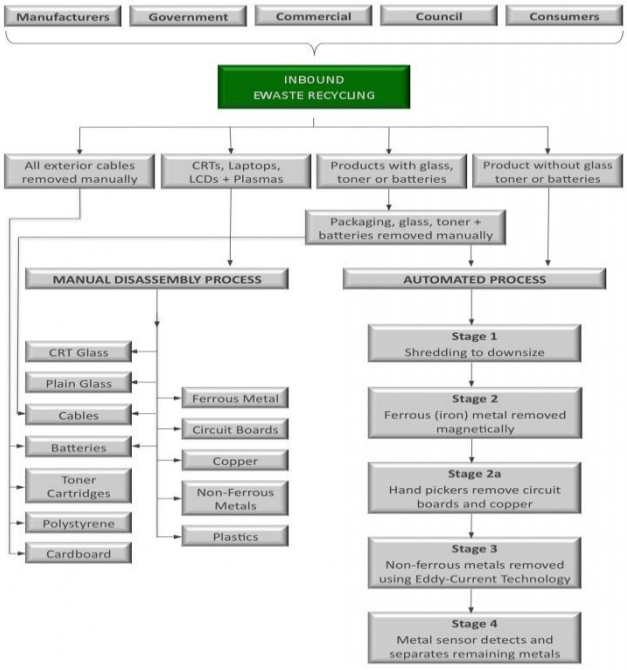

Figure 2: Flow chart defining the path for E-waste Management

The traditional methods used for the disposal of E-waste are Land filling and Incineration which is in general has a direct effect on Environment [8].

Land filling: Land filling is one of the oldest methods used for the E-waste disposal. This technique can also be used for the purpose of waste management purpose like using it as a temporary storage site or for the treatment and recycling purposes too. In this method trenches are made and the waste material is buried in it [9].

As this method disposes the waste material directly into the soil, one should not use this method for disposing off the e-waste toxic substances like cadmium; lead and mercury which are capable of contaminating the ground water and also degrades the quality of soil. This method affects the environment, discharging a lot of pollutants directly into the surroundings.

Figure 3: Land filling And Incineration Approaches results in Toxic waste.

Incineration: Incineration is a method used for disposing the E-waste controllably and it involves combustion of electronic waste at a very high temperature. This E-waste disposal method is quite advantageous as the waste volume is reduced extremely. This method also produces a lot of energy that can be efficiently used for other purposes. However, it is also not free from disadvantages like emission of the harmful gases such as dioxins and furans which are highly carcinogenic.
For the social effect of E-waste, one needs to consider the process of collection of waste which involves a lot of child labour. Most of the children are below the age of 14 and very often child labour is employed to separate the parts from the circuit board utilizing wire cutters pliers. This is a serious part which most of the times does not get proper attention due to other matters.

5. REGULATORY FRAME WORK IN INDIA FOR E-WASTE MANAGEMENT

India has ratified the Basel Convention but not the BAN Amendment, and officially opposes its enforcement (BAN, 2011).The fundamental aims of the Basel Convention are the control and reduction of trans boundary movements of hazardous and other wastes including the prevention and minimization of their generation, the environmentally sound management of such wastes and the active promotion of the transfer and use of technologies [10].

In addition, despite a wide range of Environmental legislation in India, there are no specific laws or guidelines for E-waste. The regulations banning the importation of hazardous waste for disposal are weak and imported e-waste still finds its way into the country (Montrose, 2011). The first comprehensive environmental law was the Environment (Protection) Act, which was enacted in 1986, after the Bhopal gas tragedy (Kalra, 2004).

The Hazardous Waste (Management, Handling and Trans boundary Movement) Rules, 2008, do apply to E-waste but deal primarily with industrial waste and lack elements to deal with the complexities of E-waste. The Rules are recognized as being inadequate. In addition, their lack of clarity and ambiguity makes their application impossible and encourages malpractice.

Some other existing policies and legislations are:

a) The Indian E-Waste (Management and Handling) Rules 2011 : This rule had gave many guidelines for the E-waste management but criticised because it ignores the unorganized and small and medium sector, where 90% of the E-Waste is generated and does not provide any plan to rehabilitate those involved in informal recycling .

b) The Hazardous Waste (Management and Handling) (HWM) Rules.

c) The Batteries (Management and Handling) Rules.

E-waste can also be considered as a great source of earning money as it contains many valuable components that actually may be beneficial to recover. It usually contains substantial amount of copper and also relatively high levels of several precious metals such as gold, silver and palladium. These metals together make up the major economical incentive for recycling of E-waste, as they may constitute over 95% of its total value [11]. The rapid growth of technology due to Industrial and Communication Revolution accompanied with up-gradation in technical innovation and high rate of obsolescence in electronic industry has made E-waste as one of the fastest growing waste streams in the world. By adopting proper **Recycling and Re-use** methods are the two ways by which the harmful effects of E-waste can be minimised [12].

6. NOVEL METHODS FOR PROPER E-WASTE MANAGEMENT

i. The amount of E-waste can be controlled by adopting proper steps at the time of generation of waste in the industries by using waste minimization techniques and sustainable designing of product [13]. It involves a four stage process which includes-

- Inventory management
- Production-process modification
- Volume reduction
- Recovery and Re-use.

ii. Governments should enforce strict regulations and heavy fines levied on industries, which do not practice waste prevention and recovery in the production facilities. Polluter pays principle and extended producer responsibility should be adopted. Governments should encourage and support NGOs and other organizations to involve actively in solving the E-waste problems. Uncontrolled dumping is an unsatisfactory method for disposal of hazardous waste and should be phased out. Governments should explore opportunities to partner with manufacturers and retailers to provide recycling service.

iii. Government needs to direct the industries that a separate department has to be setup to look for the waste generation and its disposal, cycling and reuse. A quarterly report should be sent to the government by the companies analysing this process.

iv. Like many other countries of the world such as United Kingdom, United States of America, Australia, Canada etc., where cities announces a day for E-waste collection, India should also employ such techniques. As India is a very big country both population and area wise, a number of collection centers needs to be setup in every district and a general awareness has to be created in the society. Almost 70% of industries and 85% of the population lacks the knowledge about E-waste and its proper disposal, recycling and reuse.

v. It is also the responsibility of citizens to ensure that they will help in minimizing the production of E-waste. Donating electronics for reuse extends the lives of valuable products and keeps them out of the waste management system for a longer time. E-Waste Management Reuse, in addition to being an environmentally preferable alternative, also benefits society [14-15]. By donating used electronics, schools, non-profit organizations, and lower-income families can afford to use equipment that they otherwise could not afford. E-wastes should never be disposed with garbage and other household wastes.

7. CONCLUSION

The E-waste management which is a burning issue in developing countries like India is more complicated due to the lack of stringent rules and regulation for monitoring the large quantity of E-waste getting generated. Providing proper infra-structure for processing the E-waste and starting an effective training program for innovative recycling and recovery methods and for the use of E-waste will strengthen the future generation technically to solve this problem.

As long as electronic products continue to contain an assortment of toxic chemicals and are designed without recycling aspect, they would pose a threat to environment and public health at their end-of-life. Even though a lot of regulating acts and rules are there, still the problem of E-waste is increasing day by day. E-waste is a serious problem as it causes severe diseases which can even lead to death of a person. Along with this, the improper disposal of E-waste also harms the environment which will affect many generations. Hence, proper management and disposal of all the electronics items which are not in use must be done properly. The concept of Recycle and Reuse need to be implemented. Also, repeated awareness programme through print and electronic media is the need of the hour and through continuous efforts of each section of society, E-waste management can be done properly.

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