# Electronic Waste Management in India: Review

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***Abstract****—This article reviews the electronic waste (**e**-waste) management trends in India and its implications. This suggestive study is done to solicit the need of proper management in India.*

***Keyword****—e-waste, health hazard, India, pollution, review*

## I. INTRODUCTION

The revolutionary advancements during last decade in the field of information technologies have changed the livelihood for human. These changes have been possible due to tremendous use to electronic equipment especially computers and mobile phones. This could be confirmed by the fact that there has been a considerable increase in the production of these items in the last decade and half [1, 2]. The rapid enhancements when compared to features and capabilities, added to this there is a decrease in the cost of such equipment. These rapid modifications in the software cause older equipment to live a shorter life. Due to all these reasons the increase in obsolete electronic devices is observed all around the world. In addition to these there are obsolete electrical devices also like televisions, refrigerators, *etc.* These obsolete electronic devices now need to be considered in serious manner because it is starting to affect human livelihood. As a matter of fact this kind of waste is more threatening as compared to conventional waste materials. This kind of waste causes more health related problems than its conventional counter parts. To separate this kind of waste from conventional ones we refer it as electronic-waste (or *e*-waste).

In India, the volume of *e*-waste has gone to an alarming high level due to our large population and increased use of ICTs in all the fields. The consistent increase in the sale of PCs in India as per Manufacturer's Association for Information Technology Industry (MAIT) performance annual review [1]. In India there were 113.26 million new cellular phone customers in 2008, and it is noted that an average of 9.5 million customers get added every month. According to TRAI report in 2007-08, the cellular customers increased from 168.11 million in 2003-04 to 261.97 million in 2007-08 [3] and expected to reach 500 million in 2023 according to statista.com. Not only these, the numbers to other electrical appliances (like refrigerator, microwave oven, air conditions, color televisions, DVD players, mp3-players *etc.*) also increasing at rapid rate due to urbanization in rural areas. Even though there is lack of authentic and comprehensive data on *e*-waste generation in domestic field. But now the state pollution controlling agencies have initiated to exercise various steps to estimate the volume of domestic *e*-waste generation rate. Studies shows among the cities Mumbai ranks first in *e*-waste generation followed by Delhi, Bangalore, Chennai, Kolkata, Ahemdabad, Hyderadad, Pune, Surat and Nagapur. Government of India estimated about 17 lakh tones of *e*-waste generated in 2014 [5]. The trans-boundary import of *e*-waste from some developed countries like USA, UK, and Japan, in developing countries like ours, both through legal and illegal roots causes extra burden on our country [6]. In this paper, we made an attempt to review the extent of dangers caused by huge amount of *e*-waste, the current management practices to curb these dangers in India and then to suggest what roadmap can be taken in this regard.

## II. TOXIC CHEMICALS FOUND IN E-WASTE

The electronic products such as smart phones, laptops, tablets *etc*. contain about thousands of hazardous chemicals and materials. Table I lists some of the possible toxic chemicals found in *e*-waste and their common sources.

**Table 1: Toxic chemicals and their sources in *e*-waste**

| Toxic Chemical | *e*-waste Sources |
|---|---|
| Mercury | CRT monitors & TVs, lead-acid batteries, thermostat, printed solders, switches, solder joints |
| Cadmium | CRT monitors & TVs, researchable batteries, switches, solder joints |
| Lead | Solders in PCBs, glass panels, gaskets in monitors, batteries |

| | |
|---|---|
| PVC | Cable |
| Antimony | Trace components of metal solders |
| Asbestos | Insulation |
| Flameretardants | Fluorescent lamps |
| Phthalates | Used to soften plastics especially PVC |
| Chloro-benzene | Formed during the combustion of chlorinated plastic PVC |
| Beryllium | Motherboard |
| Hexavalent chromium | Corrosion protection of untreated and galvanized steel plates and steel housing |
| Barium | Front panels of CRTs |
| Phosphorous | Front panels of CRTs |
| Glycol | Electrolytic capacitors |
| BFR | Plastic packaging of electronic equipment and circuit boards (Brominated Flame Retardants) |

In addition to hazardous materials *e*-waste also contains non- hazardous materials. For instance if we consider a typical personal computer CRT monitor waste, it contains about 43.7% metallic, 23.3% plastic, 17.3% electronic components and 15% glass. In a broader perspective it contains plastics, glass, circuit boards, ceramics, metals (ferrous and non-ferrous both), rubber, elements like mercury, lead, silver, gold, cadmium, platinum, *etc.* Out of these glass, gold, copper, platinum, *etc.* are non- hazardous materials which can be recycled for further use.

## III. EFFECT ON ENVIRONMENT AND HUMAN HELTH

The conventional practices to dispose municipal solid-waste (MSW) are tabulated in table II.

**Table II: Common practices to dispose off MSW**

| **Process:** | **Details:** |
|---|---|
| Landfills | Specific areas where waste is placed into the land |
| Waste combustors | Setups that burn MSW at a high temperature, reducing waste volume and generating electricity |
| Transfer Stations | Setup where MSW gets unloaded from collecting vehicles and briefly held. then reloaded for larger and long-distance transporting vehicles for shipment to landfills or other treatment or disposal facilities |

The most common practice in India is to treat *e* – waste as conventional MSW but if hazardous *e* – waste is disposed off using the conventional methods of disposing MSW, there will be serious ill-effects on environment and human health. Putting the *e* – wastes into landfills produces contaminated leakages which eventually pollute the ground water. The melted *e* – wasted materials produces acids and sludge ceases acidification of soil. The combustion practices produces toxic fumes and gases which pollute the air. Some of the human health problems are tabulated in table III.

**Table III: Effects of *e* – wastes Constituents on Health [7]**

| **Constituent of *e* – wastes** | **Health Effects:** |
|---|---|
| Lead (Pb) | Affect brain development of children, and harm nervous system and kidney. |
| Cadmium (Cd) | Irreversible damage on human health, accumulates in liver and kidney, cases neural breakdown |
| Mercury (Hg) | Chronic damage of brain, skin and respiratory disorders |
| PVC | Reproductive and developmental problems, immune system damage |
| Barium (Ba) | Muscle weakness, damage to heart-liver |
| Beryllium (Be) | Skin and chronic diseases, lung cancer if inhaled as fumes and through dust |
| BFR | Disturb endocrine system function |

## CURRENT TREANDS IN E-WASTE MANAGEMENT

According to hazardous waste rule 1989, *e* – waste should not be treated as a hazard unless it is proved to have higher concentration of some toxic substances. Even though *e* – waste containing PCBs and CRTs always exceed these parameters but there are several grey areas which need to be address. India also lacks proper standard disposal mechanism for handling *e* – waste. Due to this situation the major part of *e* – waste ends up into landfills which lead to one of the most rapidly growing environmental problem in India. Not only our home generated *e* – waste but imported *e* – waste adds up the problems. Even the import of *e* – waste requires specific permission of Ministry of Environment and Forest but still there are unknown reasons for illegal import of this. According to Basel Action Network (BSN) 50 – 80 % of *e* – waste collected in USA is imported to China, India, Pakistan, Taiwan and some African countries. The GTZ–MAIT Study in 2007 predicted that every year, about 50,000 tonnes of e – waste were imported to India. Hence, the *e* – waste management holds greater significance and needs to be addressed properly.

E-waste is contains both hazardous (PBR, lead, mercury, chromium, cadmium, etc.) and non-hazardous including precious material (copper, gold, silver, *etc.*). It is these precious materials which attract informal recyclers in

India. At this juncture, in India *e* – waste management is majorly done through unorganized sector with a handful of organized *e* – waste recyclers. More than 95% of *e* – waste is treated and processed in most of the urban slums. In this unorganized sector, untrained workers perform the dangerous procedures without using personnel protective equipment. Such procedures are harmful for their health and dangerous for the environment. The untrained and uneducated workers working in this field gets almost Rs. 5 to 10, for dismantling a PC. A pilot study suggested that the unskilled workers working in the e-waste recycling units is more than 10,000 in count for Delhi region [8]. The uncontrolled recycling of *e* – waste as done in unorganized sector is referred as backyard recycling. This backyard recycling of *e* – waste is main area to concern in the non-OECD (Organization for Economic Co-operation and Development) countries like China, India, *etc*. Even though there is no clear data on the volume of disposal of *e* – waste, performed by unorganized sector, but there is evidences that major environmental issue associated with *e* – waste is informal processing. The primitive tools and methods used by unorganised sector often involve the open atmospheric burning of plastic waste, exposure to toxic solders, acid baths to recover saleable materials and components from *e* – waste with little or no safeguards to human health. This results in the environment pollution deteriorating the land, water and air due to river dumping of acids and through widespread general dumping [9]. Toxics Link reported that about 70% of e-waste in Delhi's recycling units was actually collected through exported or dumped by developed countries [10].

## IV. LIFE CYCLE OF EEE IN INDIA

As discussed above, *e* – waste management system in India is not formally developed as it is in some other countries like Switzerland. In fact it is unorganized and ill defined. Wath *et. al.* analyzed the Indian e-waste management scenario and divided the life cycle of the electrical & electronic equipment (EEE) in India in to three stages [2].

The first stage of EEE can be regarded as entry stage of the new EEE in the form of raw material, components of EEE, assemblies or sub-assemblies in to our country. This may involve the production by producers located in India or imported from other country. Even though retailers, distributors and suppliers are not the end user of these EEE items but they are regarded as the actors in the generation of *e* – waste. Up to this stage the sector is formally well organized. Even though there are some local PC assemblers who purchase local sub-assemblies and sell these directly to consumers in the grey market at much cheaper rates. Such market avoids the high level of overall taxation like value added tax, excise duty, custom duty, service tax, license fee (on software) *etc.* as compared to branded PCs.

Second stage regarded as *e* – waste generation stage. It involves the real users for EEE *i.e.* both official and domestic consumers, who purchase the new EEE from the actors in the first stage. The consumers in India generally discard their old items for the sake of latest advanced version, features, etc. and also for more options to meet their progressive need. This scenario is more often seen in the products like PCs, TVs and mobile phones. Another important trend in India is that a single EEE may be used by more than one user, as many of the first user resale or give the used EEE to their relative, or friend for further use. There are practices of donating used EEE by some official consumers to the economically week institutes like charitable educational institutes, hotels, orphanage, hospitals, villages' societies, *etc*. It is also reported that a massive amount of *e* – waste gets imported from foreign countries in the name of donation without paying any duty.

At third stage, involves the *pre*-reprocessing and reprocessing of *e* – waste. This stage is mostly involve people working in unorganized way. The *pre*-reprocessing stage involves the collection of *e* – waste which is mostly done by scrap dealers/traders called "*Kabadiwalas*" in local language. These *Kabadiwalas* purchases *e* – waste along with other recyclable scrap (old newspapers, cardboards, books, plastics rejects, ferrous-tin material items, glass-bottles, *etc*.) from consumers and sell it to small-traders then it goes to the wholesaler. The wholesaler then perform segregation procedures to sort out different types of waste-materials. Ultimately wholesalers sell it to recyclers, dismantler and disposers for reprocessing. In India *e* – waste is treated as a part of ordinary recyclable wastes like plastics, glass, wires *etc*. which is disposed-off like ordinary recyclable wastes. The remaining of *e* – waste which contains precious materials like copper, gold, silver aluminium *etc.* gets reprocessed for these materials and then the residual waste either disposed to incinerator, landfill or open dumping.

Thus, the entire system of informal *e* – waste management is based on existing collectors, traders, and recyclers. Each one of these adds value and also creates job opportunities at every stage of the process. This makes network of activities which involves reuse, recycling and then final disposal of *e* – waste. The EEE could also find its re-use in the second sale market. The trading of re-used EEE is very difficult to predict, therefore quantification of *e* – waste is presently impossible.

## V. EFFECT OF INFORMAL RECYCLING OF E-WASTE

The use of ICTs is very important in the socio-economic development of our country which requires the many EEE like TVs, PCs, mobile phones *etc*. it play an important significant role in the running of modern business, administration and education. Due to economic disparity in our country compared to other developed countries people lacks the use of new EEE but rather makes the consumer to go for purchase of second hand EEE. This is the one among other factors which add up growth of *e* – waste in India.

It is a proven fact that *e* – waste recycling industry is market driven and growing due to its lower initial investment. The financial profit is the main incentive for small entrepreneurs working in this area without bothering about social and environmental issues related to this field. Most of the workers working in this field are poor and un-educated, they are not concern about the harmful effects which could be caused by *e* – waste on their own health and to the environment as well. The dismantling process which is used for removing components and other reusable components from *e* – waste is mainly mechanical or physical. This involves screening, size-shape based separation, magnet based separation, electric-conductivity based separation, and density based separation. Most of the work, including collection, dismantling, sorting, segregation and recovery, in the unorganized sector is done through manual labor so this business has very significant employment potential. The recovery of reusable machines, components and other materials from *e* –waste is good source of income for the poor people working in this area. Therefore, *e* – waste recycling sector offers job opportunities and source of income, which needs to be understood while framing any management system for India.

The most important problem in the current *e* – waste management practices in India is the uncontrolled emission of pollutants that are going into water, air, and soil. Even worse picture is that this is neither quantified nor monitored. The health problems caused due to harmful chemicals, fumes and ashes affect the people working in this field and expose the *e* – waste handling environment. The informal way of *e* – waste management system is driven by labours and most of the technology and methods used in this area are outdated which leads to release of uncontrolled emission of pollutants. The process used in dismantling some important *e* – waste components, and its occupational and environmental hazards are tabulated in table IV.

**Table IV: Occupational and environmental hazards involved in dismantling *e* – waste components [11]**

| *e* – waste component | Procedure used for dismantling | Occupational hazard |
|---|---|---|
| Cathode Ray Tube (CRT) | Breaking & removal of yoke then dumping | Cuts from CRT in case of explosion Inhalation or contact with phosphor containing Cd, Pb, Be |
| Printed Circuit Boards (PCB) | De-soldering and removal of computer chip | Inhalation of lead, tin, Be, Cd,Hg |
| Dismantled PCB Processing | Open burning and acid bath of waste board that has chip removed to get final metals | Acid contact with eyes Toxicity to workers and nearby residents from tin, lead, brominates dioxin, beryllium cadmium and mercury inhalation |
| Chips and other gold plated components | Chemical stripping using nitric acid | Respiratory irritation Toxic to workers and neighborhood |
| Plastics | Open burning to remove copper | Polycyclic Aromatic Hydrocarbons (PAH) and heavy metals exposure to workers, |
| Part of Computer encased in rubber or plastic | Open burning to remove copper | Polycyclic Aromatic Hydrocarbons (PAH) and heavy metals exposure to workers, |

## VI. INDIAN E-WASTE MANAGEMENT RULES 2016

On March 2016, Government of India has notified elaborated rules called E-waste management rules 2016 and it came into force from October 1, 2016. Thereby Government have fixed the responsibilities of manufacturer, producer, and recycler for the proper e-waste management in India [12]. These rules aim to tackle the situations arising due to ignorant attitudes of consumers when they dispose off their electronic equipment. It also fixed the responsibilities like dismantling and disposing, for State government in environmental management of e-waste. It clearly indicates the procedures to be followed by different stake holders, pollution boards etc. for management of e-waste.

## VII. CONCLUSIONS

In this review paper we studied the various aspects of *e* – waste in the perspective of India. We realized that at present there is an inadequate, inefficient and unorganized way of handling *e* – waste in India which further worsens by the fact that we have un-accounted import of *e* – waste from overseas. There are indications that the rate of *e* – waste generation will increase exponentially in future

also. The effects of hazardous substances released from informal recycling of *e* – waste is a matter of concern as it not only harm environment but to the human beings major effects are on those who work in this sector. The contamination of environmental compartments affects the natural resources such as soil, crops, drinking water, livestock, *etc*. There are social and economic constraints which restrict complete stoppage of informal recycling practices. These practices could not be controlled also due to lack of any pertaining legislation in this regard.

On the basis of current social, economic, occupational and environmental scenario in India we need to make *e* – waste management scheme so that it helps all the affected parties and also enhance present inefficient practices in this field. With this aim we, tried to understand various practices adopted by other countries in this regard. We realized that a whole new level of dimension is required to manage *e* – waste in India. We need to adopt the policies which will encourage private firms to operate in the recycling field. We should also encourage manufacturers of EEE products so that they encourage use of less toxic materials with recyclable constituents. Such practices can be encouraged by providing them tax benefits and other incentives. The research activities should also be increased in order to make technology more eco-friendly so that less toxicity in EEE products can be achieved. Last but not the least, we as citizens should ethical practices to in purchasing and handling EEE products.

The recent e-waste management rules being notified by Govt. of India, however promise to set and landmark change in Indian perspective.

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