CHAPTER 2

REVIEW OF LITERATURE

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CHAPTER: 2
REVIEW OF LITERATURE

Introduction
Many researchers had given their insights and findings on e-waste and related topics since this problem under study start itching the society and intensity starts increasing exponentially. The purpose of this chapter is to understand their work, to gain more knowledge this issue and correlate their efforts to create a base for further study. This chapter also includes the following objectives; to understand the problem through literature review, Sources of E-waste, its categories and generations of E-waste, hazards, drivers and challenges with respect to global and Indian scenario.

2.1 E-waste Definition

Electronic-waste is also known as E-waste, very trendy yet casual name given to electrical and electronic appliances & gazettes, either discarded or of further use.

According to California Integrated Waste Management Board 2005 Computers, televisions, VCRs, Music Systems, Photo copier, wax and other printers fall under this category. It is not very clear to add home appliances in this solid waste or not. But yet they are considered as either electronic or electrical products.

Kohler, A., Erdmann, L.,(2004) explained that the home appliance like automatic ovens, fridge or chilling machines and many others which also work on programming and computer related activities are very difficult to differentiate from WEEE as they are also part of either electrical or electronic family.
Wang et al., (2010)\textsuperscript{18}, write in detailed that electronic & electrical waste is actually a family and it has many branches which includes all personal, commercial, educational, transportation, private or public products which mainly work on power and have some at least sort of automation to function to meet the requirement.

A Catalog of universal e-waste substances are shown in Table 2.

According to UNEP, 2005; Greenpeace International, (2005) around 21,00,000 to 51,00,000 tones of e-waste produced annually around the globe and this number is very huge as well approximate as there is no clear cut method or technology to measure the actual quantity of waste produce and discarded. Further author said the percentage of e-waste of that of solid waste is around 5.

Widmer, R., Oswald (2005)\textsuperscript{9} stated in rich and developed nations the percentage of e-waste to solid waste is around 8.
Table 2 Catalog of universal e-waste substance

<table>
<thead>
<tr>
<th>Items</th>
<th>Weight</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>35</td>
<td>3</td>
</tr>
<tr>
<td>Reproduction M/c</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>hi-fi M/c</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Cell phones</td>
<td>0.1</td>
<td>2</td>
</tr>
<tr>
<td>Gaming M/c</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Light printing M/c</td>
<td>60</td>
<td>8</td>
</tr>
<tr>
<td>Broadcasting M/c</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>TV</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>VCD</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Washing M/c</td>
<td>65</td>
<td>8</td>
</tr>
<tr>
<td>Fridge</td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td>A.C.</td>
<td>55</td>
<td>12</td>
</tr>
<tr>
<td>Oven</td>
<td>15</td>
<td>7</td>
</tr>
</tbody>
</table>

Source: Cobbling (2008)

ETC 2010\(^{11}\) in a statement, the International Association of Electronics Recyclers predictable that according to existing development & slumping trends the all personal and public electronics instruments will find its way to landfills is approximately three billion. Interpretation of current financial drift, budding nations are also going to pour more and more electronic waste into the existing amount.
Table 3: Projections of e-waste generation (tones / year) in budding countries

<table>
<thead>
<tr>
<th>Countries</th>
<th>Assessment Date</th>
<th>PCs</th>
<th>Printers</th>
<th>Mobile phones</th>
<th>TVs</th>
<th>Refrigerators</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Africa</td>
<td>2007</td>
<td>19,400</td>
<td>4,300</td>
<td>850</td>
<td>23,700</td>
<td>11,400</td>
<td>59,650</td>
</tr>
<tr>
<td>Kenya</td>
<td>2007</td>
<td>2,500</td>
<td>500</td>
<td>150</td>
<td>2,800</td>
<td>1,400</td>
<td>7,350</td>
</tr>
<tr>
<td>Uganda</td>
<td>2007</td>
<td>1,300</td>
<td>250</td>
<td>40</td>
<td>1,900</td>
<td>900</td>
<td>4,390</td>
</tr>
<tr>
<td>Morocco</td>
<td>2007</td>
<td>13,500</td>
<td>2,700</td>
<td>1,700</td>
<td>15,100</td>
<td>5,200</td>
<td>38,200</td>
</tr>
<tr>
<td>Senegal</td>
<td>2007</td>
<td>900</td>
<td>180</td>
<td>100</td>
<td>1,900</td>
<td>650</td>
<td>3,730</td>
</tr>
<tr>
<td>Peru</td>
<td>2006</td>
<td>6,000</td>
<td>1,200</td>
<td>220</td>
<td>11,500</td>
<td>5,500</td>
<td>24,420</td>
</tr>
<tr>
<td>Colombia</td>
<td>2006</td>
<td>6,500</td>
<td>1,300</td>
<td>1,200</td>
<td>18,300</td>
<td>8,800</td>
<td>36,100</td>
</tr>
<tr>
<td>Mexico</td>
<td>2006</td>
<td>47,500</td>
<td>9,500</td>
<td>1,100</td>
<td>166,500</td>
<td>44,700</td>
<td>269,300</td>
</tr>
<tr>
<td>Brazil</td>
<td>2005</td>
<td>96,800</td>
<td>17,200</td>
<td>2,200</td>
<td>137,000</td>
<td>115,100</td>
<td>368,300</td>
</tr>
<tr>
<td>India</td>
<td>2007</td>
<td>56,300</td>
<td>4,700</td>
<td>1,700</td>
<td>275,000</td>
<td>101,300</td>
<td>459,000</td>
</tr>
<tr>
<td>China</td>
<td>2007</td>
<td>300,000</td>
<td>60,000</td>
<td>7,000</td>
<td>1,350,000</td>
<td>495,000</td>
<td>2,212,000</td>
</tr>
</tbody>
</table>

Source: UNEP 2007

Wanjiku et al. 2009 explained while awareness around e-waste and the hazards posed by improper recycling is growing, the allure of inexpensive access to technology is still too great for many budding nations to want to strictly regulate electronics.

2.2 The Problem

2.2.1 Rapid Technology Changes and Slow Adaptation to Changes

According to guiding principle for proper management of e-waste the Utmost important reason of the e-waste creations in world and in India is rapid technological changes slow adaption to changes because today in the world thousands of new technology develops every day which generates new demand for that new technology which finally reduces demand less developed technology which generates tones of e waste in the world.
**Figure 1:** Why e-waste is a problem.

1. Rapid technology changes slow adaptation to changes
2. Increases consumers electronic purchases cheap sales
4. More Hazardous material everywhere.
5. Increasing human health risks “richer”.

**Why is e-waste a problem?**
2.2.2 Increases Consumers Electronic Purchases Cheap Sale

Rakesh Johri, (2008) explained as new technology development in the world of electronic leads to more purchases of the electronic item like mobile phone like smart phone, note 1 & 2, oven, TV, etc. there should be expansion in the field of electronic but the cost should be verified directly or indirectly. Expansion in a field should not be achieved at the cost of human being health like kidney diseases or by disturbing environment ecology like natural environment like contamination, etc.

2.2.3 More Waste More Toxic

Kohler et al. (2004) narrated like every wastes affect the health of the human being & environment directly or indirectly e wastes also affect the health of both of human & environment directly & indirectly almost every pert of electronic waste as effect on the human health directly or indirectly like it affect nervous system, development of the children, disturb the natural ecology which is not good from everyone in the world point of view because it direct & indirect effect is on the human being.

2.2.4. More Hazards Material Everywhere

Kohler et al. (2004) further explained the main reasons for hazards material everywhere is divided into two points & they are follows:-

- Rapid development changes slow adaption to changes
- Increases consumers electronic purchases cheap sales

Due to the above reason every day e waste problem is becoming more serious. Which is not good from everyone point of view.
2.2.5 Increasing Human Health Risk “Richer”
Hilty L.M.,(2005)\textsuperscript{8} narrated the main reason in this case is lack of the knowledge about e waste management & handling to this condition in the further government, society citizen everyone as to take some important step before situation goes out of control. As e-waste is likely to touch 5.50 lakh tones by 2012 if measures are not taken at this time than it is more serious problem.

2.3 Sources of e-waste
M. Khurrum S. Bhutta et al (2008)\textsuperscript{2} explained the reasons behind this tremendous growth behind current e-waste is all organizations like public, private, home, commercial, educational, industrial, hospitals etc. All of these are equally using available automatic products, which ultimately pass on to the dumping sites.
Figure 2: Sources Of e-waste

1. Home and tiny commercial activities @ 22%
2. Big Commercial, Institution, government dept. and Outlandish Consulate @ 78%
3. Computer producers and sellers 1050 tons/year waste
4. E-waste from different nations
5. Second hand retailers
2.3.1. E-waste from in person
Darby, L., Obara, L., (2005) \(^{14}\) narrated as far as personal computers originating from separate families related data they are not major donor, they only responsible for around 23% where as the rest is given by commercial activities i.e. 77%.

2.3.2 E-waste from Business Sectors
Dalrymple et al. (2007) \(^{13}\) explained the corporate segments (Government sections, Non-government sections, trans national organizations, etc.) are the major participants in this problem as their percentage is almost 77% which is very high as compare to individual and in number it is almost near to 139,00,000.

2.3.3 E-waste from Manufacturer and Retailers
Guo J, Guo J, Xu Z, (2009) \(^{25}\) explained other than public, private and other end users their two more categories viz. producers i.e. manufacturers and sellers are also responsible for pilling of e-waste every day and year. During their routine process many faulty and low quality wise parts as well as entire products also send to the garbage and ultimately to dumping sites or for land fillings. Annually approximately 1100 tons of waste comes from this part.

2.3.4 E-waste from Importers
Ongondo, F.O (2011)\(^{12}\) explained that the developed nations are not only dumping their e-waste in dumping sites of their own countries but they also dump this waste to other areas, budding nations, under developed nations. Developed nations not only dump second hand products but also their parts like mouse, keyboards, printers, wires, motherboards etc. into under developed nations. And this dump part is of different variety as well.
2.3.5 Derived sell of Old PCs
Derived sell is nothing but a area where used electronic and electrical parts and products are easily available, like television, PCs, mobile phone, electric boards etc.

2.4 Composition of e-waste

Hilty L.M., (2005) explained in the below diagram composition of e-waste like ferrous, non-ferrous, plastic, plastic, glass, wood & other. The mobile & computer nearly generates same amount of hazards explain as follows.

Diagram 1: Composition of e-waste
<table>
<thead>
<tr>
<th>Matter type</th>
<th>Matter in %</th>
<th>Wt. of matter in PC (kg)</th>
<th>Purpose</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic</td>
<td>23.0</td>
<td>7.17</td>
<td>Covering</td>
<td>Cabling</td>
</tr>
<tr>
<td>PB-Lead</td>
<td>6.322</td>
<td>1.8</td>
<td>Fusion of metal</td>
<td>Cladding in Cathode Ray Tube</td>
</tr>
<tr>
<td>Al</td>
<td>15.234</td>
<td>3.91</td>
<td>Systemic transportation</td>
<td>Meshing, and transportation</td>
</tr>
<tr>
<td>Garmanium</td>
<td>0.0017</td>
<td>&lt; 0.11</td>
<td>Semi-conductor</td>
<td>PCBs</td>
</tr>
<tr>
<td>Gallium</td>
<td>0.0020</td>
<td>&lt; 0.11</td>
<td>Semi-conductor</td>
<td>PCBs</td>
</tr>
<tr>
<td>Steel</td>
<td>21.4298</td>
<td>6.12</td>
<td>Systemic, Magnet</td>
<td>Cathode Ray Tube, PCB</td>
</tr>
<tr>
<td>Tin</td>
<td>1.1234</td>
<td>0.30</td>
<td>Metal joining</td>
<td>PWBs, CRTs</td>
</tr>
<tr>
<td>Copper</td>
<td>7.1934</td>
<td>2.00</td>
<td>Transportation</td>
<td>Cathode Ray Tube, joining</td>
</tr>
<tr>
<td>Berium</td>
<td>0.0432</td>
<td>&lt; 0.12</td>
<td>Attach</td>
<td>Outliner in Cathode Ray Tube</td>
</tr>
<tr>
<td>Nickle</td>
<td>0.9123</td>
<td>0.24</td>
<td>Systemic Magnet</td>
<td>Cathode Ray Tube, PCB</td>
</tr>
<tr>
<td>Zink</td>
<td>3.2332</td>
<td>0.7</td>
<td>Power</td>
<td>PCB, Cathod Ray Tube</td>
</tr>
<tr>
<td>Tantalum</td>
<td>0.0213</td>
<td>&lt; 0.12</td>
<td>Holding pulse</td>
<td>Capacitors/PWB, power supply</td>
</tr>
<tr>
<td>Indium</td>
<td>0.017</td>
<td>&lt; 0.14</td>
<td>Transistor, rectifier</td>
<td>PCB</td>
</tr>
<tr>
<td>Vanadium</td>
<td>0.002</td>
<td>&lt; 0.14</td>
<td>Red P releaser</td>
<td>Cathod Ray Tube</td>
</tr>
<tr>
<td>Tarbium</td>
<td>0.1</td>
<td>00</td>
<td>Blue Green p releaser</td>
<td>PCB, Cathod Ray Tube</td>
</tr>
<tr>
<td>Berillium</td>
<td>0.01289</td>
<td>&lt; 0.11</td>
<td>Heat Transportation</td>
<td>PCB, Joining</td>
</tr>
<tr>
<td>Pure Gold</td>
<td>0.0017</td>
<td>&lt; 0.18</td>
<td>Joining and Transportation</td>
<td>Joining, PCB, Connectins</td>
</tr>
<tr>
<td>Matter type</td>
<td>Matter in %</td>
<td>Wt. of matter in PC (kg)</td>
<td>Purpose</td>
<td>Place</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
<td>--------------------------</td>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td>Er</td>
<td>0.0003</td>
<td>&lt; 0.11</td>
<td>Phosper activator</td>
<td>PCB</td>
</tr>
<tr>
<td>Ti</td>
<td>0.0251</td>
<td>&lt; 0.11</td>
<td>Metal missing</td>
<td>Cladding</td>
</tr>
<tr>
<td>Rd</td>
<td>0.0017</td>
<td>&lt; 0.11</td>
<td>Resistor</td>
<td>PCB</td>
</tr>
<tr>
<td>Cb</td>
<td>0.0164</td>
<td>&lt; 0.11</td>
<td>Systemic Magnet</td>
<td>PCB, Cathode Ray Tube</td>
</tr>
<tr>
<td>Pelladium</td>
<td>0.0003</td>
<td>&lt; 0.12</td>
<td>For Connection n transportation</td>
<td>PCB, Points</td>
</tr>
<tr>
<td></td>
<td>0.0324</td>
<td>&lt; 0.12</td>
<td>Systemic Magnet</td>
<td>PCB, Cathode Ray Tube</td>
</tr>
<tr>
<td>AG</td>
<td>0.0190</td>
<td>&lt; 0.11</td>
<td>Carrying</td>
<td>Joiners</td>
</tr>
<tr>
<td>Ant</td>
<td>0.0099</td>
<td>&lt; 0.12</td>
<td>Diodes</td>
<td>PCB, Cathode Ray Tube</td>
</tr>
<tr>
<td>Bs</td>
<td>0.0071</td>
<td>&lt; 0.12</td>
<td>For wetting</td>
<td>PCB</td>
</tr>
<tr>
<td>Chrome</td>
<td>0.0072</td>
<td>&lt; 0.13</td>
<td>Aesthetic purpose</td>
<td>Cladding</td>
</tr>
<tr>
<td>Cd</td>
<td>0.01</td>
<td>&lt; 0.12</td>
<td>Power</td>
<td>PCB, Cathode Ray Tube</td>
</tr>
<tr>
<td>Se</td>
<td>0.0017</td>
<td>0.00053</td>
<td>Identifiers</td>
<td>PCB</td>
</tr>
<tr>
<td>Neobium</td>
<td>0.0003</td>
<td>&lt; 0.12</td>
<td>Joining</td>
<td>Cladding</td>
</tr>
<tr>
<td>Rhodium</td>
<td>00</td>
<td>Attach</td>
<td>Film carrying</td>
<td>PCB</td>
</tr>
<tr>
<td>Platinium</td>
<td>00</td>
<td>Attach</td>
<td>Carrying.</td>
<td>PCB</td>
</tr>
<tr>
<td>Hg</td>
<td>0.0031</td>
<td>&lt; 0.1</td>
<td>Power</td>
<td>Cladding PCB</td>
</tr>
<tr>
<td>Ar</td>
<td>0.0014</td>
<td>&lt; 0.1</td>
<td>Attaching</td>
<td>PCB</td>
</tr>
<tr>
<td>Si</td>
<td>25.8903</td>
<td>6.8</td>
<td>Transforming agent</td>
<td>PCB, Cathode Ray Tube</td>
</tr>
</tbody>
</table>

Source: Agency for Toxic Substances & Disease Registry (ATSDR).2005’02’07
2.5 Categories of e-waste

ETC, Electronics Take Back Coalition, (2010)\textsuperscript{11} narrated the electronic and electrical equipment’s are separated into below types:

1. Big domestic equipments (Coolers, fridge, cooking machines, Cleaning M/c)
2. Undersized domestic equipments (watches, Home Cleaning M/c., Mixers)
3. ICT tools (Computers, phones, copiers)
4. Customer Appliances (Tele-Vision, Frequency Transmitters, Cam)
5. Illumination Systems (Tube Lights, Bulbs, Halogen lamps)
6. Automatic Mechanical tools (drilling M/c, Stitching M/c, Cutters)
7. Sports instruments, Recreation tools(Battery games, Consoles, Playing M/c)
8. Apparatus use for Medical Purpose
9. Observation and Disaster detection devices
10. Electrical devices for consumables like tea maker or coffee maker.

2.6 Generations of e-waste

2.6.1 International scenario

a) ETC, Electronics Take Back Coalition, (2010)\textsuperscript{11} also mentioned developed nations viz. European countries and America are mainly responsible for generating highest e-waste i.e. around 4 million tons yearly. United States of America is leading in producing highest e-waste i.e. around 4\% to its municipal waste. It also has proper segregation and treatment facilities.
b) Ongondo, F.O (2011) explained this e-waste problem can be a blessings in disguise as this huge solid waste has many sellable, attractive and important materials like silver, gold, platinum and other precious metals which can be easily extracted if the entire process get follows in a right direction.

c) Ongondo, F.O (2011) further narrated But it is not easy to dig out and get bring out glitters from this waste business as cost associated with every process involved in this business is very huge and heavy investment is required and that’s why many countries instead of providing a proper infrastructure or following proper management practices they just search a particular site or nation where laws related to this kind of waste is not so harsh and then they dump their waste in countries like India, China or many south Asian or African nations.

d) Schluep, M., Hagelüken (2009) write Europe is also not any way behind than America as growth rate of e-waste in Europe is also very high with almost 3-5 % annually.

2.7 Hazards with e-waste

Bastiaan C. et at.(2010) explained Waste electric and electronic equipment is different than that of other solid waste in many respects as it contains many hazardous material which can easily react as exposed to environmental conditions and releases poisonous substances into the environment.

These metals or substance with their probable effects are given below:
Table 5: Different metals found in E-waste and their respective hazards

<table>
<thead>
<tr>
<th>SUBSTANCES</th>
<th>PERIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hg</td>
<td>Heat-stats, Antenna, Transmission devices in relays in buttons and lamps, batteries, Liquid Crystal Display</td>
</tr>
<tr>
<td>PB</td>
<td>Joining circuits in CRT and lamps, power functions, Liquid Crystal Display</td>
</tr>
<tr>
<td>Cd</td>
<td>Buttons, connectors and PCB, Power functions</td>
</tr>
<tr>
<td>Hexavalent chrom</td>
<td>Insulator as well as cladding for protection</td>
</tr>
<tr>
<td>Polybrominated biphenyls (PBB)</td>
<td>Flame protector in PCB and guarding agents.</td>
</tr>
<tr>
<td>Polybrominated diphenylethers (PBDE)</td>
<td></td>
</tr>
</tbody>
</table>

Source: ATSD Registry (2012) \(^{37}\)

2.8 Effects of e-waste on environment and living beings

2.8.1 Human Hazards
Kohler, A. et al. (2004) \(^{10}\), ATSDR (2007) \(^{36}\) explained Lead: IT is very prominent and dangerous material found in e-waste creates problem for CNS and Peripheral NS, Functioning of Kidneys and on Blood circulation. It is essential substance used for varied purpose like for on PCB or for soldering of many components.
ATSDR (2012) Cadmium: It is also not less than lead in its poisonous activities as it damages human health up to maximum extend from where recovery is almost not possible if exposed to it. It is used in infra-red detectors, chip resistors, devices surface mount devices (SMD), and semiconductor chips.

**Diagram 3: Effect on Blood Cell**

**Diagram 4: Nervous System**
ATSDR (1999) Mercury:

It is as fatal as anything else can, it directly attacks to next generation of human beings even it causes severe problems to fetus or new born babies. It also damages to brains and kidneys. It is used in thermometer, buttons, transmission, PCBs, Power houses and in Cellular devices.

Damaged Brain

ATSDR (2012) Hexavalent Chromium or simply Chromium or simply Chrome protection from rusting when exposed to environmental conditions. It is used as a protection layer or coating on steel or iron parts. It can directly reacts with tissues and reacts with cells and starts damaging those.

Damaged Cell

ATSDR (2012) Plastic which is manmade synthetic material used for varied purposes like protection, carrying, cabling. It creates developmental and reproductive problems interfere with regulatory hormones and Immune system damage. It comprises dioxins.

2.8.2 Environmental Hazards

Hilty L.M., (2005) explained dangerous effects of burning metal parts of discarded electronic products creates severe health and environmental hazards. These metals or components cannot be oxidized at low temperature but required very high end furnace systems and which ultimately releases very high amount of toxic substances in the environment. These marts contains high amount of plastic, mercury, lead and brominated components which are very harmful even exposed to environment or fire.
Schluep, M (2009) explained due to use e-waste material for filling land sites: Whatever materials use for land filling purposes it reacts with soil and other components of environment as and when exposed to it. And this leaking creates life time effects on exposed environment. The historical dumping sites form is very bad and irreversible.

ATSDR (2012) Schluep, M. et al (2009) wrote it is very well known that metals are reacts with environment but many a number of times these metals also contains liquid substances it in which leaks and creates severe health hazards. The open landfills are also source of water and these metals can easily reacts and mix with water source which ultimately used for agricultural or domestic purposes. The discarded parts contains, plastic, CRTs, Circuits, wires, acid waters.

Hilty L.M., (2005) explained recycling repercussions: Recycling even though as compare to other available processes is advantageous but it also has many disadvantages and limitations. Recycled products cannot be use for life long as their working life is very less and they cannot cope up with recent developments and can’t fulfill current demands. During the recycling process again the existing waste has to go through a particular process where many parts exposed to different conditions and there they can react easily and create serious ill effects. Only relief with recycling is that the entire part is not discarded which up to certain extent reduces amount of generation of e-waste.

ATSDR (2012) Written additional trouble about heavy metals is that these metals are released into environment without any pre-process or activities on them and destroyed in their original forms. It is being expected to provide proper process before going for final destruction specially printed circuit boards, CRTs and power systems or batteries.
Effects on Overall Environment

Widmer, R (2005) narrated during the manufacturing processes these metals gone through varied actions and treatment but when it comes to disposal activities they are just thrown away into environment. These components contains liquid or semi liquid materials also which rapidly discharged from dumping sites and get mix or reacted with water sources or ground water available in that area and reaches to domestic or to residential areas.

Kohler, A (2004) explained Not only liquid water can gets contaminated due to illegal dumping but there are other matters which reacts with air in gaseous state and creates serious breathing problems. Air is one of the fastest moving medium from one place to place and it is very difficult to convert air conditions into its original state.

ATSDR (2012) mentioned Mercury is mostly found in liquid or semi liquid state, it is not only poisonous but one of the potent carcinogen and damage CNS and Peripheral NS, functioning of brains and Blood circulation when exposed to human conditions. It is presented in very hollow devices and when any such parts get damages due to crushing or hammering it gets releases and reacts with environment. It easily reacts with soil and water sources it also reacts with open air and other metals present in dumping sites. CRTS and PCB contain polychlorinated biphenyls (PCBs) which also contains mercury.

Bastiaan C (2010) narrated Mercury is not only present in the liquid or semi-liquid state but it is also present in vaporization state which creates similar threats to all biological system.
This reaction of metals and hazardous substances with gaseous state not only pollute local air conditions but global too. It leads to many allergic reactions and suffocating problems and it has not boundary as such. And entire global biological system suffers due to it.

Table 6: e-waste Sources, Constituents and its effects on Human Health

<table>
<thead>
<tr>
<th>Origin of e-wastes</th>
<th>Contents (Harmful)</th>
<th>Effects on Physical state</th>
</tr>
</thead>
</table>
| PCB and Screens          | Pb                 | • Dangerous to CNS  
                          |                    | • Neurotic progress of Babies |
| Microprocessors and circuits | Cd               | Dangerous to Kidney, Liver, and blood circulation           |
| Buttons, switch on PCBs  | Hg                 | Very fatal to brain functioning, skin irritation and breathing problems |
| Mainboard                | Beryllium (Be)     | Lung Cancer                                                   |
| Cathode Ray tube Panels  | Ba                 | Muscular flaw; Harmful to heart, neural system and lungs.      |

Table 7: Valuable Materials of e-waste

<table>
<thead>
<tr>
<th>Source of e-wastes</th>
<th>Constituent (Valuable)</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable, Housing</td>
<td>Plastics</td>
<td>Insulation</td>
</tr>
<tr>
<td>Funnel glass in CRTs, PWB</td>
<td>Lead, gold</td>
<td>Metal joining, Connectivity</td>
</tr>
<tr>
<td>Housing, PWB, CRT</td>
<td>Mercury, Zinc</td>
<td>Batteries, switches</td>
</tr>
<tr>
<td>Housing, CRT, PWB, connectors</td>
<td>Aluminum, Silver, Copper, iron</td>
<td>Conductivity, Magnetivity</td>
</tr>
</tbody>
</table>


2.9 E-waste Global scenario

Arun Kumar (2012)1 explained about global e-waste management, Switzerland is the first country to implement the organized proper electronic waste handling system in the world. Complete Manufacturer Responsibility and Future Recycling Charges are the backbone of e-waste management system in Many European country like Switzerland.

J, Pronczuk de Garbino (2004)7 explained Switzerland and other developed countries. Developed nations not only are the largest producers of e-waste annually around 3-4 million tones but at the same time they have the proper waste management facilities as well.
Sohaili J, Kumari (2012) narrated no doubt first world nations also know as developed nations like US, UK, and many other European countries are whole and sole responsible for global e-waste problem today but these are the nations who are more alert, attentive for management of same. But over the years they have also realized that management of such waste is not easy option so they are always in search of any such places or countries where they can deport their e-junk and the nations where rules about such import and dumping are not very harsh or strict. India, China and many other under developed nations have similar as well as supportive nations to meet the requirement of illegal dumping.

Ongondo, F.O., et al. (2012) narrated there are many countries that have already started the take back system for electronic products and they also have dedicated laws on e-waste management. In United States of America They have action plan for entire nation and not for specific e-waste producing regions. Even similar plans are implemented by European Union to tackle this problem. The European Union plan is applicable and binding on all 27 members of European countries.

Plan like Research of Use of harmful substances (RoHS), which is also implemented by other countries. According to EU directives (2003), it is mandatory for all 27 countries of European Union to recycle their e-waste.

Basel Convention is also nice step taken by UNEP to control the international trading of hazardous waste and India has also signed it.
United States of America
Electronic waste is compare to other solid waste is growing at very rapid speed. Around 15-22 million personal computer systems are discarded every year in USE alone. Only during ‘07-‘08 this particular waste category has shown tremendous growth. It is around 5% to its previous year’s collection.

On the other hand the other municipal waste reflected down trend where as this is the only type which is increasing day by day.

European Union
The member nations of European Union are also not much behind of USA, as they produce almost 7 million tons annually, and it is 8.1% of total municipal waste produced annually in member nations. The growth rate is also not lacking behind, it is in between 4.5-6 % annually. And By 2015 this particular discarded junk would reach a mark of 12-13 million tons.

It is not only growing with rapid pace but the amount of waste it generate is also huge. Earlier from EU itself the contribution was per person one kg now it has increased 3 folds to up to 20 kg per person annually.

United Kingdom
Like other European nations United Kingdom also the major e-waste generator nation. According to EA in 2009, In UK near about 1.6 million tons of electrical and electronic waste was generated, and out of it almost 80% were from personal or house activities.
Asia

Greenpeace International, 2005 explained in between 13 to 60 % contribution towards global e-waste is from Asia or Asian nations alone. Asia is the cheapest manufacturing market due to its low labor cost and high population and its density reasons.

Widmer, R (2005) explained India and China are number one number two in population account, even their per capita e-waste generation is less due to poverty but due to high population the amount of e-waste generate every year is very high.

Schluep, M., Hagelüken(2009), explained Compare to India China is far ahead in e-waste generation, it is around 3 million tons which includes all commercial and personal equipments in 2007. According to one governmental study it was near to 26 million Televisions, 6 million fridge or cooling M/Cs and 11 million cleaning machines, near to one million ACs, 11.9 million PCs, 7 million printing devices and 41 million cellular devices discarded in 2009. The study further says during next 4 years there would be sharp and exponential rise in this kind of municipal solid waste and it reaches to Acs 94 million tons, PCs 75 million and 65 million units of Televisions. The number of cellular phones and cooling or fridges would further increase and leads to global warming another outcome of over use of technology. This growth is estimated to be around 14%.

METI (Ministry of Economy, Trade and Industry, Japan) (2010) explained in Japan, around 19 million pieces including ACs (11.9%); Cathode Ray Tube Televisions (56%); Liquid Crystal Display and plasmas (0.9%); kitchen cooling M/Cs (17%); and Cleaning M/Cs (17%) were discarded in 2008-09.
2.10 E-waste Indian Scenario

In India, the number of e-waste from household and commercial activities was around 440 k tons estimating an Indian population of nearly 1.13 billion in 2006-07, this equates to 0.5 kg/capita.

Rakesh Johri, (2008) explained the story of Indian scenario; according to him our practices are very much different than worldwide accepted or followed procedures. E-waste is a matter of concern as these procedures are very illegal and not according to the accepted protocols. Therefore, counting of actual generation is very tedious task especially in country like India and, there is no mechanism and policy to check the flow of e-waste in the system. In India the number of e-waste from home activities is around 23% where as the remaining from commercial work i.e. 77%. And out of that around 84% are interested in new product and remaining are interested in second hand due to economical conditions, and that’s why commercial sector is major contributor.

M. Khurrum, et al., (2011) explained near to 1000 tons annually contribution is from producers and sellers. There is worldwide agreement on not to dump the waste from one to another nation then also India is major e-waste receiver. In India near about 64 big towns or cities are responsible for more than 66% e-waste generation. Near about 10-11 states generate 71% of the total e-waste of the country. Maharashtra is ahead in all states & then by Tamilnadu, AP, UP, WB, Delhi, Karnataka, Gujarat, MP and Punjab. About cities Mumbai stands first and then capital of India – Delhi, Banglore, Chennai, Culcutta, H’bad and Pune. Only 2 e-waste handling and management set ups are available in B’lore & Chennai. But there is not a single very large or large set up available and major work is carried out by illegal or slum areas.
In our country all the e-waste is collected by In India, probably the e waste is given to the scrap collectors or slum people and who purchase it from its owner on lump sum basis. After that all these e-waste material is collected at one place and then illegal and inappropriate way it is being broken down and after removing required or important materials from it, it is been discarded in non healthy and pollution causing way. This all happened due to lack of proper policy, non availability of technological know-how, lack of government or governing bodies intervention, slum mafias, less stringent rules and laws.

M. Khurrum, et al., (2011) \(^2\) narrated this particular way of e-waste collection, in other words illegal collection and handling has many aspects, it is profitable to its original owner as they earn something and at the same time the collectors recovers very precious materials even though at small quantities but they are free to do this. Recycling and disposal is very difficult as it needs proper technology. Major sellers or companies do not have proper returning or acceptable procedures due to that the educated people of this country also are part of these environmental degrading activities unknowingly. One of the articles says that only about 49% users are aware about its repercussion so this is a very serious problem.

2.10.1 Nation wise scenario

India produce 3.4 million tons e-waste in 2007-08 and is expected to touch 5 million tons by 2012. And 5.5 million tons by 2013, quoting the articles published in MAIT and GTZ 2007 issue. The total import during this particular period would be around another 70 tones whereas the total amount of e-waste manage through proper procedure is only 5-6 % all.
a) Other than treated by proper system around 7% will be handled by illegal activities whereas remaining will be lying as it is and creating further damage to the environment.

b) According to initial prediction findings the entire WEEE produce in India is around 1, 50,000 tons annually and it is predicted to cross the mark of 7 lack by 2012.

c) And it is around 0.2% of total municipal solid waste generation.

2.10.2 State-wise scenario

Table 8: State-wise E-waste generation

<table>
<thead>
<tr>
<th>TOP STATES</th>
<th>TONES</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAHARASHTRA</td>
<td>20,270</td>
</tr>
<tr>
<td>TAMIL NADU</td>
<td>13,486</td>
</tr>
<tr>
<td>ANDHRA PRADESH</td>
<td>12,780</td>
</tr>
<tr>
<td>UTTAR PRADESH</td>
<td>10,381</td>
</tr>
<tr>
<td>WEST BENGAL</td>
<td>10,059</td>
</tr>
<tr>
<td>DELHI</td>
<td>9,729</td>
</tr>
<tr>
<td>KARNATAKA</td>
<td>9,118</td>
</tr>
<tr>
<td>GUJARAT</td>
<td>8,994</td>
</tr>
<tr>
<td>MADHYA PRADESH</td>
<td>7,800</td>
</tr>
</tbody>
</table>

Source: Census 2011
Table 9: City wise E-waste generation

<table>
<thead>
<tr>
<th>CITIES</th>
<th>TONES</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUNE</td>
<td>2,584</td>
</tr>
<tr>
<td>MUMBAI</td>
<td>11,017</td>
</tr>
<tr>
<td>SURAT</td>
<td>1,836</td>
</tr>
<tr>
<td>BANGALORE</td>
<td>4,648</td>
</tr>
<tr>
<td>AHMEDABAD</td>
<td>3,287</td>
</tr>
<tr>
<td>HYDERABAD</td>
<td>2,833</td>
</tr>
</tbody>
</table>

Source: Census 2011

The above numbers are due to various reasons; these areas have big Information Technology businesses or many technology producing commercial organizations. Therefore these are the leading places in e-waste generation in India.

2.11 Drivers and Challenges

2.11.1 Drivers
1. Rising Electronic Gadget Consumption
2. Increased Awareness Regarding Environmental Hazards
3. Rapid product & Technology Obsolescence
4. Increased Corporate Activities
5. Government and NGO Initiatives
2.11.2 Challenges

1. Gathering & Transport of E-Waste
2. Chaotic E-Waste Amenities and Processes
3. Lack of Interest amongst Consumers
4. Challenges are higher than Drivers

Figure 5: Land Filling
2.13 E-waste treatment and disposal methods

2.13.1 Land Filling

Land filling is very simple by its meaning but yet complicated and not at all useful for to solve the problem of huge e-waste materials. Normally in land filling a part of earth is dig, soil is removed from that part and decided amount of e-waste is put in to that digging area and then it is again cover up by soil to layer it properly. To avoid contamination with water sources or other natural activities normally a synthetic material is used to block all sides. But e-waste is not at all type of bio-degradable waste, so to decompose or to get rid of entire buried material it takes years and years.

2.13.2 Incineration

This is a organized and comprehensive burning activity. During this process the waste material is fired in the specially designed blast furnace at very high temperature (901-1001 °C). The only return of this activity is that large amount of solid waste is removed from the total collection. And the dangerous or inflammable or any other type of hazardous material is come to an end without creating any harm to existing biological system. During this activity few dangerous compounds are converted into less or no dangerous type. But the repercussion is during or after burning process it releases harmful substances into the air and contaminate it. These releasing part contains very dangerous gasses and it creates severe problems to respiration, skin irritation, eye itching and leads to cancer. And it also produce huge amount of ash which is of no further use.
Figure 6: Incineration

Figure 7: Reduce, Reuse, And Recycle.
2.13.3 Recycle

Personal computers, laptops, all types of networking instruments, peripheral devices, telecommunication instruments and other type of all material which is a part of e-waste definition can be recycle.

These products are pull to pieces that is elimination of harmful substance or parts which contain this kind of substances are removed and reuse. These type of solid waste not only contains harmful substances or materials like Mercury, Helium, Cadmium but also it contains precious metals like Gold, Silver, Copper, Lead in minute quantities which can have good commercial value and can be either reuse or sell into the market.

2.13.4 Reuse

This is one of the best possible alternatives to deal with e-waste issues. Reuse means use similar or existing systems without hopping for new one. The entire problem of e-waste is revolved around buying new and discarding old one in little time span. In case of reuse systems can easily exchange between parties or owners as per their specifications with mutual understanding or through market activities. Only high end systems or programming purpose computers needs to upgrade their capacities where as majority of this junk can be again bring into main stream. Best example is printing cartridges, which are reuse by filling it again and again instead of going for new one. It not only economical mechanism but reduces the problem of e-waste as well.

2.13.5 Management Alternatives

Certain more alternatives are needed to be used other than discussed above, as the quantity involved is very huge and organization level interference is really required.
Below few alternatives are given to handle e-waste problem in a much better fashion:

2.13.6 Duties of Government

a) Authorities should come up with new vision and establish various agencies at different levels like district to tackle this problem with more seriousness. The authorities should be delegated to these units to follow guidelines very strictly and take decision by their own without sidelining environmental issues.

b) Currently in India there is no strict rules, laws are either available or implemented. So it is the duty of the government to either amend the existing laws and penalties or frame new ones at par with global practices. The heavy penalty provisions should be made.

The new laws should authorize organizations, administer & systematize the existing or newer processes to deal with proper care.

Some suggestions are given below:

- Gather elementary data on the e-waste from all possible sources including sellers, repair shops, kabadiwalas, individual through surveys and every possible responsible source of this problem.

- Find out possible harms with those materials and with the help of technical staff remove such materials and then go for proper disposal work.

I. Take help of all types of sources to understand possible risk associated with such materials and tasks.
II. Educate, guide and motivate end users to reuse as far as possible and create similar commercial or non commercial exchange mechanism to encourage reuse of existing electronic products.

Organize required training and information sessions to all categories of suppliers.

c) Such principal or controlling authorities should motivate end users even at the time of buying new electronic products and make them aware about their responsibilities. Have total control on public practices in order to reduce it to utmost level.

d) Controlling agencies or local governing bodies like muncipalities should have proper mechanism to have control on any misuse or on wrong doers. And should implement toughest rules and laws related to it.

e) Heavy penalties should be impose from industry that is manufacturing units to ultimate users about their wrong use of any electronic products and bad habits of just throwing away e-waste.

f) Those who pollute must pay rules should be implemented without any lethargy. And mechanism like extended responsibilities should be strictly observed.

g) Provide supporting hand to the other agencies like Non – governmental organizations and voluntarily organizations.

h) Discarding without any control is not at all tolerable practice for discarding of dangerous e-waste.
i) Agencies and governments should motivate and find out any such possibilities where producers work hand in hand with controlling agencies.

2.13.7 Responsibilities and Job of Producers/Manufacturers

a) Producers of electronic and electrical products should not run away from their responsibilities and start playing major role in controlling it.

b) The people working related to e-waste and e-waste management at all levels should be technically sound and have proper education and training in order to deal with this problem to it very beginning.

Different organizations can have their own rules and regulations, few are given below:

- Put proper instructions on every part to assist others down the line.
- Use and maintain proper standards so that part can be reuse.
- Re assess economical products so that other investment can use in dealing with waste problem.
- Use non-synthetic and degradable materials for manufacturing.
- Distribute all aspects of technology to all to encourage healthy atmosphere between producers so that they can come together later on for managing waste.
- Implement and encourage eco-friendly buying procedures.
- And use bio-degradable material for packing and wrapping.

c) All business activities should never ignore the environmental responsibilities and adopt best and environmental suited policies and procedures. The waste reduction is not only national concern but it also saves lots of money of the
manufacturer too. So a kind of mechanism should be adopted to support greener practices without sacrificing future needs.

The hazardous materials are not only costly but create great threats to human health so it should be reduced at the very first step and that is production.

These kinds of practices and objectives not only reduce the generation of electronic waste but also save our mother earth from further digging for their raw materials and substances.

d) All producers and sellers and others those who are benefitting due to this particular business should come forward and provide helping hand in waste reduction.

e) All producers, retailers and other sellers are not only encouraging users to buy more and more but dump their products by lucrative advertisements and offers. Such kind of acts only increases waste and its related problems. They should not run away from their responsibilities do not encourage customers. And where ever possible put proper labeling, its potential hazards and guidelines to overcome such hazards on each and every part and material.

2.13.8 Duties of the End users and Citizens

a) Recycling is the best option to tackle this waste problem. But other than this if citizens avoid excessive buying and use existing products for few more years instead of frequently changing or replacing existing then this would be really helpful for the entire biological community.
b) If not reuse for self-purpose then at least hand it over to the needy person instead of just keeping, dumping or selling it to illegal collectors which ultimately goes to dumping sites or become reason to generation of pollution.

c) The non-working electronic waste should not keep along with other household solid waste and should be handed over to proper collectors at the right time to send it to proper location for further processing by trained personals.

d) Certain guidelines while purchasing electronic products given below:

1. Contains less hazardous materials n more bio-degradable substances
2. Recycled materials
3. Power saving
4. Those with Standardized parts to avoid unnecessary replacement.
5. Very less wrapping
6. With return options
7. Issued or accepted by certifying bodies
8. End-users should go for up gradation of existing system instead of unnecessary replacement and buying.

e) Non Government Organizations should participate in E-waste reduction,

2.13.9 India Introduces e-waste Management Rules

1. Accountabilities of manufacturers, gathering hubs, customers, separators, recycling people etc. Are explained and considered in rules.

2. India has come up with strictest and serious guidelines to deal with these e-waste issues. The E-waste (Management and Handling) Rule, 2011 puts accountability on the manufacturers for the whole lifespan of a product, from
plan to disposal. These rules are at par with international standards and observed on strict basis. The law is drilled from 1, May 2012.

3. According to this regulation, ‘e” apparatus which is depends upon electronic and electrical products should be treated with proper technology and such treatment should be established and mentioned at the time of production only.

These regulations are applicable to each and everyone like producers, retailers, sellers, agents, dealers, collection centers, storage people, customer or mass customers directly or indirectly indulge into any purchase or buying or trade.

4. The rule published through Ministry of Environment and Forests on 30 May. This rule was applicable to entire nation by 1st May 2012.

This rule is a real victory for environmentalist and this is a huge set back to the people who believe in out of sight out of mind concept, where their individual responsibility ends as soon as the product is given away by them.

Some initiatives like other nations taken by government of India are as follows:-

**BASEL Action Network (BAN) &**

**Silicon Valley Toxics Coalition (SVTC)**
Advocacy groups that researched e-waste exportation to Asia
Produced the report, “Exporting Harm: The High-Tech Trashing of Asia,” 2002
Major influence on emerging national, state, and international policies among most outspoken critics of governments and industry

**National Safety Council**
National alliance for information exchange produced the report, “Electronic and Electrical Product Revitalization & Recycling Guideline Description: Recycling of Special Electronics Products in the USA,”
Remanufacturing Of Electronic Equipment for Reuse & Recycling (DEER2)
Department of Defense initiative to encourage electronic equipment recycling and reuse. One of the first organizations to address e-waste challenge.

National Electronic Product Stewardship Initiative (NEPSI)
Strong coalition of producers, sellers, state and local governments, & environment agencies.

Addressing e-waste challenge through producer responsibility ("product stewardship") models Pursuing “front-end financed system”. Include costs of managing e-waste in overall purchase price of electronic products.
2.14 The Five Points Guide to e-waste

2.14.1 The Problem

Figure 8: E-waste the problem

Many people presume e-waste to only mean computers and their peripherals (cables, printers, etc.) and handsets. Though, the meaning of e-waste consist of all out of date ‘e’ equipments including consumer electronics such as televisions and DVD players and household products like ACs, Cleaning M/Cs, & Cooling systems. Even MP3 players and irons contain e-waste. A 12-city study conducted by the Central Pollution Control Board of India and German NGO GTZ found total amount of e-waste produced in 2005 was 146,000 tones (22).
According to Delhi-based environmental NGO Toxics Link, the figure currently stands 400,000 tones, which is projected to double to 800,000 tons in 2012. In 2005, Mumbai generated 11,000 tons of e-waste, more than any other city in the country. In 2006, the amount of e-waste generated by our city had already risen to 19,000 tones, says Toxics Link. Most e-waste ends up in the unorganized sector, i.e. in the hands of your local radically or scrap dealer, where inexperienced and unprotected laborers dismantle products, often with their bare hands, with the aim of reselling the components. PVC, Lead, mercury, cadmium, and brominates flame retardants are some of the disease-causing hazardous materials that are released during the unmonitored destruction of e-waste.

2.14.2 What You Can Do When Buying An Electronic Product?

Buying environment-friendly products might be a little costly, but from economic angle they prove to be very cost effective. It is to be checked that the product is definitely upgradeable in terms of volume and technology. Ask the company or the dealer if they have a take-back scheme, or recycling amenities. If more people demand such amenities, the more likely they are to offer it. Use goods till the end-of-their life. This means resisting the attraction to buy a fancier TV, washing machine, or mobile phone even if your present one now seems obsolete. Know your rights. When the Ministry of Environment & Forest’s came with E-waste Rules from January 1, 2012, it will be officially obligatory for companies selling electronic goods to take back their products for recycling.
2.14.3 Give it away before you throw it away

Visit and donate for a list of schools and NGOs in Mumbai in need of PC equipment. You can also give your old laptop or desktop to an NGO. According to the Centre for Science and Environment, some of the NGOs you could give your I.T. e-waste to are Parham, United Way of Mumbai and Childine India. Free-cycle. Donate old TVs, iPods and computers to friends or friends-of-friends who are thinking of purchasing them. They may not mind using somewhat slightly old if it’s in good, working state and saves them from an extra expense.

2.14.4 Brands that Recollect and Recycle e-waste

Not all brands have e-waste collection and recycling amenities in Mumbai, or even in India. The ones that do offer details of the process on their authorized websites, most of which recommend that they gather and recycle only their own products. Call the help lines to ask if they will collect and recycle products of other brands as well. It’s desirable to collect a fair amount of e-waste before requesting collection.

a) HCL Info systems offers to take back all HCL-manufactured products for reprocessing. In Mumbai, HCL’s e-waste collection site is located at HCL Tower, Andheri (E). Tel: 2526518/19.

b) HP accepts HP-branded hardware products such as desktop and notebook computers and printers for recycling. HP shed light on Policy on Export of Electronic Waste to budding nations on 11th Feb 2010. We have strong commitment towards electronic and electrical waste clearing system.
In 2004 it was published, a ban on the export of dangerous or regulated material from grown to budding nations.

HP’s export policy related to e-waste contains the guarantee of the company to conscientiously set out of all e-waste produced by HP’s world process and return back programs

c) **Nokia** collects all Nokia-branded handsets, chargers and batteries.

d) In September, **Samsung** launched a take back and recycle programs under which it gathers and reprocesses for free, all Samsung-branded buyer electronics. Smaller objects such as digital cameras and mobile phones can be deposited at numerous drop-off locations, while larger items such as TVs and computer monitors can be disposed-off by calling a collection center. To find your nearest collection center or drop-off location, visit their website or call the Samsung Helpline on (011) 3030 8282 or 1800 110011 between 9am and 8pm.

e) **Wipro** assembles and reprocesses PCs manufactured by any brand. Call Praveen Dhamdhere on 9819797775 or mail pravin.dhamdhere@wipro.com

Wipro rated greenest electronics company.

2.14.5 Authorized Recyclers

If you sell your old PC or music system to your resident raddiwalla, you might get hundred rupees but you do so at a cost to the environment, and ultimately yourself. If you have products of brands other than those listed above, you can give them to one of the two companies authorized to recycle e-waste in Mumbai by the Central Pollution Control Board. They are:
a) **EARTH SENSE**, A-7, sjop No.1 to 3, Mezzanine, Prerana arcade, Anjur Phata, Dapoda Road, Bhiwandi, Thane.

b) **ECO RECYCLING LIMITED**, Eco House, near Top Glass Enclave, Bhoipada, near Range Office, Sativali Road, Vasai (East). For collection of your e-waste. Email-john@earthsense.in orewaste@earthsense.in and include in your message, your name, address, telephone number and details of your e-waste.

c) **ECORECO** in Mumbai are one of the authorized recycler in Mumbai is located in Kurla and Andheri.

### 2.15 Critical Review of Literature:

The review of earlier research in the related field is very important as it gives an idea about on what different aspects the earlier research was oriented and what was the depth of it. The review of literature discussed different aspects related to E-waste like, technical, environmental and economical. It also discussed the types and hazards related to e-waste. M. Khurrum, et al., (2011) explained near to 1000 tons annually contribution is from producers and sellers. Due to lack of proper policy, non-availability of technological know-how, lack of government or governing bodies intervention, slum mafias, less stringent rules and laws due to this it leads to non-healthy and environmental damaging activities. Whereas Kohler et al. (2004) narrated like every wastes affect the health of the human being & environment directly or indirectly e wastes also affect the health of both of human & environment directly & indirectly almost every pert of electronic waste as effect on the human health directly or indirectly like it affect nervous system, development of the children, disturb the natural ecology which is not good from everyone in the world point of view because it direct & indirect effect is on the human being. To the best of my knowledge my study put light on non-corporate users of MMR which exclusively presented the views of the end users.
regarding practices, its harms and government initiatives in terms of responsibilities and different enactments.

In addition to above all it is very important to know, No study of e-waste management in Mumbai was conducted with this depth earlier. And this is an earnest attempt to fill the research gap in this direction.

2.16 Conclusion:
This chapter gives an overall idea related to the problem under study. On the basis of reviews it is quite helpful to understand the research gap in order to remain focus and work on research problem. Thus, the review on different literatures evidently explains that the different aspects of the problem under study i.e. study of e-waste management.

The proper management e-waste is very new and upcoming concept even in an IT specialist country like India. Our nation is producing e-waste not less than any developed country. Moreover, our country is on receiving end to accept e-waste from many developed nations which increases this problem many folds. The reviews of various research focus on variety of aspects of research under study. According to reviews maximum proper practices are accepted and adopted by many developed nations and it is very important to understand and find out what sort of practices and up to what extend these practices are carried out in our own country where environmental related laws and rules are not that stringent and observe that effectively. Our country is a proper mix of developed, developing and under-developed areas, and Mumbai, economical capital and area under research is the best representative of this mixture where MPCB (State government pollution control board), Private players, and unorganized sectors like slum areas (sakinaka, Andheri, Kurla, Panvel-Taloja, Thane, Ulhas nagar, Bhiwandi and many others) follow and undertake different practices to tackle this problem at their own level.
The reviews of research literatures mentioned in this chapter is an attempt to compare the aspects, practices, rules-regulations and controls between practices around the globe by keeping in mind local problems and research objectives of this study.

In this chapter the researcher discussed literature review, Sources of E-waste, its categories and generations of E-waste, hazards, drivers and challenges with respect to global and Indian scenario.

So, an attempt has been made by this research to understand, compare, inspect and study e-waste management and its related sides.
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