

Recycling of E-Waste w.r.t. Mumbai and E-Waste Management

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Abstract: Today's Electronic Gadgets are tomorrow's E-waste. With the new advanced technologies, Changes in Style, Fashion and Status we often get bored and would like to end up with the latest version with advanced features and easy to use technologies. Smartphone's are the perfect example for this. Have you thought that our today's electronic gadget will definitely become tomorrow's E-waste and will be harmful to us? E-waste?? E-waste is nothing but our day to day electronic equipment's such as Smart Phones, Refrigerators, Computers, Laptops, Pen drives, Printers, Cable Wires, Televisions, VCR's, DVD's Stereos, Game Consoles and many more which is no more in use and had become obsolete or we would like to replace with the new electronic gadget to meet our own needs. Effective way to use this E-waste is to recycle as it contains precious metals such as Gold, Copper, Aluminum, Plastics and many more which can be further used as a raw material. Ministry of Electronics & Information Technology (Government of India) had laid down E-waste Management rules for electronic manufacturers, producers, dealers, collection centers, refurbisher, dismantler, recyclers and consumers in 2011. These rules are amended and currently 726 companies are assigned with Extended Promoter Responsibility Plan (EPR) to control E-waste and if rules not compulsorily followed will cause these companies to bear with penalties. In Mumbai, Brihan mumbai Municipal Corporation (BMC) is coming up with ideas for effective E-waste Management and had given authority to Eco Recycling Company to set up Recycling Centers & Collection Centers. The Company had successfully launched E-waste drop Points at 27 locations with 2 recycling centers. There are other E-waste companies too helping Mumbai to clean E-waste.

Keywords: E-waste, Generation, Management, Recycling, Waste Recovery, Electrical equipment, Electronic equipment and components

1. Introduction



Fig. 1. A Representational Image of E-waste Dump

With the technology development of consumer electronics, the whole world is facing serious problems caused by high E-waste flow produced every day. India continues to be generating highest e-waste vis-à-vis China, USA, Japan and Germany as on 4th June 2018 ASSOCHAM-NEC Study. Absence of stringent laws, poor infrastructure, legislation and framework leads to only 5% of e-waste recycling and leading to a waste of diminishing natural resources, irreparable damage of environment and health of the people working in Industry. Over 95% of e-waste generated is managed by unorganized sector and scrap dealers in this market, dismantle the disposed products instead of recycling it. Below table gives information about E-Waste contribution equipment's wise.

Table 1
 Category wise E-waste Contribution in India as per ASSOCHAM-KPMG Study

Category	E-waste Contribution
Computer Equipments	70%
Telecommunication Equipments	12%
Electrical Equipment	8%
Medical Equipments	7%
Household Equipments	3%

In India, Maharashtra contributes the largest e-waste of 19.8% but recycles only about 47,810 TPA (tones per annum), Tamil Nadu (13% and recycles 52,427 TPA), Uttar Pradesh (10.1% and recycles about 86,130 TPA), West Bengal (9.8%), Delhi (9.5%), Karnataka (8.9%), Gujarat (8.8%) and Madhya Pradesh (7.6%). This increase in quantity of E-waste is because of increased consumption but also obsolescence. Users discard old computers, mobiles and other equipment much faster than before.

According to a study in May 2017, the volume of e-waste is growing at an estimated 21 per cent annually. India's annual electronic waste (E-waste) generation in 2020 is expected to be 5.2 million MTs and 8 million tons in 2025. If the per capita generation of E-waste is taken into account individually; every person on the planet at present is responsible for generating 6kg of E-waste annually. About 80% (4.8kg) of this either ends up in landfills or is informally recycled, exposing workers to hazardous and carcinogenic substances and contaminating soil, ground water and food supply system.

India has a capacity to dismantle and recycle only 20% (over 4 lakh tones) of its total E-waste. Though there is no

comprehensive state-wise inventurisation of E-waste generation in India, the country has a total 178 dismantler and recycling units with highest number of such units (57) being in Karnataka followed by Maharashtra (32), UP (22), Haryana (16) and Tamil Nadu (14). The document is a template for Microsoft Word versions 6.0 or later.

2. E-waste generation and collection

A. Sources of E-waste

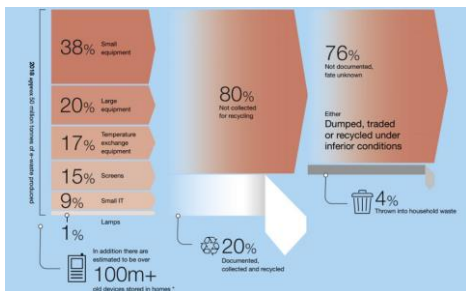


Fig. 2. A representational image of sources of e-waste equipment wise

The main and the continuous sources of generation of E-wastes are IT Sectors, Educational Institutes, and Government sectors, Commercial Sectors, Household and Manufacturing Sectors.

B. Sources of E-Waste

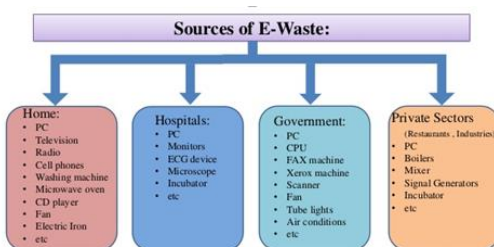


Fig. 3. A representational image of sources of e-waste equipment wise

Below mentioned table gives information about the product estimated life:

Table 2
Life span and mass of electronic goods

Item	Typical Life Span (Years)	Mass (Kg)
Mobile Telephone	2	0.1
Computer	3	25
Kettle	3	1
Telephone	5	1
Electronic Games	5	3
Toaster	5	1
Television	5	30
DVD Player	5	5
Microwave	7	15
Photocopier	8	60
Washing Machine	8	65
Radio	10	2
Electric Cooker	10	60
Freezer	10	35
Hair Dryer	10	1
Refrigerator	10	35
Vacuum Cleaner	10	10
Electric Heaters	20	5

C. Steps involved in Recycling of E-waste



Fig. 4. A representational image of steps involved in disposal and recycling of e-waste

D. Disposal and recycling process

Recycling of E-Waste takes place in three major steps which are depicted here.

1) Detoxication



Fig. 5. A representational image of the process of detoxification to ensure safe recycle or disposal

To ensure safe disposal or recycle of E-Waste, detoxication process takes place for the electronic materials. Detoxication is the process of removing critical components from the electronic waste in order to avoid contamination with toxic substances during the downstream processes. Critical components include lead glass from CRT screens, CFC gases from refrigerators, light bulbs and batteries.

2) Shredding



Fig. 6. A representational image of the shredding process in disposal or recycling of e-waste

In the next step electronic materials are broken into pieces to obtain concentrates of recyclable materials in a dedicated fraction and also to further separate hazardous materials. The mechanical processing plants where shredding takes place includes shredders, crushing units, magnetic and eddy current and air-separators. The emitted gases are filtered and residues are treated to minimize environmental impact.

3) Refining



Fig. 7. A representational image of refining, the third step of e-waste recycling

The third step of e-waste recycling is refining of the shredded materials to obtain reusable components. Refining of resources in e-waste is possible and the technical solutions exist to get back raw material with minimal environmental impact. Most of the components need to be refined or conditioned before they can be sold as secondary raw materials or to be disposed of in a final disposal site.

Other Techniques:

1) Incineration



Fig. 8. A Representational Image of the Process of Incineration

It is a process to destroy the waste by burning. As there are toxic materials present in the e-waste there may be a risk of generating and dispersing contaminants and hazardous substances. The gases released during the burning and the residue ash is often toxic especially when it is employed without prior treatment or sophisticated flue gas purification. Metals like copper, which is presented in printed circuit boards

and cables abundantly, works as a catalyst for dioxin formation when flame retardants are incinerated. These brominated flame retardants can lead to the generation of extremely toxic polybrominated dioxins (PBDDs) and furans (PBDFs) when exposed to low temperature (600-800°C). PVC, which can be found in e-waste in considerable amount, is highly corrosive when burnt and also forms the dioxins which are dangerous for both live creatures and atmosphere.

2) Open Burning



Fig. 9. A representational image of open burning of e-waste

Generally, e-waste is burnt in the open fire but since it is burnt at low temperatures, it releases relatively more pollutants in the atmosphere than incineration process. Inhalation of open burning emissions may cause serious health problems such as asthma attacks, coughing, chest pain, eye irritation, etc. If open fires burn with a lack of oxygen, it forms carbon monoxide, which poisons the blood when inhaled. In the burning of e-waste chronic emissions are released which may lead to diseases like emphysema and cancer. The PVC releases hydrogen chloride when it is burnt, forms hydrogen chloride acid reacting with water. It can lead to corrosion of lung tissues and other respiratory complications.

3) Land filling



Fig. 10. A representational image of land filling used for water disposal

It is the most widely used method for waste disposal. If the landfills are leaked, e-waste as it contains heavy metals and toxic substances can contaminate ground and water resources. Although landfills are sealed to prevent toxins from entering the ground but with the time they may have chance to be leaked

Table 3

Metals present in electronic products and their effects on human health

Metals Present	Occurrence in e-products	Effect on human health
Copper (Cu)	Copper wires, Printed circuit boards, coils, conducted in cables	Damages the liver and kidney and even causes death
Lead (Pb)	Soldering agent, lead rechargeable batteries, gaskets in computer monitors, transistors, lasers, thermoelectric elements	Affects the brain development in children, cause damage in kidney, central and peripheral nervous systems
Mercury (Hg)	Relays and switches, LCDs, pocket calculators	Damages the respiratory system, brain, and causes skin problems
Cadmium (Cd)	Printed circuit boards, computer batteries, Cathode ray tubes	Affects the neural health, accumulates in the liver and kidney and have teratogenic effect
Brominated Flame Retardants (BFRs)	Circuit boards, casing, cables and PVC cables	Damages endocrine system
Lithium (Li)	Lithium batteries, mobile phones, photographic equipment	Injurious to health
Arsenic (As)	Microwaves, LEDs, diodes, solar cells	acutely poisonous and injurious to health
Polychlorinated biphenyl (PCBs)	Transformers, capacitors	Cause cancer, effects on the immune system, reproductive system, nervous system, endocrine system and other
Plastics and PVC	Cables and body parts of e-products	Incineration generates toxic gases like dioxins which damages the immune system, causes reproductive problem, and interferes with regulatory hormones.

and thus pose a much greater danger of releasing hazardous emissions. Besides leaking, vaporization is another concern in landfills. Significant impacts from land filling could be reduced by separating dangerous materials from e-waste and by land filling only those fractions for which no further recycling is possible. Also it should be ensured that the whole process respect environmentally sound technical standards. The electronic products contain different valuable metals, precious and hazardous metals when treated in an unfriendly manner produces harmful gases (Dioxin and Furan) and effluents (acid/base/hot) which have negative effects on aquatic animal, human and environment. Table 3 shows the metals present in different e- products and their effect on human health. Below table summarizes Metals which affect human health if not decomposed appropriately.

3. Recycling of E-waste in Mumbai



Fig. 11. A representational image of Mumbai e-waste

Over the last few years, Mumbai has been the leading E-waste generator. The Eastern and Central regions are among the most underdeveloped regions in terms of E-waste management due to the lack of consumer awareness and sluggish industrial growth in these regions. Mumbai bagged the tag of the cleanest state capital in India in the Swachh Survekshan (cleanliness survey) 2018 rankings. Mumbai itself is producing 12cr kg of E-waste in a year. The Navi Mumbai Municipal Corporation has plans to set up Swachh Park at Nisarg Udyan in Kopar Khairane which earlier used to be the city’s dumping ground. This park will create awareness on handling all kinds of waste – dry, wet and electronic,” said municipal commissioner Ramaswamy. He also conveyed, “Navi Mumbai has achieved the distinction of being the second most liveable city in the country and ranked among the top 10 in Swachh Bharat Abhiyan. The city will take steps to emerge as a model for handling electronic waste.”

The BMC, the country's richest civic body, has even shed responsibility for E-waste generated by its own office, awarding a contract to a third party and earning Rs 16 lakh from this. The city generates more than 325 metric tons of E-waste per day. As per the Praja Foundation's solid waste management handbook, the BMC can earn Rs 98 crore per year by having collection centers in place and by selling this waste to vendors and factory units. The BMC has already agreed to sell five-year-old electronic appliances from its building, including desktop computers, printers and air-conditioners to m/s RT Corporation. For this, the civic body would get Rs 16.6 lakh. The BMC had made an attempt to fix this back in 2016, by inaugurating a collection point near Mithibai College in Vile Parle by Eco Recycling Ltd (EcoReCo) a project by BMC’s Solid Waste Management Department (SWMD). EcoReCo had been assigned contract to take care of E-waste in Mumbai and to successfully accomplish the same the company had recycling center in Virar and Bhiwandi respectively. The company had installed E-waste collection bin at 27 locations as mentioned below till date and soon going to install at 96 more places.

Now days, E-waste had become a profit centre and people are willing to capture the market. More jobs are created. These companies are spreading awareness and also giving free pick up facilities for the collection of E-waste. List of companies are mentioned in Table 5.

Table 4
List of E-waste Drop points in Mumbai

Sr.No	Place	City
1	Ajmera Global School	Borivali
2	St. Xavier's Institute of Education	Goregaon
3	Patkar - Varde College	Goregaon
4	KES Shroff College	Kandivali
5	Lokmanya Seva Sangh	Vileparle
6	Sannyas Ashram	Vile Parle
7	Chhatrapati Shivaji International Airport (T2, T1B)	Santacruz
8	Juhu Vile Parle Gymkhana (JVPG) Club	Juhu
9	World Trade Centre	Cuffe Parade
10	Royal College of Art, Commerce and Science	Mira Road
11	Navi Mumbai Bengali Association(Kali Mandir)	Vashi
12	Sumer Trinity Towers	Prabhadevi
13	Vidyalankar Technology Institute	Wadala
14	Vivekananda Education Society	Chembur
15	R.A. Podar College Of Commerce	Matunga
16	Great Eastern Gardens	Kanjurmarg
17	Mulund College Of Commerce	Mulund
18	Kalwa Ward Office, Wagle Estate Ward Office	Thane
19	Majiwada-Manpada Ward Office	Thane
20	Lokmanyagar-Sawarkar Nagar Ward Office	Thane
21	Thane Municipal Corporation (Head Office),	Thane
22	Shahu Market, Naupada, Thane	Thane
23	Diva Ward Office	Thane
24	Naupada-Kopari Ward Office	Thane
25	Vartak Nagar Ward Office	Thane
26	Uthalsar Ward Office	Thane
27	Mumbra Ward Office	Thane

Table 5
List of E-waste recycling companies in Mumbai

S. No	Company Name	Address
1	Earth Sense Recycle Pvt Ltd	A-7 , Gala no: 1,2&3, Ground Floor, Prena Complex, Anjur Phata, Vill: Val, Tal: Bhiwandi Dist: Thane
2	Just Dispose Recycling Pvt Ltd,	A-103,104,110,119, Arvind Industrial Estate, Navghar , Tal: Vasai, Dist: Thane
3	Z-Tronics Infratel Pvt. Ltd.,	Survey No: 103, Gala No: 538, 539 At Village: Pimpri, Post: Dahisar, Tal & Dist: Thane
4	Green Valley E-waste Management Pvt. Ltd.	Pritesh Complex, Bldg. No. A-7, Gala No 7, Anjurphata, Dapoda Road, Val: Vill: Val Tal Bhiwandi Dist: Thane
5	Indian Scrap Traders	Ghusia Market, Gala no: 661 Vill: Pimpri, Post: Dahisar Dist: Thane
6	Go-Green Recycling	Plot no. 32, Sec 1A , Service Industrial Area, Koparkhairne, Navi Mumbai
7	Hari International	Shree Parasnath Complex, Unit no. 6 Bldg no. D-4, Anjur Phata, Dapoda Road, Vill, Val, Tal: Bhiwnadi Dist: Thane
8	R. T. Corporation	S. No. 377, Hissar No: 2, Ambisi Ganeshpuri Road, Village: Palsai, Tal: Wada, Dist: Thane
9	E-waste Recycling, Nicholas Compound	Near Agarwal Naka, Sativali Road, Valiv, Vasai, Distt. Thane
10	R. K. E-Recycling International LLP	Gala No. 2, Tirupati Industrial Park, Sativali Road, Waliv, Tal. Vasai, Distt. Thane

11	Eco Recycling Limited	Eco House, Near Top Glass Enclave, Bhoipara Vasai (East) dist, Thane
12	ECO Friend Industrial,	Plot No. A-205, TTC Industrial Area, MIDC Pawane, Navi Mumbai- 400710
13	E-incarnation Recycling Pvt. Ltd	Plot No. J-56, MIDC Tarapur, Dist: Thane
14	Green World Recycling	Vill: Val, Pritesh Complex, Building No, B12, Gali No. 7,8 Anjur Phata, Village: Val Tal: Bhiwandi, Dist: Thane
15	Clean Tech,	B_8, Gali No. 3, Parasnath Indl. Estate, Anjur Phata Road, Village Val, Tal. -Bhiwandi, Dist.- Thane
16	Enviroicare Recycling Pvt. Ltd	Unit No. 8_C-1, Actual Industrial complex, Uchat Road, Vill. Nagothane, Tal. Wada, Distt. Thane
17	Krishna Metal Refinery	Plot No. 2_143, Sapronde Vill., Tal. Wada Dist. Thane

Apart from this various activity are conducted in Mumbai to promote E-waste. Clean 2 Green campaigns were launched in 28 municipality schools in Mumbai where the students were more than 600. Manufacturer Information Technology union had come up with the plans in 2019 and the article is launched on 26th Jan 2019 in Maharashtra Times and local newspapers.





EcoRox Waste Collection Drive in three societies was a successful event and ended up with the collection of E-waste of **800Kg**. The event was carried out in Amarbaug Society, Chembur Yoganand Society Borivali Akruati Atria Society, Andheri

4. E-waste management

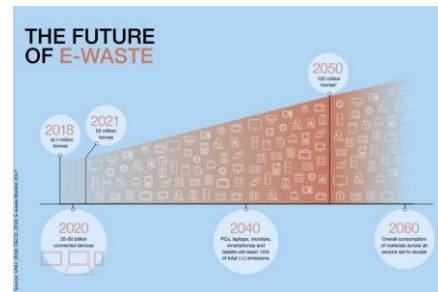


Fig. 12. A Representational Image of Future of E-Waste

Few events which happened in FY2018-19 towards E-waste recycling in Mumbai are listed below:

Table 6
List of events in Mumbai during the FY 2018-2019

Date	Place	Event
23.01.2019		Clean to Green company comes up and educate municipal school children's about E-waste. Anand Vidyalaya
05.11.2018	 Soorya Balasubramanian and Trisha Bhattacharya students of VIBGYOR High - Goregaon, Mumbai work towards saving the environment and educating the under privileged.	Two students from std IXth and Xth (Soorya Balasubramanian and Trisha Bhattacharya) collected 380kg of E-waste and donated to an NGO and helped to educate 17,000 slum children's.
14.10.2018		Collection of E-waste in Red Bins at School started by Mayor Jayant Sutar at Sadhu Vaswani International School Sanpada, Navi Mumbai

India being a developing country suffers from inefficient infrastructure for waste management with increasing rate of E-waste generation. During the past few decades, Indian Government has initiated certain rules and regulations provided in E-waste management and handling rules, 2011 which is being modified in 2015 and further in 2016 and 2018. But lack of community awareness and insufficient knowledge there is very poor implementation of the rules. The lack of proper collection, processing, transportation and disposal of E-waste is a great emerging problem for a sustainable E-waste management system. The rising issue of E-waste is very complex and the biggest challenge is the involvement of government, waste collectors, dismantlers, recyclers, different entrepreneurs and NGOs actively for the same issue. Proper planning and design should be made by the stakeholders for achieving sustainable development. The management strategies initiated by the Indian government and the policies for the betterment of management of E-waste s can be summarized as follows:

A. Extended Producer Responsibility Program



Fig. 13. A Representational Image of how Extended Producer Responsibility works

EPR authorization has been provided to 726 producers by the Central Pollution Control Board (CPCB) as on 12 Oct 2018. As per the government rules notified late last March but effective Oct 2017, the life of a Smartphone has been determined as five years, and feature phone at seven years. Accordingly, handset makers selling phones prior to five years or seven years have to collect E-waste equal to 10% of the sales done in the financial year five or seven years back, while those starting operations later will need to meet lower targets of 5%. Earlier, the rules stated that older companies had to start with a target of 30% collection of the sales done in previous years, while new companies had to meet a target of collecting E-waste equal to 10% of the sales. In effect, players such as Samsung, LG, Panasonic NSE 6.63 % and Micromax will have to collect E-waste equal to 10% of Smartphone's sold in FY 2013-14, in the fiscal 2017-18, since they have been selling Smartphone for more than five years in India. But for Chinese players such as Xiaomi, Oppo and Vivo, who entered the market in the last three-four years, the target for the present fiscal will reduce to 5% of sales in 2016-17. The new E-waste collection targets, also known as the Extended Promoter Responsibility Plan, will rise by 10% every year for older companies until it hits 70% by FY24, and will stay at that level from that year onward. But for newer companies, the target for FY 2018-20 stays at 5% of the sales done in FY 16-18, rising to 10% in FY 2020-2022 for sales done in the consecutive financial years. This target again rises to 15% in FY 2022-24 and 20% from FY 2024 onwards.

B. Deposit refund scheme

Deposit Refund Scheme has been introduced as an additional economic instrument wherein the producer charges an additional amount as a deposit at the time of sale of the electrical and electronic equipment and returns it to the consumer along with interest when the end - of - life electrical and electronic equipment is returned. This act as incentives for consumers to voluntarily adopt the system of E-waste management

C. Restriction of hazardous substances (RoHS)

Government had putted restrictions on the usage of six hazardous material viz., hexavalent chromium, cadmium,

mercury, lead, polybrominated biphenyls and polybrominated diphenyls which are being used in electrical and electronic items. A minimum use of toxic material should be made in product designing and the companies should bear the costs for recycling and disposal practices.

D. Role of Government for encouraging Recyclers

There lies a huge gap between the collection facility and the recycling centers due to lack of infrastructures and proper management system. Take back policies are not in proper practices and the informal sectors are getting much more benefit out of this mismanagement. Formal sectors are very few in number in India and moreover running privately without government aid and with a very limited quantity of wastes. Schemes for getting incentives are not being given to the producers and recyclers who are interested in handling the E-waste with proper care. If some relaxation in terms of tax and incentives are made, it would be of great step to encourage the recyclers to cover all parts of India. Research work should be encouraged and technology transfer can be done to develop the processes of recycling the E-waste s in a more environment friendly way. Establishment of small scale industries and promotion of cottage industries can develop India with newer and safe technologies and techniques for the safe handling, recycling and disposal of E-waste s following a zero waste concept.

E. Awareness programmes



Fig. 14. A representational image of creating consumer awareness

Lack of morality and awareness among people is the big hurdle in the management of E-wastes. Collaboration of the NGOs and government for planning different awareness campaigns programs to spread the information related to electronic products and their harmful effects after end of life is required at the earliest. The consumers should be informed about the take back policies and the utilization facilities. Schools can be the best option to raise awareness in the society regarding environmentally sound E-waste management. In today's world, electronic media is a wonderful tool to spread any type of messages and information throughout the world. Different campaigns can be made in different places with live demonstration of all the steps from generation of E-waste s to safe disposal to make people understand and make India a more developed country.

5. Conclusion

This paper presented an overview on recycling of e-Waste with respect to Mumbai and E-Waste Management.

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