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Electronic Waste: Growing challenges and Management

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ABSTRACT

Generation of electronic waste (e-waste) is increasing rapidly which causes significant challenges to its management. Many toxic and hazardous substances contained in e-waste pose hazards on the human health and environment via air, water and soil. The infrastructure to deal with e-waste is insufficient in terms of technology; Rudimentary and primitive techniques are used to treat more than 90 % of e-waste. Intensive study of the characteristics of various hazardous materials in e-waste essential to create the awareness among the people. This paper reviews e-waste generation, composition, recoverable, recyclable, and hazardous materials, potential health environment impact, current management practices and trends.

Keywords - Environment, Hazardous, Heath , Management, Process

I. INTRODUCTION

Exponential growth of electronics industry combined with rapid product obsolescence created e-waste which is a big challenge to the environment. E-waste means electrical and electronic equipment, discarded by the consumer, rejected from manufacturer, refurbishment and repair processes. This happens because of changes in technology, change in fashion, and new equipment with more features available at lesser price, decreased life-span of equipment, Improper method of e-waste dumping by developed nations. The typical composition of PCB is; non metals(plastics, epoxy resin, glass)>70%,copper 18%,solder 4%,iron,ferrite 3%, nickel 2%, silver 0.05%,gold 0.3%,palladium 0.01% others < 0,01%

E-waste treatment cost is quite more than recovery of materials from e-waste. Because of this huge amount of e-waste flow from developed countries to developing countries. Safe and sustainable disposal and recycling of electronic waste is a major issue because e-waste waste contains some toxic and hazardous substances which have an impact on human life and environment Disposal of such heterogeneous mix of materials and metals etc entails a scientific approach and special treatment for effectively mitigating the issues with the passage of time. Improper management of hazardous chemical components present in e-waste has adverse impacts on ecosystems and human health

Recycling, recovering and reusing e-waste is of the most global challenging task A large amount of such e-waste is creating an unsolved problem in terms of storage handling and disposal space.

This papers provides an overview of current e-waste scenario, environmental and health hazards., current disposal ,collection and recycling. It gives an insight of available technologies in both developed and developing countries for recycling of e-waste.

WASTE SOURCES AND FACTS

Stake holders of e-waste are: Manufacturers, suppliers, end users, collectors, and regulators. aggregators, resellers, recyclers.

Figure 1: Sources of E-waste

Major sources of E-waste are

A. Formal Sector
   1. *Importers, Producers/manufacturers*
   2. *Retailers, Businessmen, Government etc*
   3. *Consumers, business , Government*
   4. *Traders*

B. Informal Sector
   1. *Scrap Dealers*
   2. *Disassembles/Dismantlers*
   3. *Smelters*
   4. *Recyclers*

Intrinsic desire from the customer to have a better lifestyle leads to obsolescence concept in design. There are three types of obsolescence practices promoted by equipment manufacturers: functional obsolescence,, where a product is replaced by another product with its better functionality;

quality and convenience, Technological obsolescence which, which puts a strong influence on the end users to discard their electronic devices. This leads to the huge amount of generation of e-waste shown in Figure2

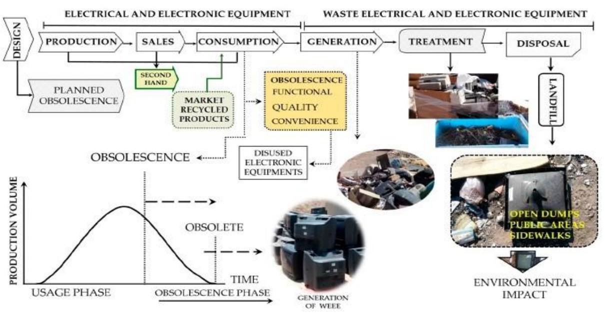

Figure 2. Obsolescence in life cycle of electrical and electronic equipment.

Some E-waste ends up in common garbage disposals sites and exposed to a collection of chemical substances and heavy metals contained in the E-waste . This exposure is highly hazardous and, to ameliorate environmental impacts. Therefore we need an appropriate disposal method.

The huge amount of e-waste generation threatened the environment safety. Because it contains hazardous metals and inorganic and organic compounds; Lead(Pb), Mercury(Hg), Cadmium(Cd), Tin(Sn), Antimony(Sb), Arsenic(As), Asbestos(As), Barium(Ba), Beryllium(Be), Chromium(Cr-vi), Nickel(Ni).. E-waste is a diverse and complex nature of waste having both hazardous and non-hazardous ingredients. The hazardous substances explode while handling, recycling, and recovery of the recyclable material from the e-waste in uncontrolled condition.

Proportions of materials recovered from the e-waste are as follows; Steel constitutes 50%, copper, aluminium and other metals 13% and plastics 21% [ETC/SCP], however e-waste is made of wide variety of substances. The hazardous and toxic metals constitute about 1% of the total weight and rest of the material like precious metals constitute gold 0.1%, Silver 0.2% and palladium 0.005% respectively. Various sectors are sources and re responsible for he generation of generation of E-waste

The general flow E-waste across different sectors is as shown in figure 3.

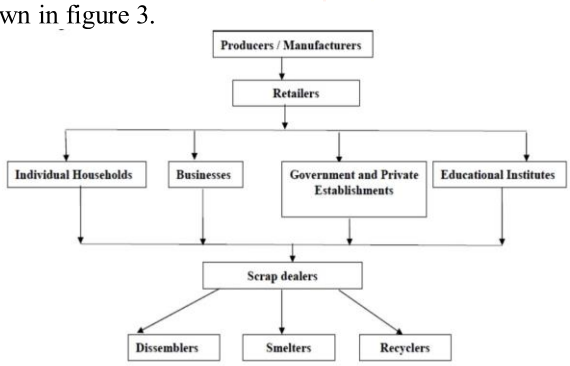

Figure 3: General flow of E-waste across different sectors

Every year hundreds of millions of tons of e-waste are discarded. Most of thee e-waste generated in developing countries is often exported to developing countries for recycling. This is ending up with a landfill. Therefore environmental pollution is increasing at very fast rate .This is creating severe health and environmental hazard. Open air burning of plastic waste , toxic solders, river dumping of acids, widespread dumping and landfills. Majority of the e-waste generated in developed countries are dumped in developing ountries. Electrical and Electronic good are classified as into three major types.

1. *White goods:* comprises of house hold appliances such as air conditioners, dishwashers, washing machines:
2. *Brown goods :* comprises of televisions, camcorders, cameras
3. *Gray Goods*: computers, printers, fax machines, scanners etc.

Gray goods are more complex to recycle because of their multilayered configuration and higher toxic composition

a. E-Waste global Scenario

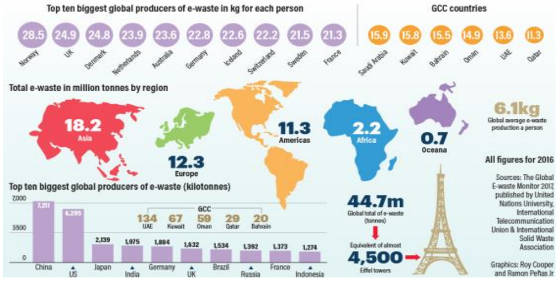

Figure 4 : Global top E-waste producers https://www.thenationalnews.com/opinion/editorial

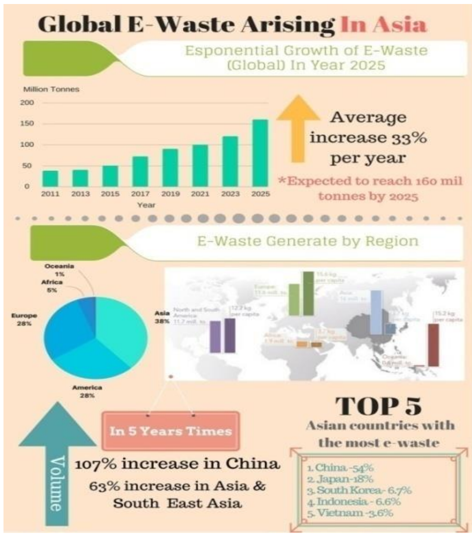

Figure 5: Global e-Waste generation

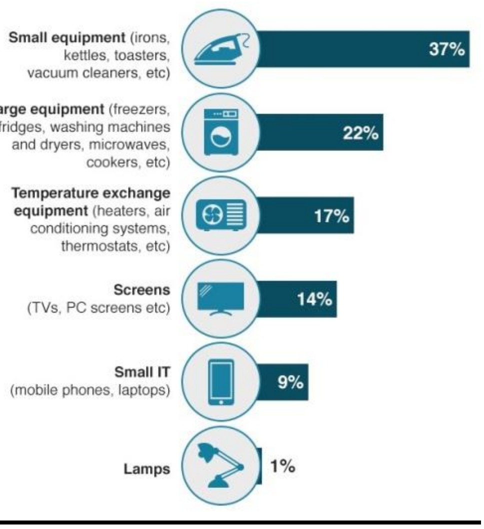

Figure 6 : Global e-waste -2020(USEPA) olu.com/global-e-waste-in-asia

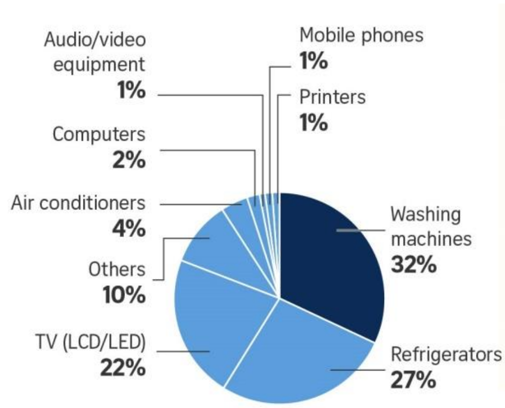

Figure 7: Types of e-waste (by weight)

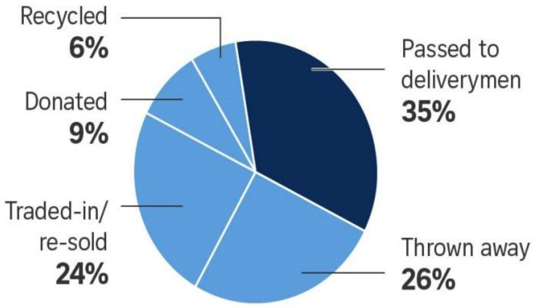

Figure 8 Disposal Pattern (weight)

Major sources of e-waste generation globally industrialized and developed counties.

a. E-waste Facts

1. E-waste represents over all 70% of toxic waste
2. Electricity required by 3657 homes in a year can be generated by recycling 1 million laptop
3. Only 12.5% of e-waste is recycled
4. For every 1 million cell phones that are recycled 35,274 lbs of copper,772 lbs of silver,75 lbs of gold, and 33 lbs of palladium can be recovered
5. To manufacture one computer and monitor requires takes 530 lbs of fossil fuel, 48lbs of chemicals and 1.5 tons of water
6. One metric tons of electronics waste contains more gold than gold from17 ton of gold ore, 6000 mobile phones gives 130 gm of copper, 240 gm of gold, 140 gm of palladium

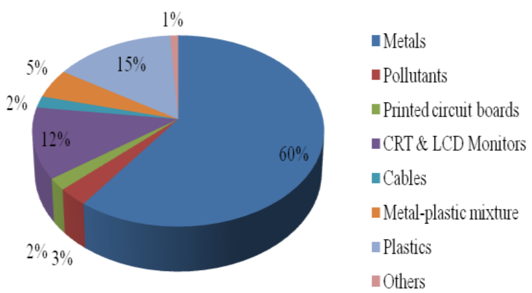

Figure 9: Distinctive materials in E-Waste

E-waste contains valuable and toxic materials. The composition of e-waste depend on device type, model, manufacturer, manufacturing date, etc. For instance a mobile phone contains more than 40 elements base metals such as copper(cu), tin(sn) ,lihium(Li), cobolt(Co), indium(In),antimont(Sb) precious metals such as gold,(Au), Silver(Ag), Palladuim(Pd). PCB contains arsenic(AS), cadmium(CD), chromium(Cr), mercury(Hg), and other toxic chemicals

b. E-Waste composition

- Valuable metals like gold, platinum, silver and palladium..Useful metals like copper, aluminium, iron etc.
- Hazardous substances like radioactive isotopes and mercury.
- Toxic substances like PCB's and Dioxins.
- Polystyrene (HIPS), Acrylonitrile Butadiene Styrene (ABS), Polycarbonate (PC), Polyphenylene oxide (PPO) etc.
- Cathode ray tube glass made up of SiO_2, CaO, Na. For example, a mobile phone contains more than 40 elements, base metals such as Copper (Cu) and Tin (Sn), special metals such as Lithium (Li), Cobalt (Co), Indium (In) and Antimony (Sb) and precious metals such as Silver (Ag), Gold (Au), and Palladium (Pd).

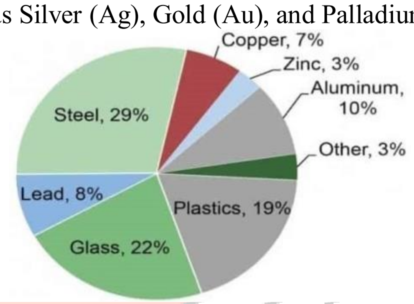

Figure 10: Composition of material in e-waste

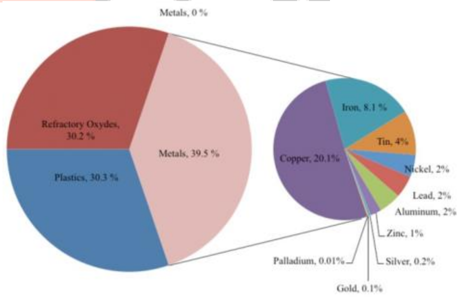

Figure 11: Composition of metals in e-waste

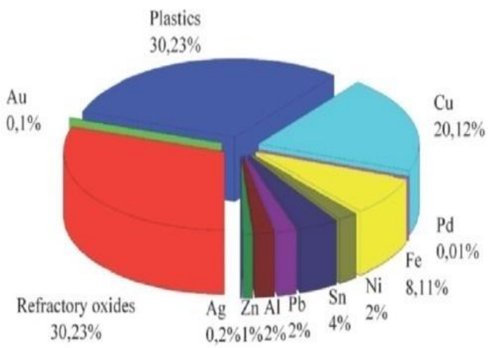

Figure 12 : Average composition e-waste

The Precious metals recovered play a major role because it gives 95% financial support to the recycling infrastructure, also other metals and materials like lead, nickel and various plastics may worth after recovery from e-waste[He et al. 2006, Cui and Zhang 2008].

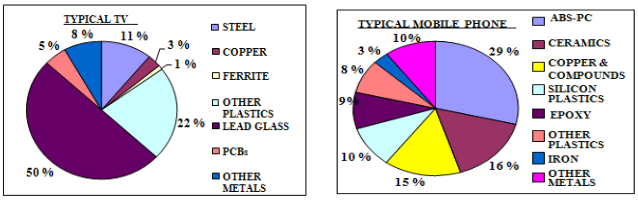

Figure 13 Material composition in typical mobile phone, TV (https://www.weforum.org)

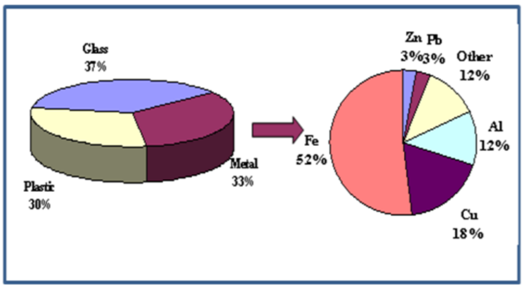

Figure 14 material compositions in computer

The material present in PCB can be categorized into three groups. Organic materials, ceramics and metals Figure 16 shows the material and their properties in PCB from E-waste

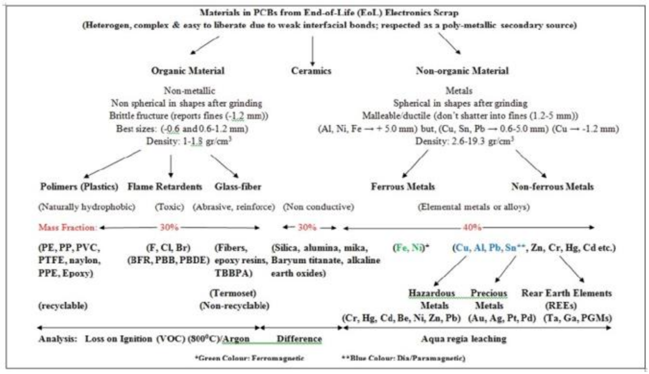

Figure 15: Materials and Their properties in PCBs

c. Impacts of E-waste

E-waste contains various components which are inherently hazardous and highly toxic in nature. These materials if not scientifically recycled and disposed will impact life, environment and climate. The sources of e-waste and their impact on health are listed in table 1

Table 1: E-waste sources and their health effects

S.No	Source of e-wastes	Toxic component	Medium of exposures	Health effects
1	PCBs, computer monitors, Television, bulbs	Lead (PB)	Air,water, soil, dust	Nervous systems, DNA, blood system reproductive health
2	Batteries	Nickel	Air,water, soil, dust, food	Lungs, dysfunction
3	PCBs ,Wires	Copper	Air,water, soil, dust	Headache, dizziness ,ENT disorders
4	PCBs Monitors Chip devices, phones, connecting components	Candmium (CD)	Air,water, soil, dust, food	DNA damage, Reproductive health kidney, lever. Causes neural damage.
5	Memory tapes and disks	Chromium	Air,water, soil, dust,	DNA damage, reproductive health, Lungs dysfunction
6	Relays and switches, printed circuit boards	Mercury (Hg)	Air,water, soil, dust,	Chronic damage to the brain. Respiratory and skin disorders
7	galvanized steel plates, decorator or hardener for steel housings	Hexavalent chromium (Cr) VI	Air,water, soil, dust,	Asthmatic bronchitis. DNA damage.
8	Cabling and computer housing	Plastics including PVC	Air,water, soil, dust,	reproductive health , Immune systems damage, hormones
0	Plastic housing of equipments and circuit boards.	Brominated flame retardants (BFR)	Air,water, soil, dust,	Disrupts endocrine system function
10	Front panel of CRTs	Barium (Ba)	Air,water, soil, dust,	Muscle weakness; Damage to heart, liver and spleen
11	Motherboard	Beryllium (Be)	Air,water, soil, dust,	lung cancer, beryllicosis. Skin diseases such as warts

d. Effects of E-Waste on Nature

The improper disposal or recycling or treatment or handled without appropriate security measures has harmful effects on environment and public health.

Air: Large amount of dust particulates are produced due to disassembling and shredding of e-waste. These particles affect the respiratory health of human. Damages both neurological and immune system of humans and animals because the burning of e-waste produces toxin i.e dioxins especially brominated & chlorinated dioxins which are toxic. Extraction precious materials from e-waste through the improper use of acids also contaminate the environment.

Water: Toxic chemicals used to extract precious materials. These heavy metals penetrate from soil to groundwater and water resources. Acidification and toxification can extend to several kilometres away from improper and illegal e-waste treatment sites. Depending on the degree of contact, health issues can range from irritations to life threatening disease. (Landfills are not properly designed to hold e-waste + Illegal dump sites + Improper recycling & disposal of e-waste) = compounds leach into the ground = Groundwater gets toxified due to heavy metals from e-waste.

Soil: Breaking of e-waste releases toxic heavy metals (lead, arsenic, and cadmium). These toxins leach directly from e-waste into the soil, contaminating groundwater and soil affects the plants and trees. The improper burning of e-waste to extract precious materials, produces ash contaminated by heavy metals and flame retardants that affect the soil. Soil is contaminated by direct contact with contaminants from e-waste or its by-products from recycling & disposal + indirectly through irrigation. Soils become toxic when substances such as cadmium, arsenic, and polychlorinated biphenyls (PCBs) lead, mercury are deposited in landfills. Contaminated soils have bad impacts on microbes and plants => the pollutants reach higher animals or humans through the food chain.

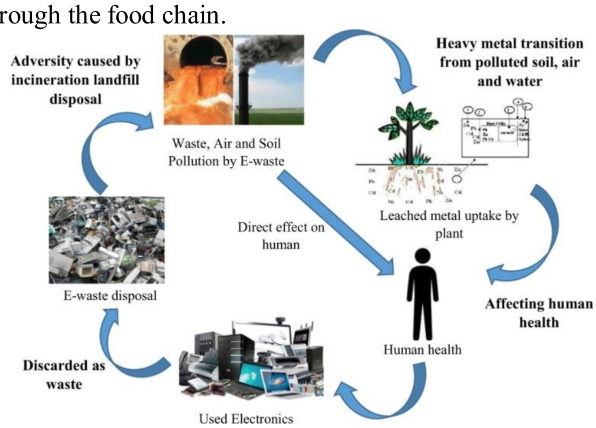

Figure 16. Effect of e-waste on nature and human

e. E-Waste Disposal and Recycling

The following are the methods to handle the E-waste

Figure 17 Methods of E-Waste handling

The commonly used disposing methods are

- **Landfills:** Disposal of electronic waste is mainly through land filling. The highly toxic constituents found e-waste contributes to metal leaching, leading to large-scale soil and groundwater pollution, and the situation worsens with passage of time for sites subjected to dumping for prolonged periods of time..
- **Incineration:** fumes of heavy metals release din atmosphere, municipal incinerators are giving dioxins In this complete combustion process, the waste material is burned in specially designed incinerators at a high temperature (900-1000o C). It reduces waste volume and some environmentally hazardous organic substances are converted into less hazardous compounds.
- **Recycling**: The unscientific methodology adopted for material salvaging has an extremely high environment and health hazard. Such method of recycling has its inherent limitations with respect to recovery of both metals and non-metals e.g., copper, gold, silver, aluminum, iron, tin, lead, and plastics. Many vital metallic components, such as germanium, barium, platinum, antimony, cobalt, nickel, etc. remain unrecovered
- **Reuse:** Refurbishing used computers and other electronic devices for reuse after minor modifications is a common societal practice. This can considerably reduce the volume of E-Waste generation converted into less hazardous compounds Such deemed unhealthy practices adopted for product reuse despite their limited life span contribute to burden of waste .Apart from this , being lured by the retailers to monetize the old gadgets by exchanging against new gadgets in the form of additional discounts

II. E-waste Recycling

E-Waste recycling can be classified into two types1.1.Informal recycling 2. Formal recycling

Informal E-Waste Recyclers: It essentially involves collection, segregation, dismantling. There are extensive repair and refurbishment activities resulting in an extended life of the products and a large second hand market.The informal sector in India is also involved in extraction of precious metals. These generally small units exercise little or no control over their activities and use highly-polluting process

Illegal extraction of precious metals is causing highly dangerous and toxic emissions such as dioxins, heavy metals, lead, cadmium, mercury etc. Discharges and the smudges from e-waste processing leads to contamination of water bodies and soil due to residues e.g. acids, spent fluids/chemicals, traces of polychlorinated biphenyl (PCB), brominated flame retardants (BFRs), etc. This leads to health and safety concerns and environmental hazards.

Formal E-Waste Recyclers: With increasing e-waste quantities and with new regulatory requirement, formal recyclers increasingly enter the e-waste recycling sector. These formal sector recyclers would be able to manage e-waste in an environmentally friendly manner. However, it is not clear whether the advent of formal recycling would come at the expense of informal sector recyclers or would complement their activities. Additionally, investment in machinery and increased working standards are more cost intensive and competition with informal sector recyclers is tough.

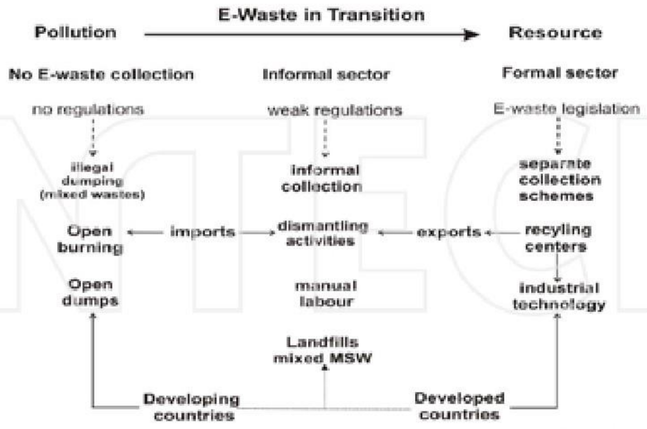

Figure 18 E-waste Transition

Figure18. Differences between formal and informal channels for e-waste management

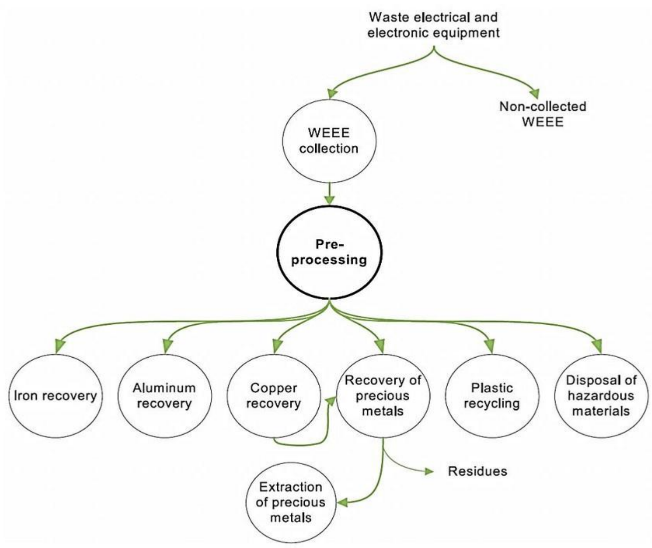

Figure 19 E-waste processing

a. Recycling process:

There are four main steps involved in the recycling of E-Waste, viz: collection, transportation, treatment, and disposal. Recycling electronics is an often a complex and challenging activity because e-scraps consists of diverse elements. The process of recycling can vary, depending upon materials being recycled and the technologies employed, but here is a general overview.

Picking Shed:: Collection and transportation are two of the initial stages of the recycling process, including for e-waste. First step involves sorting all the items manually..

Disassembly: Second step involves manual dismantling process. The e-waste items are categorized into core materials and components. The items are then separated into various categories that can be re-used or still continue the recycling processes.

Shredding: The success of subsequent separation relies on shredding. Shredding involves breaking e-waste into smaller pieces for proper sorting. With the use of hands, these tiny prices get sorted and then manually dismantled. This is typically labor-intensive as waste items are, at this stage, separated to retrieve different parts. After this, the materials get categorized into core materials and components. Then, these items get sorted into various categories.

Over-band Magnet In this process a strong overhead magnet is used to remove all the magnetic materials including steel and iron from the e-waste debris.

Dust Extraction: The tiny waste particles get smoothly spread via a shaking process on the conveyor belt. The smoothly spread e-waste pieces then get broken down even further. At this point, the dust gets extracted and discarded in an environmentally compliant manner. This way, there is no environmental degradation

Non-metallic/metallic components separation. In this process separation of metals and non-metallic components takes place. The metals are either sold as raw materials or re-used for fresh manufacture.

Water Separation. In this process plastic content is separated from glass by use of water. One separated, all the materials retrieved can then be resold as raw materials for re-use. The products sold include plastic, glass, copper, iron, steel, shredded circuit boards, and valuable metal mix

Purification of waste stream: The next thing is locating and extracting leftover metals from plastics to purify the waste stream further

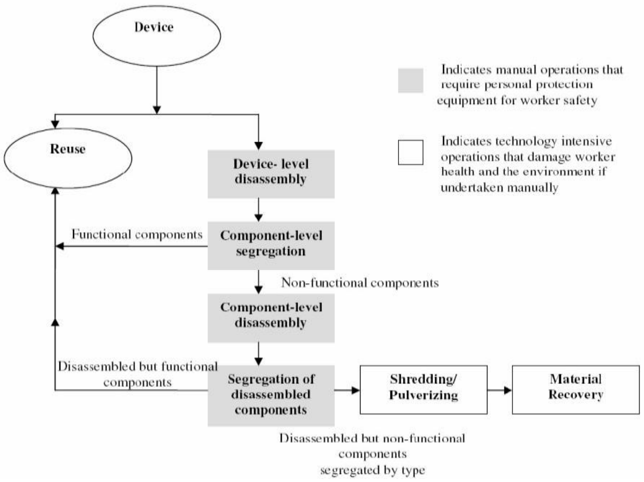

Figure 20: Various processes in E-waste recycling

Key Indications need to be followed prior Recycling Process.

- One should need to find out what materials these electronics are made of, what type of metals are used for the manufacture of the product.
- When one takes electronic products for recycling, make sure that the labels on the products are intact. If they are not, it's essential to file them away. Make sure One does this to avoid the possibility of them getting lost. Only then one can start with the recycling process.

III. E-Waste Treatment

The peoples involved include producers, consumers and the agencies that handle downstream products. Recycling typically involves segregation and disassembly, followed by shredding or pulverizing, and material recovery. The various stages involved in recycling are depicted in Fig. 2.

The e-waste treatment can be implemented in three tier mode. The first and second level are dry process based treatment are shown in the figure 21 and Fig 22 respectively.

First level treatment: In first level treatment only plastic is separated and the remaining items are passed to the second where metals are extracted.

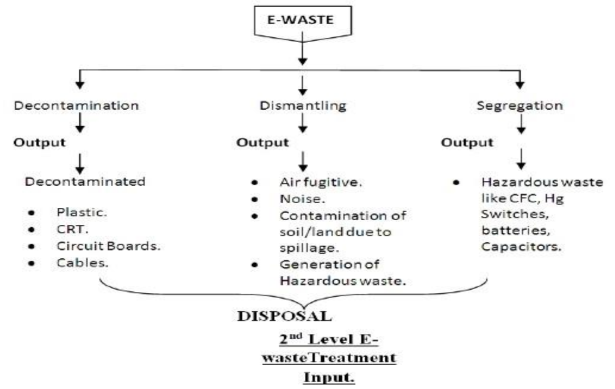

Figure 21 first level of e-waste treatment

Second level treatment: In this the plastic mixtures and plastic with flame retardants, glass, lead, are separated and the other metals are separated by using Magnetic and Eddy current separation of ferrous and non-ferrous metals like Fe and non Fe (Cu, Al, Au, Ag and other precious metals using the material physical properties like electric conductivity, magnetic properties and density.

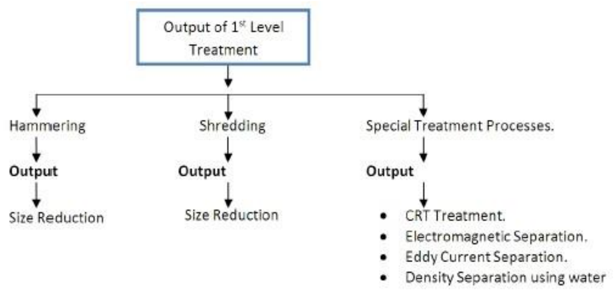

Figure 22: second level e-waste treatment

The pre-communicating of e-waste is essentially required to prepare a feed stock for magnetic and eddy current separation processes. It includes mill hammering, shear shredding and pulverisation of e-waste. Further, the material is screened and de-dusted followed by separation of valuable metal fraction of Copper, Aluminium and residual fractions of precious metals (Gold and Silver etc) by using electrostatic, gravimetric, eddy current technologies. Overall magnetic separation, eddy current separation, electrostatic separation, air tables, gravity air classifiers, air cyclones and shape screens are used among other processes also.

However, the yield of these metals besides these technologies depends upon the particle size and shape, feeding rate, optimum operations also. For example eddy cur n t separation for non-ferrous metals is best suited for granular metal of size more than 5 mm. Also eddy current separator ensures better separation of Aluminium fraction in comparison to the fraction of Copper, Silver and Gold. The grounded material having size less than 2 mm, electrostatic precipitation is used for copper recovery most of time. However, electrostatic separation gives poor separation efficiencies at - 100 µm fine sizes compared with column air separator.

Third level treatment: The 3rd level treatment is based upon the input (residual fractions), technologies used and its final output. Apart from eddy current separation, magnetic separation etc. the e-waste feedstock is treated with incineration; refining, smelting and distillation to get heat energy and concentrated metals. The various processes of 3rd level treatment are input, unit operations and respective output is presented in the table 04.

The techniques are available with developed Nations to recover recyclable material like plastics, ferrous metals, nonferrous metals and their efficiencies are high and vary material to material. For example magnetic separation achieves a target of ferrous metal recovery is 90% to 95% from e-waste and eddy current separation of non-ferrous metals is more than 90%[MoEF, 2008]

IV. Benefits of E-waste recycling

E-waste recycling is a global concern for a many reasons. Recycling is the most effective solution to the growing e-waste problem. Most electronic devices contain a variety of materials, including metals that can be recovered for future uses. This facility precludes the in extracting and mining virgin minerals from the earth's crust which consumes ten times more energy than the energy used in recycling. Recycling of E-Waste provides many benefits such as

- Reduces greenhouse gas emissions s..
- Reduces energy consumption
- Reduces air and water pollution
- Reduces global warming
- Protects environment
- Judicial and sustainable use of resources
- Create green jobs
- Conserve natural resources
- Saves landfills and reduces global warming
- Helps to conserve natural resources
- Prioritizes environmental protection

V. E-Waste Management

Recycling is the most effective and economical solution to managing electronic waste. It is one of the components of the 3R options of reduce, reuse and recycle E-Waste.

Handling WEEE is complex because of its wide variety of products. Additionally, there is a large diversity of compositions and components, made of different materials, as well as many hazardous substances. That variety of products, compositions, components, and materials is especially difficult during the handling phase. In particular, electronic waste products that include substances such as heavy metals are the most challenging in terms of management. Among the heavy metals included in WEEE we can find mercury, lead, cadmium, and chromium, halogenated substances, such as chlorofluorocarbons (CFCs), chlorinated biphenyls (PCBs), and polyvinyl chloride (PVC), as well as some flame retardants. Therefore, it is important to evaluate the risks and make integral e-waste management strategies.

	Exporting countries	Importing countries
Positive benefits	• Minimizing amounts of wastes recycled domestically • Minimizing pollutions • Increasing financial profits	• Providing cheaper secondary products, components and materials • Generating job opportunities • Solving digital divide • Promoting recycling industrial scaling-up and technology advancement
Negative effects	• Causing environmental injustice when exporting hazardous and non-recyclable wastes • Facing obstacles of changing regulations in importing countries	• Increasing environmental and human health risks
Negative effects for both countries	• Increasing illegal trade • Increasing difficulties on monitoring and controlling trade • Increasing illegal storage and dumping when hard to recycle at the possible cheaper costs	

Table 2 Positive and negative effects of recycling fragmentation trade

Table 2 presents the positive and negative effects on recycling fragmentation in both exporting and importing countries, which enables the multidimensionality of problems and policies to be taken into account and is beneficial in developing feasible and effective of implementation.

Informal recycling process is shown in figure 22

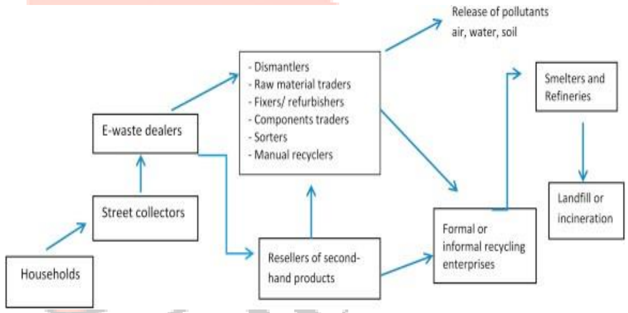

Figure 22: Informal recycling process *Journal of Cleaner Production Volume 114, 15 February 2016, Pages 71-80*

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Figure 23: Future vision of e-waste management

Issues related to E-waste in India

1. Volume of E-waste generated
2. Involvement of Child Labor
3. Ineffective Legislation
4. Lack of infrastructure
5. Health hazards
6. Lack of incentive schemes

7. Poor awareness and sensitization-
8. E-waste imports
9. Reluctance of authorities' involved
10. Security implications
11. High cost of sourcing e-waste
12. High cost of setting up recycling facility

E-waste scenario in India

The main source of e-waste in India comprises of government, public, and private (industrial) sectors discards about 70% of the total e-waste generation. . Large scale consumption of TVs, refrigerators, air conditioners mobile phones etc are certainly attribute to this amount .Most organization upgrade their hardware at an interval of 3-5 years .The trend of usage is also changing with advancement in technology, lower product cost which is leading to generation of e-waste .Another main source of e-waste is import. Most developed countries benefit economically by dumping e-waste in developing counties

The lack of stringent environmental regulations, weak enforcement mechanism , cheap raw materials and labor and with unorganized nature of trade contributions significantly to the growing imports of e-waste in India.

Electronic and consumer market grew in India because of quality, price, and services offered, infrastructure reforms, e-governance and IT revolution .The technological developments, led to an wide gamut of E-waste from households, commercial activities, industries, and public sectors.

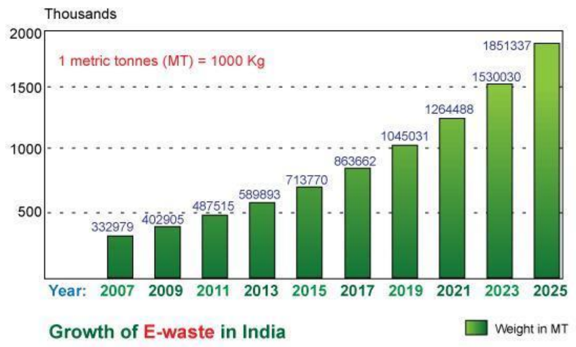

Figure 25 : E-waste generation in India

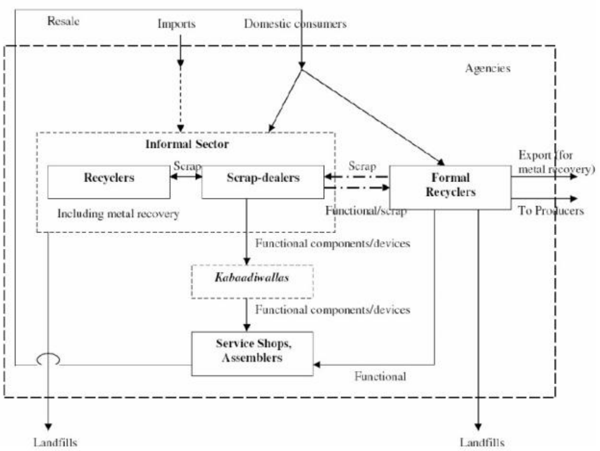

Figure 26: E-waste flow in India

Fig. 26 shows that domestic consumers interact with both the formal and the informal sector.. The figure also shows that e-waste flows seamlessly not only within the informal sector, but also across the boundaries of the formal and informal sectors.

Solution to E-waste Problem

Solution to e-waste problems are involvement of stakeholders from industry academia, government, NGOs. Internal organization has provided the following guidelines to develop e-waste management systems and legislations.

1. Establish a legal frame work for e-waste collection and recycling
2. Extended producer responsibility is required to ensure producers finance the collection and recycling of e-waste
3. Enforce legislation for all stake holders and strengthen monitoring compliance mechanism to ensure a level playing filed
4. Create a favorable investment conditions for experienced recyclers
5. Create a licensing system or encourage certification via international standards for collection and recycling.
6. E-waste collected by informal collection system is sent to licensed recyclers through incentives.
7. When no local end processing facilities exist ensure good and easy access to internationally licensed treatment facilities
8. Ensure e-waste treatment cost are transparent and stimulate the competition in collection and recycling system to drive cost effectiveness
9. Ensure that all stakeholders involved in e-waste collection and recycling are aware of the potential impact on the environment and human health
10. Create awareness on the environmental benefits of recycling among consumers

Conclusion:

Safe and scientific disposal management of e-waste continues to remain an uphill task, in both developing and developed countries. The conventional methods of e-waste management by disposing in landfills or incineration or exporting to developing or underdeveloped countries are becoming redundant. There is need for evolving fool-proof solution, which addresses the limitations of current technologies, provides accessible and comparatively cost-effective techniques, efficient and eco-friendly methodologies in addressing the menacingly escalating threat to environment and life, including but not limited to the carcinogenic impact of the toxins released in crude processing of e-waste. Management of E-waste is a formidable task and involves multidisciplinary approach. The various management methodologies reported in the available literature include segregation, recycle, and recovery options and combinations thereof. However, there is no standard or proven methodology evolved as yet for the management of E-waste. In this context, the best available practices of management of E-waste have also been reviewed

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