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Global and Indian Perspective of E-Waste and its Environmental Impact

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***Abstract*—Development of technology helps people to make their work easy. Current modern time is the time of advancement of the technology. We all are working in new era of computing technology that will become a part of our daily life. All invention provides us comfort and our life become easy. We are using a lot of electronic devices that help us to make our every work stress-free. Hence, the production of electronic devices is growing day by day and electronic industry continues to grow exponentially. This growth increases the problem of e-waste all over the world. Disposal of e-waste is very harmful and it is a cause of environment pollution. In this paper, we discuss the global and Indian views on e-waste. We also included the Indian government initiative for electronic-waste control and showed the impact of e-waste on our environment.**

Keywords: E-waste, Electronic Recycling, E-waste Management, Toxicant, PBFR, PCB, SME

I. Introduction

E-waste is a self-descriptive word that meaning is "electronic waste". All the electrical and electronics appliances like TVs, personal computer, monitors, mouse, keyboards, CPU, printers, air conditioners, mobile, batteries, remotes, CD/DVD, chargers, refrigerators and other household appliances comes in this category [1]. With the expanding measure of shopper hardware and tech savvy gadgets, the measure of electronic waste is expanding gradually. The assembling business must look for novel arrangements, creative materials and innovations to lessen the unsafe idea of the electronic waste, which is produced after the utilization and transfer of these gadgets. With the expanding issue of e-squander, new arrangements must be done in order to substitute any unsafe materials, which may build the contamination amid the transfer of waste handling. Appropriate reusing is likewise ending up more imperative, while the greater part of the materials in hardware are basically non-degradable. Printed Circuit Boards (PCBs) are basic piece of the produced squander that is the reason it is in center of numerous exploration groups everywhere to discover eco-accommodating arrangements, or the way of proper disposal of it. The metals that considered in making PC boards, monitors and other electronic parts are zinc, aluminium, copper, lead, steel, stainless steel, nickel and titanium, which are very harmful for environment [10]. Electronic-waste comprises risky elements that if preserved improperly at end-of-life, could harm human wellbeing and its surrounding nature as well. It likewise contains compound profitable ingredients, for example, valuable metals that should be dealt appropriately to successfully recoup them with insignificant natural effect. The structure of e-waste is incidental, falls under 'dangerous', and non-hazardous' classifications Comprehensively, it comprises of ferrous and non-ferrous metals, printed circuit sheets, plastics, wood or plywood, solid, glass, earthenware products, elastic and several other things. Steel and iron constitutes around half of the waste, followed by plastics (21%), non-ferrous metals (13%) and various other constituents. Non-ferrous metals that includes metals like copper, aluminium so on and valuable metals like gold, silver, platinum, palladium et cetera. WEEE administration is unsafe procedure of extricating copper from printed wiring sheets.

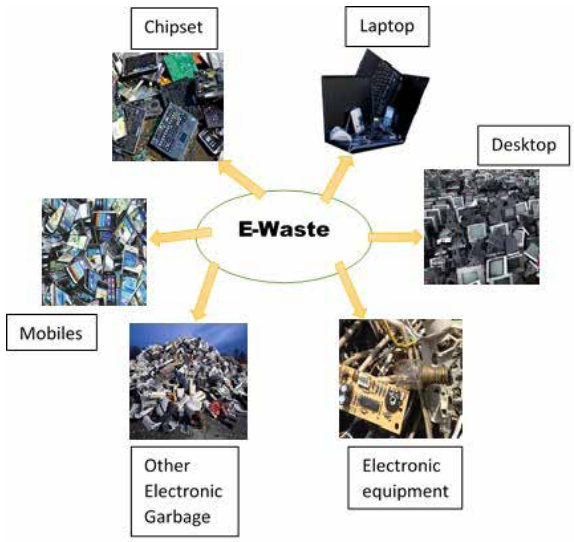

Fig.1. Simple View of E-Waste

Three countries are taken for research- Delhi-India, Beijing-China, and Johannesburg-South Africa. These three cities are compared using an assessment indicator system, which considers the structural framework, the recycling management and its various effects on its surrounding environment [6]. Following key points have appeared from the assessments so far:

- Electronic-waste recycling has developed a market-based activity in all countries.

- India and China, it is based on the informal sector like small or medium-size enterprises (SME), if we talk about South Africa, all these things based on the formal sector.
- Every country is trying to stunned incompliances in the present system through developing new strategies for reform.

The electronic waste growing fast because need of PCs, Mobile and other electronic device are increasing day per day or we say that this industry is so far away from saturation. According to a study, our PCs or other devices average life span decreasing rapidly. The total amount of e-waste includes 13 million tons of hardware, 12 million tons of extensive gear, 8.0 million tons of temperature trade equipment (solidifying and cooling gear), 7 million tons of screens and monitors, 5.0 million tons of Small MT and 1.5 MT of electronic lights gadget [4].

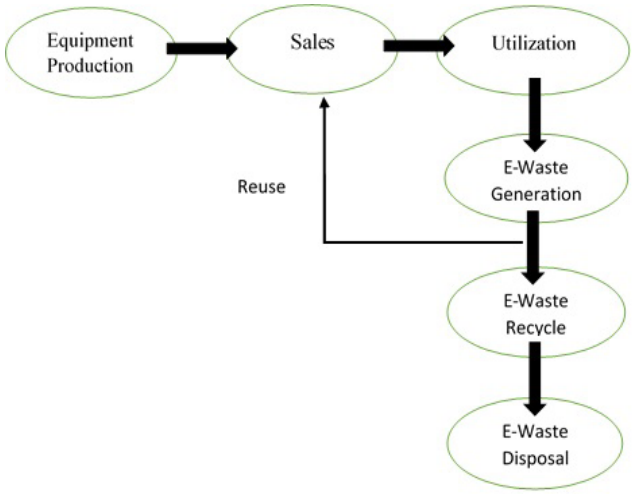

Fig. 2: Life Cycle of E-Waste

Lifespan of mostly IT products have very less, basically computers and mobile devices. These devices are not designed for long elastic use. Mostly these device average lifespan has 2 to 5 year now a day. It is a main cause of rapidly increment of electronic-garbage.

II. E-Waste Problem in Worldwide

The reason behind this focus is that the amount of e-waste produce across the world is increasing at an alarming rate. The greater part of the things that we devour in our everyday life is made out of non-sustainable assets and these materials are progressively getting hard to reach as time goes. A significant example of global initiative against e-waste problem is the 1989 'Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their disposal'[4]. Millions of computers, TV, Mobile devices and other electronic waste of developed countries dumped illegally in developing country. 70% to 80% electronic waste being shipped to developing countries such as India, China, Nigeria and Ghana for recycling. The worldwide volume of electronic waste is relied upon to develop by 33% in the following four years. As indicated by U.S. EPA revealed that lone 8 percent of mobile phones were reused by weight, alongside 17 percent of TVs, and 38 percent of PCs. The world created almost 54 million tons (49 million metric tons) of utilized electrical and electronic items a year ago. That is a normal of around 43 lbs. (20 kg), or the heaviness of eight blocks, for each of the 7 billion individuals on Earth [7]. If we talk continents wise electronic waste production, the Europe come in the first place. After that flowed by Asia, America, Africa and Australia. E-waste management and disposal rising as a big problem in worldwide. USA is a major e-waste producer country in the world. But, a study by US environment agency says that exporting e-waste to Asian countries are 10 time cheaper than the process this e-waste in the America. The European Union countries are highest e-waste recycling countries of the world [8].

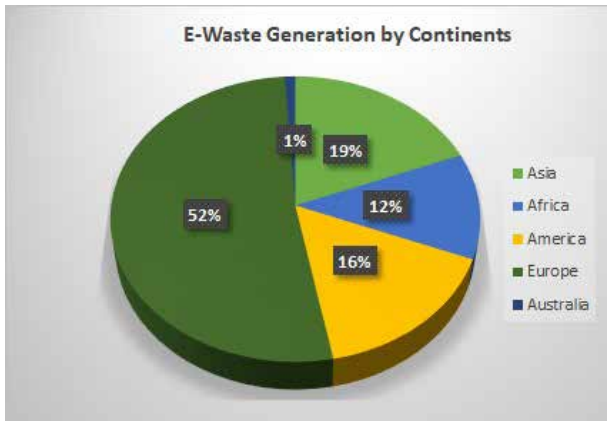

Fig. 3: Continents Wise Representation of E-Waste

E-waste trading are increasing globally. Some countries like Uganda and Senegal can expect that flow of computer e-waste increase 4 to 8 percent by 2020. US, China, Japan, India, Germany and Russia are the highest e-waste producer countries of the world [9]. Fig.4 shows some highest e-waste producer countries of the world.

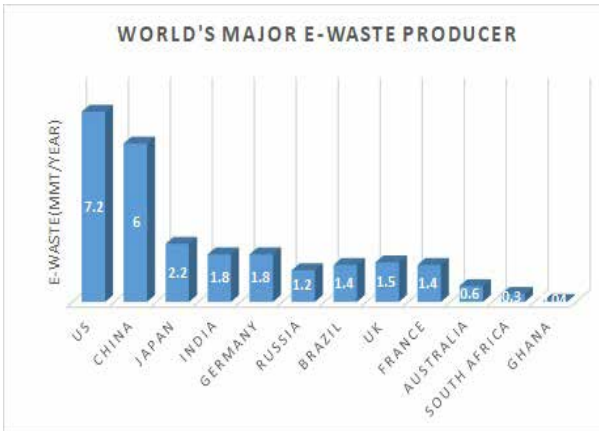

Fig. 4: World's Major E-Waste Generator Countries

Transportation of the e-waste is not properly legal. Last many years' environment agencies (organization) and media group exposed many smuggling and dumping activity of e-waste. Beside that many countries exporting and dumping e-waste for their personal benefits.

III. E-Waste Problem in India

Like other hazardous waste that pollute our environment, the e-waste also become the big environmental problem. All electronic waste produce very harmful material and gases when we dispose and recycle of these waste. Everywhere throughout the world, the amount of e-squander created every year, particularly PCs, cell phones and TVs has frightened all industry. India, which has turned out as the world's second biggest portable market. Now it has 1.03 billion subscribers and it is increasing rapidly. According to the new reports, India is also the fifth largest producer of e-waste. India roughly produce 18.5 lakh tonnes of electronic waste each year [13]. To give you a perspective, the amount of solid waste generated in Mumbai in the year 1999–2000 was around 5,355 tons per day. This number has gone up to 11,000 tons per day. This marks about more than 200 percent increase in the amount of waste produced in less than one and a half decade. The growth is more drastic when compared in Delhi with an increase of over 2000 percent growth from 400 tons per day to 8,700 tons per day in the same amount of time according to the report by Central Pollution Control Board, Ministry of Environment, Forest and Climate Change (CPCB) [3]. According to some survey or government reports Mumbai is the highest e-waste producer city of India followed by Delhi. Some other highest e-waste cities of India shown in the Fig.5.

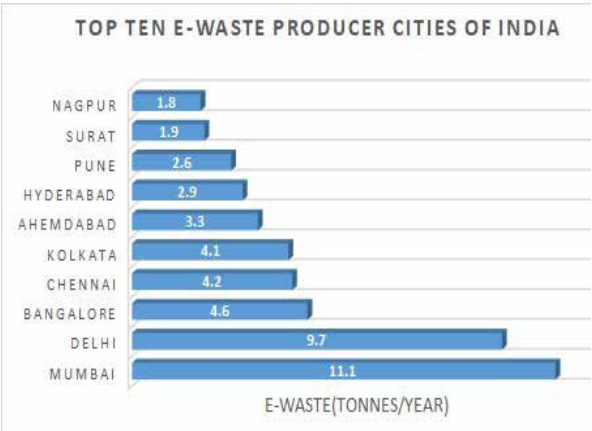

Fig. 5: Major E-Waste Producer Cities of India

A report introduced by Assocham, it is said that the 'creation' of e-squander is expanding 3 times more, starting from the current 18 lakh metric tons to 52 lakh metric tons per year till 2020 at a compound yearly development rate of around 31%. The investigation on 'E-Waste Management in India,' directed to check World Environment Day, states as Indians wind up plainly wealthier and spend more on electronic things and apparatuses, PC gear represents just about 75% of e-squander material, trailed by media transmission hardware (12%), electrical hardware (8%) and restorative gear (7%). Other gear, including family unit e-poop represent the rest of the 4% [11]. Just 1.5% of India's collective e-waste is reused because of poor foundation, enactment and structure, which prompts outrageous retrogression of characteristic assets, hopeless harm of condition and soundness of the general population working in different industries. More than 94% of e-squander created is overseen by the sloppy division in addition to the scrap merchants in this market disassemble the arranged items as opposed to reusing it. The primary wellsprings of electronic waste in India are the administration, open and private (mechanical) segments, which represent just about 75% of aggregate waste age. The commitment of individual family units is generally little at around 16 percent; the rest being contributed by makers [5].

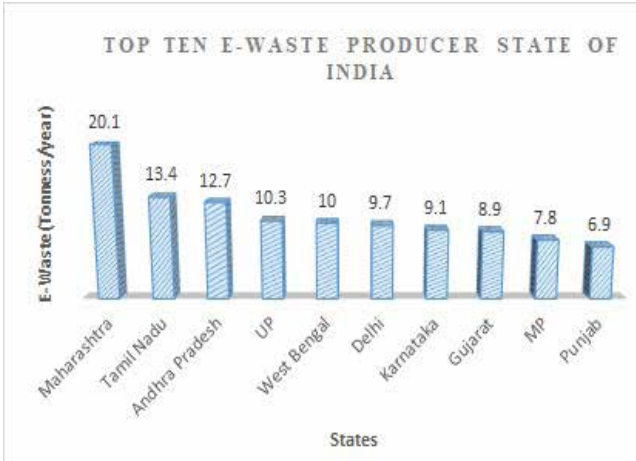

Fig. 6: India's Top E-Waste Producer State

There is also a growing e-waste trade problem in India. According to a report, it is estimated that, by 2020, the amount of old computer dumped in India would be increase 500 percent.

IV. Indian Government Initiation For E-Waste Control

Environment pollution is one of the most inflammable problem for government. E-waste also increase this problem now days. Rapid production of electronic devices increases the reasonableness and accessibility of these items, whose expansion the continuous entrance into littler spots like towns and villages, which are currently indicating amazing offers of electronic devices. Central Pollution Control Board (CPCB) reported that more than 36 thousand companies are generating more than 6 million MT hazardous waste in India [12]. The Ministry of Environment & Forests (MoEF) provide financial assistance for developing e-waste treatment facility [3]. It also supports public private partnership mode for hazardous and integrated recycling facilities for e-waste. As per the MoEF, by and by there

are 30 operational plants that works upon the treatment, Storage and Disposal Facilities for risky waste control and administration in India.

- Indian government take the initiation for e-waste control and develop four project in four major e-waste producer cities of India they are Delhi, Mumbai, Bengaluru and Hyderabad. Now these cities become the hub of e-waste recycle in India.
- The first initiative was come to the knowledge of the Indian Parliament and Government on 23 December 2005, when a Bill on 'The Electronic Waste (Handling and Disposal)' was introduced in Rajya Sabha by Shri Vijay J. Darda (member, ministry of company affairs) [3].
- In the parliamentary note Minister of State for Environment and Forests, Jayanthi Natarajan's has notified the e-Wastes Rules, 2011 (Management and Handling), for e-waste management and handling that came into force from 1st May 2012. This bill changes many rules for e-waste generation and disposal [12].
- The e-waste (Management) Rules 2015, were distributed by the Government of India in the Ministry of Environment, Forest and Climate Change on 10th June 2015 in the Gazette of India. These rules come into effect from the 1st October 2016 and called E-Waste (Management) Rule 2016 [3].
- In this year 2017, government also release the amendment in E-Waste (Management) Rule 2016. Government set the target to collect the e-waste, which is some percentage of total production. It helps us to control the e-waste generation. Below following table shows the e-waste collection target.

Year	E-Waste Collection Target (Number/Weight)
2017-18	10% of the quantity of waste generation.
2018-19	20% of the quantity of waste generation.
2019-20	30% of the quantity of waste generation.
2020-21	40% of the quantity of waste generation.
2021-22	50% of the quantity of waste generation.
2022-23	60% of the quantity of waste generation.
2023-Onwords	70% of the quantity of waste generation.

Supreme Court set many laws for hazardous waste and disposal facilities of hazardous waste under direction, 43. They strictly instruct the states to flow these laws for the last ten years. Some state flow these rules properly for the disposal of waste or e-waste. But according the CAG report 70 to 75 percent of state bodies are not implementing these laws or showing their laziness in implementation.

V. Enviormental Impacts of E-waste

Development of electronic equipment and there use in real world increase many environmental problems. Now every country [14] wary about this situation how we control the real world issue that becomes a big problem of digital media development. In the year 2006, the United Nations considered the measure of total electronic waste disposed annually to be 51 million metric tons (MMT) [1]. As suggested in a report by United Nations Environment Programme (UNEP) titled, "Recycling – from E-Waste to Resources," the amount of e-waste being generated – including mobile phones and electronic gadgets – can be ascend by as much as 500 percent throughout the following era in a few countries, for example, India have the control on that. E-squander represents roughly 35 to 40 percent of the lead and 60 to 65 percent of substantial metals found in landfills. These toxins prompt water, air and soil contamination [9]. Accessibility of shabby gadgets in the general public increment the utilization of the electronic gadgets. This hazardous development in the hardware business, in any case, has prompted a quickly heightening issue of end-of-life (EOL) gadgets or e-waste. This issue takes the attention of industries, government and society [15]. Personal Computers, laptops, televisions and cell phones are the most hazardous because they have high levels of lead, cadmium and mercury[7]. They have very harmful effect on human health. Some causes are as following:

- Mercury – Mercury work as a toxicant for human body if we can take small dose every day it may cause of brain and kidney damage.
- Lead – Lead also have negative effect on human health. Basically it effects children and cause of brain damage.
- Beryllium – Beryllium is another carcinogenic material. Many electronic devices like motherboard and connectors are contain beryllium.
- Cadmium – Cadmium is one of the cause of cancer, additionally when it collects within the human body, it may cause kidney damage also.

Beside of these harmful effect that cause of many dangerous diseases in human being e-waste also the cause of several environmental pollutions.

(a) Water Pollution - Improper disposal of heavy electronic equipment's those contain metals like lead, barium, mercury, lithium etc., are cause of water pollution when these metals drain through the dirt to reach groundwater and flow with the rain water. This water reach small ponds or rivers and pollute them. All living animal and plant are dependent on these water sources [18].

Nevertheless, this dirtied water is the reason for death of a portion of the plants and creatures. Admission of good measure of the sullied water by people and land creature's consequences of numerous diseases like liver and kidney damage.

(b) Air Pollution - Most of time we burn the waste for their disposal. In time of burning many harmful gasses are realised this is a main cause of air pollution. For example, a British description about Lagos and its tenants, popularly known as "Welcome to Lagos", shows various landfill scroungers who practice various landfills in Lagos probing for shamefully arranged hardware, which includes wires, blenders, and so on, to make some pay from the recycling of these waste products. These men look for wire to get the copper (an exceptionally profitable item) in them by outside combustion, which can release hydrocarbons into the environment.

(c) Soil Pollution - Most of time we dump electronic waste under the soil. But it is not a proper way of e-waste disposal. These electronic waste contain heavy chemical or toxic metals and these contaminant grasp by the plant as a food which reduce the productivity of soil. Some chemical and toxicant metal are not biodegradable they persevered in the soil for long periods of time.

(d) Harmful effects of Unscientific Disposal of E-wastes

- Electronic waste effects each part in the human body because it contain so many of poisonous parts including Mercury, Cadmium, Lead, Polybrominated Flame Retardants, Lithium and Barium [6].
- Many electronic equipment contain the plastic covering on the gadgets. These items contain Polyvinyl Chloride. This polyvinyl chloride is very harmful for humankinds. This poisons effect many body parts of human like nervous, regenerative frameworks, cerebrum, heart, liver and kidney [9].
- Sometime e-waste is burned, yet this is tricky on the grounds because it is a cause of releasing heavy metals into the air. Incineration treatment of waste is very popular in some countries like Japan where there is shortage of land.

VI. Solution for E-Waste

The rising life style of human being increase the consumption of electric and electronic devices. This is increase the market demand of computer system, laptops and mobile devices, so these industries are developing rapidly [16]. Hence, the quantity of electronic wastes is increasing day by day. Now days this is become a hues problem for our environment and human health. Therefore, we need to find a proper solution that help us to control e-waste problem [20]. Here we discuss some solution that help us to control e-waste problem.

A. Recycle [6]

20 to 50 million metric tons of e-waste are disposed worldwide every year. Various sites offers connects to reusing focuses:

- International Association of Electronics Recyclers.
- Electronic Industries Alliance.
- Electronics Recycling Initiative.

In the process of e-waste recycling we only get 20 to 30 percentage useful things and remaining is waste material. A reprot publish by EPA , 'expert says that recycling of 1 million mobile phones recover 25kg of gold, 9kg palladium,250kg silver and 9000kg copper'. Some time old electronic devices are re-certified or resold for reuse [17]. Developed country also sent old electronic equipment to slightly growing countries for reuse. But these equipments used very short period of time and then discarded. Remarking on the advantage of safe reusing, the former President of India, Dr. A.P.J. Abul Kalam likewise said at the introduction of the Attero Recycling Plant (Roorkee) in Delhi in January 2010: "With metal prices rising, recycling will help in sustaining our economy as it is much cheaper than extracting metals from its ore" [23, 2].

B. Increase the Active Donation of Old Equipment

We need to develop the habit of donation for the help of needey person. For instance, provide an operable computer to a poor family, friends, school, or nonprofit organizations such as Training Centers and Goodwill Foundations.

C. Involve Public and Private Organizations

The IBM PC Recycling Service enables shoppers and organizations to reuse any PC for a moderate expense, including shipping. HP likewise offers a comparative administration. Newtech Recycling, which offers equipment resale, financial aids, or recycling also provided help to other businesses or companies [4].

D. Involvement of Consumers

E-waste recycling is a harmful process with serious consequences on the health of the workers employed by these local scrap collectors. Consumer also need to proven their responscibility. Consumers can contact the companies pickup to donate their electronics for recycling. According to the 'Guide to Greener Electronics' and 'Cool IT Leaderboard', electronics companies like Xiaomi, Wipro, HP and HCL are leading the initiative of reducing e-waste by recycling [9]. This is a consumers resposcibility that they provide the help to these companies and aware the other people for e-waste management.

VII. Conclusion

E**-waste** is any kind of electronic waste that is produced from electrical gadgets and is no longer wanted or is now obsolete, whether it works or not. Any electronic gadgets like Televisions, DVD players, old VCRs, stereos, copiers, fax machines, tablets, pcs, and many more electronic devices all become **e-waste** as soon as they are not needed anymore. To decrease the negative effects of e-waste in the area around us, it is necessary to gather a better knowledge of the problem, and related issues driving the predicament about how we can make a change and help solve this problem. In regions with dangers of flying particles, concoction sprinkles, brilliant warmth et cetera, labourers should wear suitable security gear, for example, eye, face, hand and arm assurance and impermeable garments. Sufficient sterile offices ought to be given, and labourers ought to be urged to wash before suppers and to wash altogether and change garments before leaving work. Indian government likewise taking a great initiative for the e-waste control. However, they need to improve more involvement of private and public sectors or organization. It also need to spread the awareness between the peoples, how much e-waste is dangerous for their life. We need to discover new technology and update our old technology that help us to reduce e-waste problem.

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