Environmental impact of E-waste and its management in India

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Abstract- E-waste or electronic wastes are the electronic and electrical products which are no more used and discarded. To-day India faces many challenges in the e-waste management sector. The main problems in e-waste management are insufficient awareness among consumers, problems in informal cycling, proper rules and regulations. The enormous creation of e-waste has formed a new e-waste stream in the country containing no more used goods besides full life of electrical and electronic goods after their complete use. The quick formation of e-waste is due to innovation, product design and globalization of electronic equipments. The e-waste treatment infrastructure in India is not as at par with the solid waste management system on account of the domain of flexible legislature frame. In the last decade, e-waste becomes a prime global issue and especially for India due to producing a large quantity of electronic waste in everywhere. The methods of recycling e-waste are not at the satisfactorily level in India. People's awareness with respect to e-waste is very low on account of less media coverage. So, the electronic waste generated and dumped in rivers dump yards without proper recycling or treatments. From the study, it is found that computers contributed around 70% of the total e-waste generated in India, while telecommunication equipments contribute 12%. As per the research analysis, it is found that Mumbai is figured topmost among the cities with regard to e-waste formation followed by Delhi and Bangalore. In case of the states concerned the maximum e-waste generated are Maharashtra followed by Tamilnadu and Uttar Pradesh. This paper presents the scenario of E-waste in India and suggested some measures to curb the problems.

KEYWORDS: E-waste, design, recycling, computer, telecommunication

1. INTRODUCTION.

The greatest task performed by information science in modern society is to link, communicate and connect the whole world in a systematic manner leading to boost economy and enhance life style of a common man. Inclusive dependence on electronic products has paved the way for an emerging environmental concern over electronic waste. E-waste is produced from used electronic devices as well as household appliances and those are not fit for their further use and are intended for recovery, recycling or disposal. E-waste accounts approximately one thousand different substances having toxic and hazardous nature. Generally these materials are obtained from

tablet, printer, computers, mobile phones, sound boxes, parts of refrigerators and air conditioners etc. On account of human requirement there is an outstanding growth in the manufacturing and consumption of electronic and electrical equipment in the last few years. The e-waste is one of mostly created alarming issues for the globe. Generally large number of electronic items is used in households, IT industries are also generates e-waste. It is need of the hour to take care the environment so that the e-waste management may play a crucial role in preserving the environment and making free from dangerous toxins which pollute air, water, soil, etc. The 4R approach namely i.e. Reduce, Reuse, Recycle and Recreate have to make practice and should be adopted for minimizing the waste. According to Organization of Economic Cooperation and Development (OECD), any device using as a domestic and electronic appliances with the help of electronic power supply that has exhausted its entire life is known as waste from electronic and electrical equipments (WEEE). WEEE is a term which has received maximum notice since past 15 years. Approximately 90% of the total waste generation belongs to three categories of WEEE which includes house hold appliances having maximum share of 42% first followed by ICT equipment which accounts to 34% and consumer electronics items occupy the share of 14% [1]. The desktop selling is maximum value of 5.52 million during 1994 to 2007 [2]. In India, there is drastically change of mobile users from 90 million to 433 million during the period 2006 to 2011 and finally it reached to 900 million in 2015-16[3-4]. The status analyzed by Associated Chambers of Commerce and Industry of India (ASSOCHAM). Approximately four out of the five workers of e-waste workers in our country suffer from respiratory problems like breathing difficulties, irritation, coughing and choking due to improper safeguards. Without any protective appliances in hands, faces, heads, workers and children are frequently comes in contact with the most toxic fumes on a daily-basis. Out of the available e-wastes, computer generated e- waste is found to be more proportion as compared to the other wastes on account of increasing demand of information technology and its application to society. As a consequence, quick product obsolescence multiplied with lower costs discarded electronic and electrical equipment results in the high alarming waste problem in the world. Each companies trying today to design their products for planned obsolescence. This creates toughness by marketing and retailing practices with affordable and convenience that have been taken over from product durability as key drivers [5].It is a concerned matter that e-waste often contains both toxic and valuable materials inside it. Metals such as iron, copper, aluminum, gold and other in a e-waste is nearly posses 60% where as the pollutants comprises of 2.70% [6].Considering regarding waste treatment, recycling of e-waste is very important in addition to recovery of valuable materials out of it. It has been calculated that approximately 100 million computers and other electronic devices break or become no more use every year. Out of these products some are reused, some are refurbished whereas few of them are recycled. E-waste management is a critical task since it contains many toxic substances. When these substances are dumped, land filled or when the waste is incinerated, then various contaminants and toxic chemicals are formed and evolved into the ground making pollution of the environment. Methods of e-waste disposal are very complex on account of its involvement with many people, enterprises, and extensive areas and long time span. Different toxic substances such as mercury, lead or brominated flame-retardants are contained in e-waste. It is a

matter of concern that these substances lead to damage of almost all major body systems such as nervous systems, blood systems, brain development, skin disorders, lung cancer, heart, liver, and spleen damage on continuous exposure. These cases are found to be happening mostly in persons working in informal sector because a substantial number of informal e-waste workers do not take any preventive measures towards their health.

2. LITERATURE RIVIEW

The formation of e-scrap and sales of electrical and electronic equipments found to be increase in day by day. The calculation shows that the total quantity of e-waste formed has approximately 41 million tons in 2014 and it increases its proportion each year. Additionally, there is also significance of recycling and its benefits [7]. There should be some sustainability in cooperated system for supervising the electronic waste. New legislation and acts should be used in managing e-waste [8]. The government should be takes the steps to establish few areas related to removal of e-waste materials. It also a mentioned thing that healthiness of a creature is rests with e-waste and this ecological teaching is necessary from lower to higher grade in education system [9]. Public knowledge and supports of manufactures are crucial steps for electronic waste managing method. The government should take proper care of the environment for the removal of unwanted electrical wastes those are creating the diseases like skin, respiratory, intestinal, immune, and endocrine and nervous systems. E-waste management should be done by using safe methods for recover and recycling of materials [10].

2.1. E-Waste Management in India.

According to the report given in Economic times, 2015, India produces approximately 1.7 million tonnes of electronic and electrical equipment waste in 2014 [11]. In the world scenario, in the production of e-waste India occupies 5th position. Generally various e-waste processes such as e-waste collection, transportation, segregation, dismantling, recycling and disposal are performed by untrained labours. Rag pickers collect the e-waste which is present in the garbage due to their low awareness. As some reusable and precious materials are present in the e-waste, so rag pickers sell these things to scrap dealer to carry out their livelihoods. At the end, the recyclers using different technologies to treat the e-waste [12]. Approximately 12.5 MTs of e-waste is generated every year as per the report given by [13]. Out of the 178 nations, India positions is 155 in environmental performance index, its ranks in health hazards is 127, in air quality is 174,in water quality and sanitization is 124 [14]. Many of the developed nations use India as dumping ground in e-waste purposes.

Table 1: E-waste generation in different countries

Si.No.	Country	Amount in Tonnes
1	USA	11.7 Million
2	China	6.17 Million
3	Japan	2.2 Million
4	Germany	2.0 Million
5	India	1.7 Million

2. 2 percentage share of e-waste imports

Comparison of country-wise share of e-waste imports, it has been observed that US has a maximum share of around 42% followed by China having 30% then it will comes Europe whose share is around 18% and rest 10% is belongs to other countries like Taiwan, South Korea, Japan etc. In India, 10 States and union territories shares about 70% of the total e-waste generated in the country.

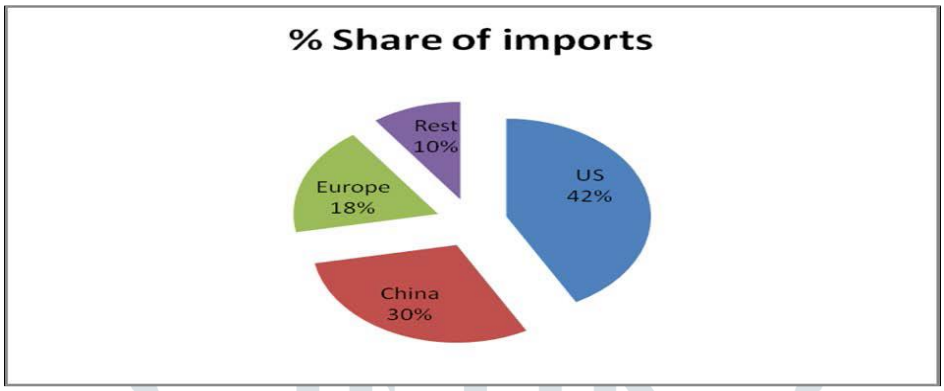

Figure 1- percentage share of e-waste imports

Source- (Economic Times, 2015).

2.3: Top 10 E-waste Producing states and cities of India:

A study conducted by ASSOCHAM-KPMG [13], Mumbai Occupies 1st position producing 1,20,000 tonnes of e-waste annually followed by Delhi and Bangalore 2nd and 3rd position by producing 98,000 and 92,000 tonnes of e-waste generation respectively. The report given by Rajya Sabha in 2011, total 60% of e-waste is generated by 65 cities [15]. Out of the generated wastes seventy percentages belongs to computer related while twelve percent belongs to telecommunication sectors and the rest is others. On the other hand on considering the e-waste generated with respect to states, Maharashtra is found to be occupied the highest position followed by Tamilnadu and Uttar Pradesh respectively. The detail of waste produced in different states and cities are given in table 2 and 3. As the report provided by ASSOCHAM and NEC on ahead of the Environment Day on 5 June 2019, Maharashtra found to be produces highest shares of 19.8% of e-waste while it recycles nearly 47,810 tonnes per annum (TPA). Secondly, Tamil Nadu produces e-waste with a share of 13% and recycled around 52,427 TPA. Similarly Uttar Pradesh shares around 10.1% with the recycling capacity of around 86,130 TPA.

Table 2: E-waste generation in states

Si.No.	States	E-Waste generated in MTA
1	Maharashtra	20270.59
2	Tamil Nadu	13486.24
3	Andhra Pradesh	12780.33
4	Uttar Pradesh	10381.11

5	West Bengal	10059.36
6	Delhi	9729.15
7	Karnataka	9118.74
8	Gujarat	8994.33
9	Madhya Pradesh	7800.62
10	Punjab	6958.46

Table 3: E- waste generation in metropolitan cities

Si.No.	Metropolitan cities	E-Waste generated in MTA
1	Mumbai	11017.1
2	Delhi	9729.15
3	Bengaluru	4648.4
4	Chennai	4132.2
5	Kolkata	4025.3
6	Ahmadabad	3287.5
7	Hyderabad	2833.5
8	Pune	2584.2
9	Surat	1836.5
10	Nagpur	1768.9

2.4 : India's e-waste from old mobiles in 2020 increases by 1800 %:

The e-waste from old mobiles and computers in India will increase by nearly 1800 % and 500 % respectively during the years 2007 to the year 2020 as per the report given by ASSOCHAM-KPMG [13]. Nearly 25 per cent closing stages up in e-waste annually out of more than 1.1 billion mobile phones in circulation. India has found to be 2nd largest mobile user markets after China and in terms of production of e-waste, it occupies 5th position. Out of all the e-waste generated, telecom equipment contributes exclusively 12 per cent respectively. There is tremendous growth in mobile phones in the last decade due to such a large population. In the year 2016, 1.1 billion users as compared to From 310 million subscribers in 2001. The number of mobile phone users in India is around four times that of USA today and it occupies second position after China in the world, which has 1.3 billion mobile subscribers.

Table 4: Comparison of Mobile phone users in China, India, USA

Si.No.	Country	2001	2016
1	China	150 Million	1.3 Billion
2	India	310 Million	1.1 Billion
3	USA	120 Million	320 Million

2.5: Complexity and challenges of E-waste flows in India

The final consequences of poor e-waste management practices are toxic materials flows inside to the waste stream resulting into adverse effects on the environment and human health. As a result resources are wasted by economically valuable materials dumping into detrimental conditions those are developed during the informal recycling [16]. Almost half of all unused and end-of-life electronic products are taking into landfills, junkyards and warehouses. The informal recycling sector uses commonly unskilled migrant labor and those from marginalized groups in India. In general migrant laborers are coming from poorer Indian states such as Uttar Pradesh, Bihar, Orissa and West Bengal. Women and children are belongs highest share of this work force. Peoples working in this area are the urban poor having low literacy levels as well as having very little awareness regarding the hazards of e-waste and the recycling processes. Most of the workers engaged in crude dismantling of these electronic items for their livelihood leading to their health are at risk condition. For that reason, it would necessitate to take defensive strategy in relation to health hazards of e-waste managing among these workers in India [17]. Although E-waste Management and Handling Rules, 2011 are in force since May 2012 but it's implementation is very gloomy. Slack regulations and poor vigilance are the driving force of the failure of the rules. Hence, management of e-waste is wearisome task in India because of its exponential growth and the undeveloped recycling processes existing in the unorganized sector.

The prime concern among manufacturers and consumers are little knowledge of the hazards rising out of incorrect e-waste disposal. There is no availability of exact data of e-waste produced and those recycled. Adequate amount of e-waste produced is processed by the informal sector using traditional methods of acid leaching and open-air burning by virtue of which other environmental damage takes place. There is hardly any idea regarding toxins in e-waste by the workers and is exposed to health hazards. Susceptible social groups belonging by women, children and immigrant labourers are affected by high-risk backyard recycling operations in addition to ineffective recycling processes leading to significant losses of materials and resources. Cherry-picking by recyclers recovers costly metals like gold, platinum, silver, copper, and improperly dispose of the rest materials causes environmental hazards. In this regard no particular legislation of e-waste management brought out till now.

3. METHODOLOGY

This paper prepared as per the systematic review of different literatures which sourced from government reports, earlier convention of environmental issues, journal articles and conference papers, and ASSOCHAM-KPMG joint study. Basically it is a type of quantitative and analytical research. The data deals with the E-waste

data of India and other Countries. The study conducted by secondary data only which are sourced from websites and reports. In this paper also discussed about environmental impact of E-waste.

4. DISCUSSION ON ENVIRONMENTAL IMPACTS OF E-WASTE

4.1. Potential environmental problems related to e-waste

The constituents containing in e-wastes depend on the type and the age of the electronic objects those are not required. Usually it can be determined by different metal alloys like Cu, Al and Fe attached with some other plastics or ceramics. Some substances like heavy metals are used for the production of electronic items whereas Polycyclic Aromatic Hydrocarbons (PAHs) are generated by e-waste burning at low temperature. Finding says that burning the isolating plastic cover of cables in open barrels creates hundred times more dioxins in comparison to domestic waste [18]. Considering that the annual e-waste production almost 20Mt, the total quantities of the several pollutants contained in the e-waste in a maximum extent with respect to landfills affecting the environment and public health. In addition to this extensive recycling, e-waste is accountable for 5000t Cu released to the environment annually [19]. The refrigerators and air-conditioners discarded contain CFCs (Chlorofluorocarbons) that will finally eradicate the ozone layer. In the future, CFCs escapes from the e-waste dumping site [20]. The problems discussed above make a large issue on account of the fact that the majority of e-waste are not recycled because few of the electronic and electrical items are required in addition to household waste leading to no further treatment [21]. Most of the waste collected for recycling is exported to countries like Malaysia, Nigeria, Ghana, China, Pakistan, Vietnam, Philippines, etc.[22].

4.2 Environmental pollution caused by e-waste disposal and recycling

Usually the common method of e-waste treatment is landfill methods. The implementation of the appropriate test is TCLP methods, i.e. Toxicity Characteristic Leaching Procedure. It has exhibits that e-waste not needed at urban waste dumping sites do not produce leachates with heavy metals concentrations away from the environmental limits [23]. Whereas, this chemical cocktail producing leachate follows the TCLP test from several electronic items that was toxic for aquatic organisms [24]. Besides, the normal management practice of e-waste compression discarding in landfills may broaden the leachate volumes before or during because of the disturbance of the numerous electronic circuit parts. Hence, it is projected to perform cement solidification on e-waste that raises pH value and reduce the aqueous solutions flowing in the discarded waste [25]. Burning before to discarding at landfill sites raises heavy metals mobility contained in circuits covered with a plastic grid. On account of this while not being bio-available following wash-out, they are free to the atmosphere at the time of burning. Hence, e-waste recycling comprises disassembling and destroying the individual parts to retrieve several materials. Computer's useful materials of 95% and of cathode ray tubes materials of 45% can be retrieved by adopting recycling process . By using Japanese recycling methods in addition to appropriate technology least environmental impact can be observed [26]. The practices usually followed in developing countries such as child labour, e-waste burning and emission of several pollutants to the air, etc. the total environmental benefit impact is not always found to be effective. It should be kept in mind that any environmental benefit from recycling becomes void when the waste for recycling is transported to large distance by vehicle because of the energy consumed by transportation process. [27].

4.3 Environmental pollution caused by plastics in e-waste obtained from computer:

While considering waste treatment and recovery of valuable waste, recycling of WEEE is an important subject. Even though mechanical processing gives a way for recovering valuable materials but difficulties found with it. The significant one is industries have to afford the taking apart of the different material in WEEE. This problem finds some way to approaches to optimize the process. The appropriate separation methods involves on their physical and chemical properties of materials to make recycling of material with WEEE economically profitable [28]**.** Out of different wastes, computer bodies and computer monitors are found to be most waste generating substances as per the research finding. It has been observed that 500 million PCs contain roughly 2,872,000t of plastics, 718,000t of lead, and 1363t of cadmium and 287t of mercury [29]. E-plastics shares nearly 15-22% of the weight of WEEE out of which 30-35% is suitable for mechanical recycling and two third needs to dispose by other means [30]. In case of rich countries, e-waste accounts only 8% of the urban waste volume [31]. The wastes generated from the different sources have various life cycles. For example waste generated from refrigerators and electrical cook-stoves having an average life cycle of 10-12 years whereas e-wastes formed from electronic computers are average 3 year life cycles [32]. The plastic waste recycling involves low level of processing such as granulation or pelletization then it undergoes melting or partial melting to form the end product. It is found to be difficult due to polymeric materials presents in them. Thermoplastics as well as thermo sets require high levels of flame retardants added during production. The usual high halogen contents results due to the flame retardants present in the plastic material from unnecessary electronic devices. Remolding cannot be done for thermo set polymer whereas thermo set composite contains high amount of inorganic glass reinforcement. Plastic material used with fire retardants checks the fire safety when create toxic substance during combustion. The lowering density of electronic equipment lessens the volume of waste making, repairing and recycling.

5. RECONDMENDATION AND CONCLUSION

Management of e-waste in India is not so simple as compared to that of other countries due to different factors like complexity of the E-waste issue in India, vast diversity in its geographical conditions, cultural arena and economic inequalities etc. Rapidly growing e-waste volumes in domestic as well as through imports is one of the major concerns in addition to lack of exact data's of the quantity of e-waste generated and recycled. The other concern's besides above are insufficient awareness among the manufacturers and consumers of the hazards, incorrect e-waste disposal, recycling of e-waste in the informal sector. E-waste workers have poor idea regarding toxins in e-waste and its exposing causes to serious health hazards. Improper recycling processes make sufficient substantial loss of materials. The main drawback in India that there is no such technology or policy to check the disposal of e-waste among the fastest growing waste in the world. There must be consciousness among the users and manufacturer of electronic products. Both toxic and non toxic substances are found to be possessed by electronic products. Metals like copper, aluminum, iron which are non toxic and can be reused while lead,

cadmium and mercury can be disposed off with other chemicals so that the resulting gases or substances are dangerous for human health and also not help to reduce the pollution due to waste material. E-waste collection, transportation, segregation, dismantling, recycling and disposal are done manually by untrained labors in informal sector due to low awareness and sensitivity. The legislative work for e-waste treatment is not done properly as well as timely. Hence, the awareness regarding e-waste need to be increased and the rules should be properly implemented so that there is proper control of e-waste in future. There is an emergent need to have a proper information system through standardized mechanisms and existing policies, guidelines in accordance with the international standards and practices for a healthy e-waste management system. The major challenges are to reduce e-waste through reuse, recycle, and recovery and reduced use of toxic substances to invent labor intensive intermediate technology to recycle / recover e-waste safely and to distribute the responsibility of managing e-waste on one or more stakeholders. The awareness regarding e-waste should be spread more with advertisements and e-waste issues should mandatory in curriculum. A number of hurdles found to be e-waste management in India. The major one is dominance of informal sector. So the steps should be taken to formalize the informal sector by strict implementation of rules and to levy heavy penalties on defaulters. There should some requirement for assessment of the E-waste with regards to its quantification, characteristics, existing disposal practices, environmental impacts and the establishment of e-waste collection, exchange and recycling centers in partnership with private entrepreneurs and manufacturers. There is need of an effective take-back program providing incentives for producers to design products that are less wasteful, contain fewer toxic components, are easier to disassemble, reuse, and recycle may help in reducing the wastes. To handle e-waste properly there should be more recycling facilities and development of infrastructure. Each state should develop its own scrap yards in the respective cities to warehouse e-waste.

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