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E-WASTE: A FURIOUSLY GROWING TECHNICAL WASTE WITH MINIMUM MANAGEMENT PERSPECTIVES IN INDIA

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ABSTRACT

Electronic waste is the by-product of digital revolution. A kind of physical waste comprising harmful organic, inorganic compounds and specially the heavy metals. There is a myth that high digitization preserves environment. But actually it needs to understand that at the time of production of electronic items; it's safe disposal and recycling is a major challenge. These wastes contain treasures if they recycled properly. People need to follow 3R strategies (Reduce, Reuse, Recycling) in every country, unfortunately the maximum number of e-wastes is not recycled properly due to lack of expertise, which results in a situation that has ill effects for humans as well as environment. If Indians don't take it as matter of alarming situation sooner there will be new pandemic of dealing with a different sort of disease and might the cause could be electronic wastes and harmful products generated from these devices. This paper summarizes the various sources of e-wastes and hazards associated to e-wastes with the possible solutions, major challenges of their management and comparative scenarioto developed countries. It also summarizes an online survey information from a set of people, aiming to create awareness about this new threat of electronic waste its ill effects and its management in India. It also explores the issues related to planning and implementation of rules and regulations regarding electronic waste. Technological advancement should not only emphasis on production and profitability. It should be on minimizing the environmental ill effect from its production up-to its disposal or recycling.

Keywords: Electronic waste, Digital, Recycling, Disposable, Biodegradable

INTRODUCTION

E-waste known as Electronic Waste is related to waste products produced by the end life of electrical and electronic equipments. It comprise wastes produced by computers, monitors, printers, air-conditioners, ovens, refrigerators, washing machines, TV sets, mobile phones, toys, lighting equipments, medical devices etc.The e-waste consists of organic as well as in-organic compounds. Organic compounds include flame retardants, dioxins, chlorinated benzenes and phenols, non phenol etc. In-organic compounds include arsenic, barium, asbestos, cadmium, copper, mercury, lead, nickel, chromium, selenium, zinc, tin etc. **[Figure 1]**.

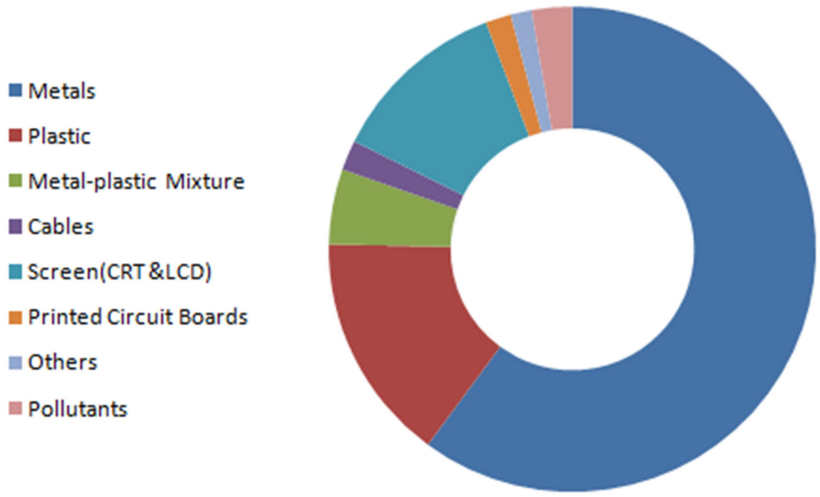

Figure 1: Composition of material in E-Waste

The production and use of electronic equipments has increased drastically in the previous few decades. Electronic equipments are made up of many intricate parts which are interconnected to each other which make it internally complex in nature. An electronic product becomes waste when it stops working properly and finally when the user discards the product that is called the e- waste **[1]**. The E-waste level in India is going to increase by a significant margin by the year 2020. To be more specific, old computers will add a staggering 500% more, mobile phones will see a 18% rise and e waste from televisions and refrigerators will be increased by 1.5 to 2 % and 2 to 3 times respectively if compared to the levels from 2007. It will amount to 2 million metric tons by the year 2025 **[2]**. The study provides an insight on the current status of E-waste processing and issues faced. If the recycling is not done in a proper way, it can produce grave environmental and health issues. It will also impact the supply to formal recyclers and also remaking

electronic products from the e waste possess a high threat for safety. This can't just be solved by working against informal recyclers and collectors but by creating a better recycling structure and including informal sector into it by providing improved work environment along with profitable rates and efficiency. In china, knowing what incentives are needed to get informal recyclers into the formal sector is a big problem **[3]**. The organizations in developing countries like India often look upon the economic efficiency of e -waste instead of focusing on the environmental aspects of e waste recycling. For making recycling a gainful sector, a systematic recycling of the produced e waste is said to be of the utmost priority but coming up with such a well-organized plan is a very difficult task **[4]**.

Review of Literature

E-waste is physically and chemically distinct from the municipal waste because it possesses economically valuable and physically harmful, both types of constituents. Indian Industries have long been inconsiderate about the products recycling and the impacts of the products on the environment. The Indian IT industry has been a major driver of change for the economy but it is also responsible for the bulk of the electronic waste produced in the country. The main constituents of electronic waste are glass, plastic and aluminum (80%) whereas the valuable and rare metals found in lesser amounts but still they hold a lot of importance **[5]**.

SOURCES OF E-WASTE

On the Environment Performance Index of 2018, India was ranked 177th amongst 180 countries as per the report submitted by World Economic Forum in 2018 and in contrast, we are ranked 5th amongst top 5 countries which are producing E-Waste followed by USA, China, Japan and Germany and are incapable of recycling less than 2 percent of the total. The rankings and data are quite pathetic. Our country generates more than 2 million tons of E-waste along with importing huge amount from other countries as well **[6]**. According to the Global E-waste Monitor Report findings in 2016, only twenty percent out of eighty percent e-waste was properly recycled **[7]**. As per the statistics of India, computers contribute almost 70% of total E-Waste in turn followed by Telecommunication Equipment (12%), Electrical Equipments (8%), Medical equipments (7%) and the remaining from the household waste. With a population of 1.7 billion people by the year 2050, the problem is going to increase for India because we are yet not even able to recycle the waste we produce.

The contribution of e-waste from different sectors is depicted in fig 2, part (a) explains the contribution of Government, Public and

Private Sector which is 70% while 15% each from household and EEE Manufacturer. Out of household contribution, 42% is only from household appliances, 34% from Information and Communication Industries, 14% from Consumers Electronics and rest 10% from other categories or miscellaneous (b). The contribution by Mobile phones is 34% and followed by consumers electronics, Computer Hardware and so on and the minimum contribution by LED which is approximately 2 %(c) **[8]**.

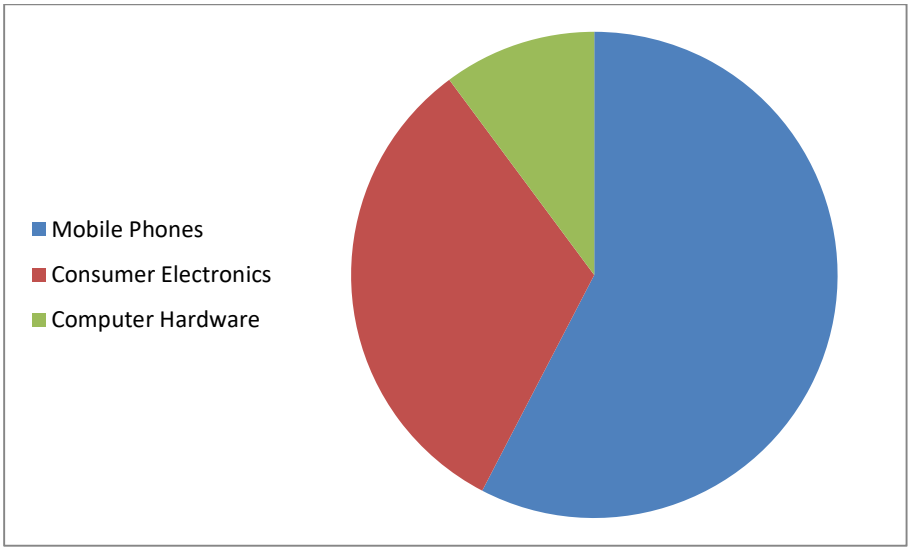

Figure 2 (a): Sources of E-Waste Generation in India

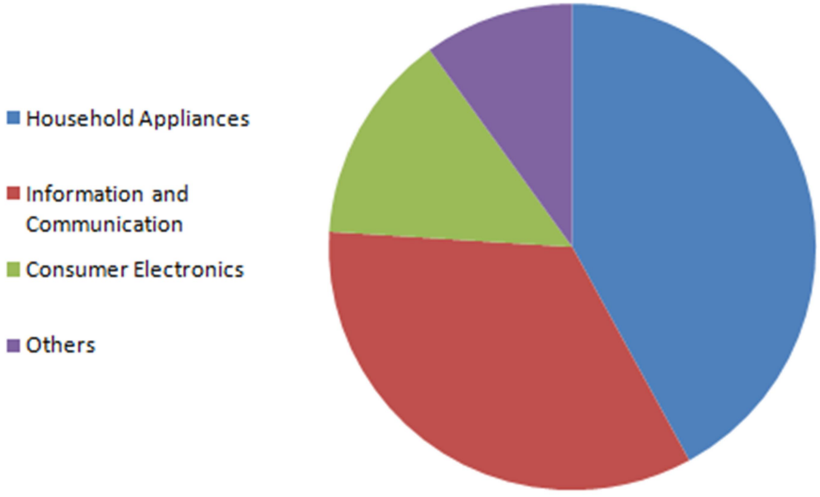

Figure 2 (b): Category wise E-Waste generation in India (%)

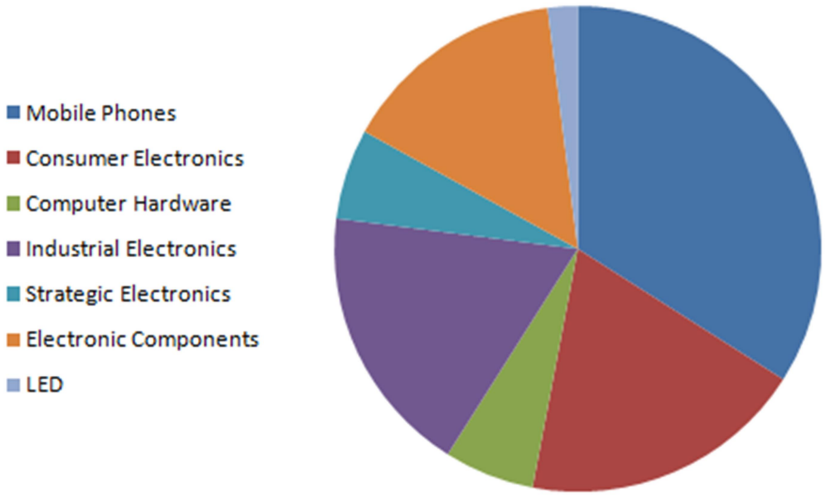

Figure 2 (c): Share of electronic products in India 2017

In India, by the end of this year e-waste from old computers would rise by 500%, while that of mobile phones would increase 18 times and from that of refrigerators by 2 times as compared to that in 2007. Electronic items contain a wide variety of materials and mostly copper but only 30% of world copper consumption is recycled through the scrap and electronics industry stands second in the consumption of copper. Surprisingly for every Kg of Cu mined at least 210 kg of waste arises and still there aren't efficient mechanisms for the proper recovery of copper from the electronic waste products.The thirst for new gadgets has created a vast empire of electronic waste **[9]**.

HAZARDS CAUSED BY E-WASTE

- Like any other waste, electronic waste can't be just normally disposed off because of internal constituents which are harmful to human health because it is made up of heavy metals like Cadmium, Chromium, and Mercury etc. **(Table 1) [10]**.

Table 1: Table representing the effect of different metals on human body

Material	Source	Effects on health
Mercury	Switches, Circuit Boards	Brain Damage, Respiratory and skin disorders
Lithium	Lithium-ion battery	Lung edema, harmful to babies
Copper	Wires, circuit boards	Nausea, liver damage
Cadmium	Chip Resistors, Semiconductors	Accumulation in liver and kidney, Neural Damage
Lead	Solder in circuit boards	Damage to nervous system, damage to circulatory system
PVC and plastics	Cabling and computers	Burning produces dioxin which causes reproductive damage
Beryllium	Motherboard	Carcinogenic(Lung Cancer)

- More carbon dioxide is produced during the production of an appliance than its use by the consumer that highlights the fact that industry standards need to be strict for reducing the overall Carbon Footprint of an Electronic Product **[11]**.
- Most of the LED screens producers' release Fluorinated Green House Gases (FGHGs). They are the most powerful and heat trapping emissions. In a study in the Guiyu village which is located in China, the air was found to be severely contaminated with several toxic chemicals because of the open incineration **[12]**.
- The e-waste is the major source of heavy metals, hazardous chemicals and carcinogens **[10]**.
- Some diseases like the diseases related to skin, respiratory, intestinal, immune, and endocrine and nervous system including cancer are directly related to e-waste **[10]**.
- The unsystematic channeling of e waste will not only affect the environment but also humans as it contains toxic elements. Other than the current form of management of e waste in Sri Lanka, acquiring green and clean production blueprints should be emphasized more upon **[12]**.
- Every waste affects directly or indirectly to the individual health like: it affects growth of the children, nervous system, disturb the ecology which is not good for every person in the planet **[13]**.

Management Challenges

It is a matter of grave concern that an unidentified portion of American E-Waste is quietly exported mostly to Asian countries and it can be explained by the Pollution haven Hypothesis which elaborates to *"where there are weaker environmental laws, more pollution intensive activities would happen at those places",* and countries like India and China are the finest examples of the same. The ideal way of dealing with the waste has been displayed in Fig.1 but generally there are poor standards followed in absence of proper training **[14]**. Recently 4 major metropolitan cities in India that is Delhi, Mumbai, Kolkata, Chennai have been marked to be contaminated with heavy metals, dioxins, furans, PAH (poly cyclic aromatic hydrocarbons) in the surface soil and are in hand of informal sectors to be processed **[15]**. The current generation of E-Waste in India is around 1.85 million tons per annum and Delhi, Mumbai, and

Bengal alone accounts for 0.3 million per annum, which is 17% of national E-Waste generation. Currently India has 178 E-Waste processing units with the capacity of around 43,800 tons per annum, with states like Karnataka (57%), Maharashtra (32%), U.P. (22%), Haryana (16%), and TamilNadu (14%). For the recovery of Cu, Al, Plastics, and Fe are done primarily in Uttrakhand and Rajasthan. In India, we lag behind in recovering silver, gold, and other rare earth metals because we are not equipped with appropriate technology. Hence loosing high value resources and affecting the recycling viability **[16]**.

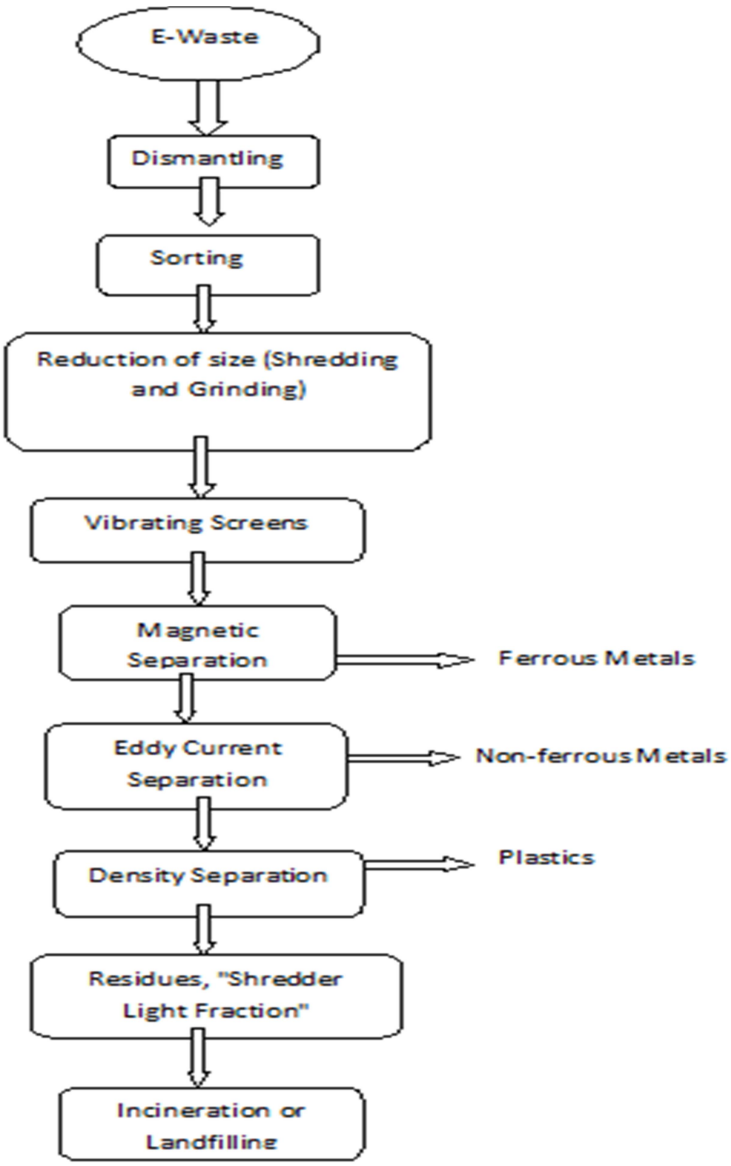

Figure 3: Flow of E-Waste

The government can also recommend methodologies and practices offered by other countries as a role model for collection and recycling of E-Waste. South Korea managed to recycle 21% of its total 0.8 million tons of its E-Waste **[16]**.

Comparative Scenario to Developed Countries

Switzerland was the first country which had an industry linked system for the management of E-Waste but users had to pay money for the recycling of the electronic goods whereas in countries like India, the users get money from scrap dealers **[17]**. The Basel Convention has been the International Step taken towards stopping the movement of electronic waste **[18]**. In a study in 2004 that a minimum of 50,000 tons of waste/annum is required to recover sufficient amount of material for running the operations successfully. While, In India there is lack of infrastructure for such massive recycling **[19]**.

China being the second largest producer of e waste claimed that U.S. is the only developed country which has not ratified the Basel Convention of Hazardous Waste (A treaty to restrict export of E-waste with 186 supporting parties). China is handling almost 70% of world's processed E-Waste. But, last year in January, Beijing implemented a ban on import of E-Waste. The campaign named as "Natural Sword against Foreign Garbage" was aimed at rejection of E-waste. It was spurred because of concerns regarding the contamination of water and health of children. This ban caused the diversion of waste to small nations which lack expertise to handle that overflow.So far, European Union has enforced toughest laws in the world for E-waste management. Banning export to developing countries and compelling developed countries (manufacturers) to help and fund recycling **[20]**.

Major challenges or loopholes in e-waste management

- **Lack of infrastructure** - the recycling also needs to be cost effective and in turn depends upon a number of sub factors which includes: Investment Requirement, Pollution Control Measures, Size of facility/ Infrastructure, Availability of sufficient quantity of waste, Environmental clearances requirement **[21]**.
- Failure in the implementation of Extended Producer Responsibility (EPR) due to Weak Legislation **[22]**.
- **Transportation distance** from actual processing site and **Cost of equipments [22]**.
- **Lack of Expertise** - The agencies involved in the collection, transportation, processing and recycling have untrained workers with no expertise and they are

even incapable to extract reusable components from electronic waste. Moreover, toxins leakage, compromising safety and health aspects are contributing factors not to choose these professions for upcoming generations **[23]**.

- **Slow implementation of laws in India is a major hurdle**. Upcoming startups which include e-waste recycling and disposal should be given preferences and concessions. -The collection network of E-Waste which is unorganized and it needs to coordinate with collection in organized sector to process e-waste in an eco-friendly manner. The collection, facilitation and creation of infrastructure must go hand in hand by harmonious collaboration between Consumers, Retailers, Government, NGO'S, Municipalities, Self Help Groups and local health agencies Localities must have separate bins for the collection of e-waste **[23]**.

Possible Solutions for the raised issue. Nokia was the first mobile phone manufacturer which took serious efforts for E-waste management **[24]**. The Government of India made mandatory amendments in waste management roles in 2018 under the Ministry of Environment, Forest, and Climate change to improve the regulation and mechanism for recycling **[20]**.

- **Advancement in Technology** - The recycling units of E-Waste need special technique advancements for extracting precious metal components like Au, Ag, Cu and other functional parts. In Delhi, Seelampur is the largest E-Waste dismantling area in Delhi. They have workers of all age working 10-12 hrs/day (wet chemical processes) and have open incineration along with acids leaking on the ground. The workers in these types of areas need special type of training and expertise along with concerns regarding their health and safety issues. They need gloves, masks and other essential gears because people here manually extract the heavy metals and often inhale harmful fumes which cause, kidney, liver and neurological disorders **[25]**.
- **Strict Laws for Producers and Consumers** - To manage the e-waste, a legal procedure must be followed, imposing EPR, RoHS for attaining this goal. There must be decided targets for manufacturers and suppliers for reducing electronic waste. They must be

encouraged to buy back the electronic products from the consumers, authorized recyclers must dispose off the bulk e-waste and also the final disposal of the non-tradable e-waste must be in the hands of the authorized private developers **[21]**.

- **By Public Awareness** - To reduce and improvise e-waste management system, it is essential to bring about public awareness and cooperation of manufactures **[26]**.
- **Production by Government Authorized License** - To attain the internationally adopted environment legislations in the country, the government must make a proper provision to allocate grants for this purpose. To curb the illegal smugglers and handlers of e-waste management, licensing can be adopted .Many harmful effects of e-waste can be avoided by proper management and disposition of e-waste **[26]**.
- **By Developing Eco- Friendly Devices**–E-waste can be managed by developing eco-friendly devices, cautiously collecting e-waste, recovering e-waste material by the use of safe method **[27]**. The negative impacts of e-waste can be mitigated by the use of environment friendly substitutes instead of harmful substances, with the use of innovative changes in the product as per Extended Producer Responsibility (ERP) **[21]**.
- **Finance Independence** - The separate collecting and recycling agencies and producers' financial responsibility significantly contributes to the extended producer responsibility-based environmental policies success **[28]**.
- **By Acquiring Systematic Process** - Systematic sourcing along with collection right till extraction and dumping of material can be achieved with appropriate e waste management by making sure that profitable businesses can be formed out of it. By keeping the guidelines for a better and efficient product in mind, the manufacturers can work on sustaining the production methods by taking steps like better and more recyclable blueprint from selecting the raw material to the end product. The proper channeling of the e waste that's been disposed can prove to be very fruitful as it can help in better recycling or disposing of the e waste **[29]**.

- **Be a part of School Education** - In schools as part of environmental education subject. By doing so, the researchers hope to introduce this topic to more and more people at a young age as it can help in developing a more aware population as the education structure plays a major role in making sure that people practice it on a regular basis **[30]**.
- **Repairs for Electronics**–An interesting research done on the repair centers for electronic goods in the studied area showed that they can help in improving the life and condition of the electronic goods that would lead to electronic waste. The high costs for repairs for electronics and the accessibility to inexpensive and a feature-rich electronic product that fuels the culture of throwing away outdated products makes chunks of e waste. By developing strong systems for recycling, sustainable development can be achieved **[31]**.
- **By Forming Formidable Techniques** -By Forming Formidable Techniques for controlling e waste, its quantity can be reduced **[32]**.
- **Promotion of Reduce and Reuse** - To control waste, the first priority should be reducing the generation of E-waste. To achieve this target ,one should change their life style.In developed countries people change their gadgets not because their gadgets stop working ,just to use the updated version of that.If the lifespan of the gadget is prolonged then the production of e- waste would be less **[33]**.

Taking into consideration the prevalent situation one online survey was conducted to gauge people awareness of E waste they owe and management scenario. The objectives of the survey are as follows;

Objectives of the survey

The objectives of this survey on E-waste management in India are:

- To make a set of population aware of new threat to health going to be posed due to electronic items
- To gauge opinion of education related professionals on management of electronic waste in present scenario
- To identify new approach to combat E-waste problem in developing country like India.
- To predict the implications andSuggestions for further

improvements for gearing up futuristic approach to health concern.

Methodology

This research was conducted by an online survey over one of the most popular portal site in India. Response of each participant was collected using linked survey and response were automatically generated and recorded. However those who failed in completing the survey were excluded from the analysis. The survey was equally responded by teachers and students contributing almost equally. The link was disconnected in one week time. The questionnaire included twenty-eight questions covering awareness of e -waste discard, management and present status of condition prevalent in India. The questionnaire was applied on a sample consisting of 111 participants which in turn reflects major population of professionals from education sector. The period of application of the questionnaire was June30th –to July6th, 2021. The demographic profile of the audience was diverse. The responses obtained from rural and urban areas were almost equal and 7% of the total was from metropolitan areas. 85% of responses were obtained from the students and approximately 12% were from teachers and rest being from the other people. 62% of the participants were female and rest being the males.

Sample: A total of 111 participants completed the questionnaire data on "Electronic waste management in India –A threat to the upcoming generations." were collected between June 30th, 2021 – July 6th, 2021 using an online questionnaire spread throughout the internet.

Tool: A web-based survey design was adopted. The survey was developed using the free software "Google form".

Procedure: A survey questionnaire was administered uniformly on a sample of 111 participants mainly teachers and students of different states of Haryana.

Participants were assured by the researchers that their information would be used only for research purpose. There is no right and wrong responses. If they exist they were cleared by investigator to the respondent.

The purpose of this study was to spread awareness regarding electronic waste management in India

Statistical analysis: After collecting the data, every question percentage was calculated.

Survey Results

A survey titled, "Electronic Waste (E-Waste) management in India-A new threat to the upcoming generations" was conducted in the state of Haryana and the survey was made using the freely accessible "Google Form" which enables the user to collect information and visualize the results in the form of pie charts and bar graph.

- **Circulation of Survey**

The link of survey was circulated through Whatsapp and 85% of responses were obtained from the students and approximately 12% were from teachers and rest being from the other people. 62% of the participants were female and rest being the males. The responses obtained from rural and urban areas were almost equal and 7% of the total were from metropolitan areas. The primary objective of the Google Form was to gauge the knowledge level of the participants and make them aware simultaneously regarding E-Waste Management.

- **General Awareness in people**

Sixty percent of the participants were aware that E-Waste is a major challenge and we are on the verge of another pandemic due to E-Waste mismanagement and approximately half of the participants were aware that India is incapable of recycling even 2% of the 2 million tons of E-waste it produces. It was observed that 55% of the participants had no clue about Seelampur (The famous E-Waste dismantling area of Delhi) and hence it shows that the masses are unaware with the harsh reality. More than 40 % of the people agreed that computers contribute more than 40% of the E-waste and rest is contributed by medical, electrical and telecommunication waste.

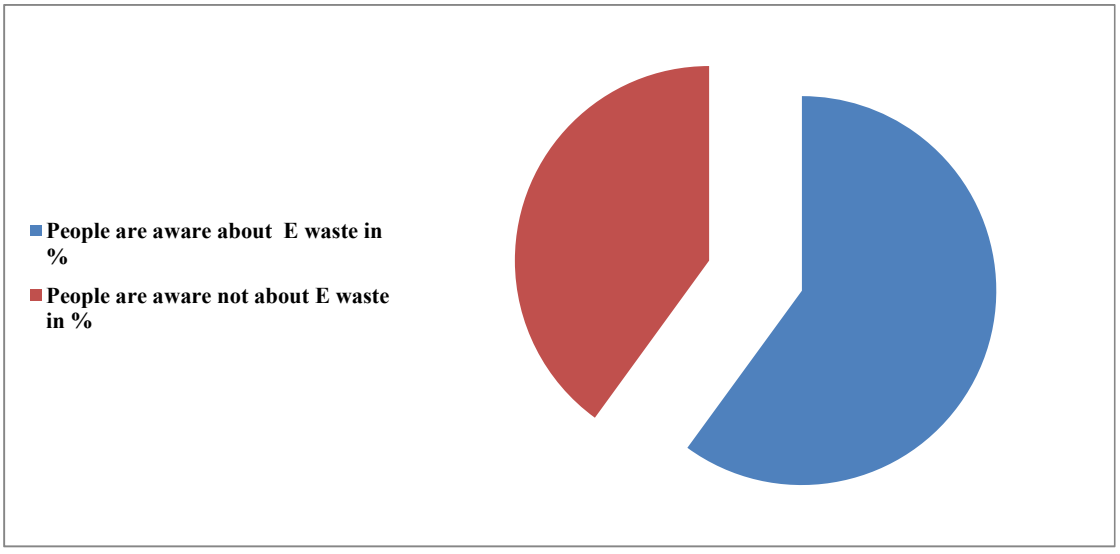

Figure 4: Graph representing percentage of people aware and unaware of e-waste (Online Survey)

- **Awareness about the ill effects of E-waste**

E-Waste contains significant amount of precious metals like Silver, Gold, Mercury and Cadmium etc and 67 of the participants were found to be aware about this fact.

The improper E-Waste dismantling can cause health issues like neurological, respiratory, immunity based and radiation ill effects and 94% of the participants were aware of it.

- **Awareness about 3R strategies**

The users must repair and reuse the damaged items instead of throwing or giving them away and approximately 50% of the participants agreed that they don't get their products repaired.

The E-Waste management system in our country needs to be strengthened and 79% of the participants agreed that Government along with companies and citizen's participation should hold responsibility for E-Waste management. The companies can also roll out Buy-Back schemes to collect the E-Waste back from the users and 45% of the participants were in its favor. Approximately 70% of the participants were also aware that in countries like Japan and Switzerland users have to pay money for the E-Waste disposal and management.

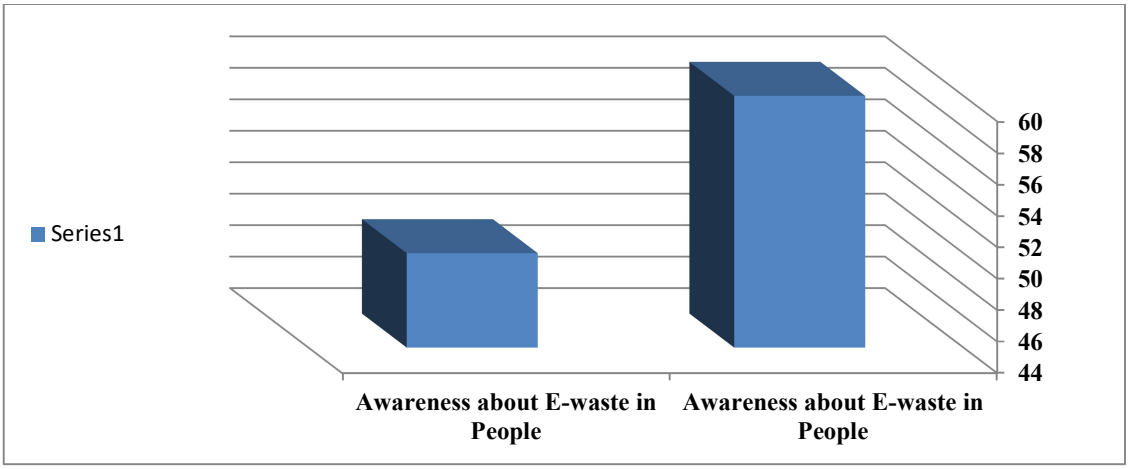

Figure 5: Bar Chart presenting awareness of 3R Strategy in a sample (OnlineSurvey)

CONCLUSION

The amendments made in 2018 have facilitated and effectively implemented the environment friendly management of E-Waste and all the rules are in effect since October 1, 2017. The government of India made mandatory amendments in waste management roles in 2018 under the Ministry of Environment, Forest, and Climate change to improve the regulation and mechanism for recycling. The government must collaborate with industries to develop formal and standard operating procedures. It's rather ironic that

the whole world has welcomed the proliferation of multiple computers in families and workplaces, believing that a computer-centric world would strain the environment. As it turns out, computer systems did offer a paper-unfastened commercial enterprise surroundings however greater forests at the moment are being chopped down simply to assist the electricity ate up via way of means of digital computing devices. Moreover Personal Computers are warming-up the environment to such an extent that more power is being used to keep the workplaces cooler. It is accepted that every Personal Computer has the ability to utilize about 50% of the total electrical power it consumes. Hence, looking greener computing solutions isn't about making a choice anymore. The situation is getting unapproachable with every passing day and businesses need to understand the mutual benefit, their commercial interests and the environment, will derive from greener and practical computing technologies.

REFERENCES

[1] Tanskanen P, Management and recycling of electronic waste. Acta Materialia, 61(3), 2013, 1001–1011.

[2] UNEP A report - recycling - from E-waste to resources. United Nations Environment Programme (UNEP); February 22, 2010.

[3] Chi X *et al*., Informal electronic waste recycling: A sector review with special focus on China. Waste Management, 31(4), 2011,731-742

[4] Gupta, S *et al*., A review on various electronic waste recycling techniques and hazards due to its improper handling. International Refereed, Journal of Engineering and Science, 3(5), 2014, 5-17.

[5] Jayapradha A, Journal of Chemical and Pharmaceutical Research, , 7(3), 2015,232-238

[6] Saurab Babu Environmental Performance Index: Where does India stand?. ECO-Intelligent, Making the World Ecologically Intelligent, 2018.

[7] Pimonenko T *et al*., Environmental Performance Index: relation between social and economic welfare of the countries "Environmental Economics", 9(3), 2018,1-11.

[8] Arya S, Kumar S, E-waste in India at a glance: Current trends, regulations, challenges and management strategies, Journal of Cleaner Production, Volume 271, 2020, 122707,

[9] Borthakur A, Generation and Management of Electronic Waste in the City of Pune, India. Bulletin

of Science, Technology & Society, 34(1-2), 2014, 43–52.

[10]Monika, Kishore J. E-waste management: as a challenge to public health in India. Indian J Community Med., 35(3), 2010, 382–385.

[11]Wong M H *et al*., Export of toxic chemicals – A review of the case of uncontrolled electronic-waste recycling. Environmental Pollution, 149(2), 2007, 131–140.

[12]Smarkoon M B Dr. A Review of Electrical and Electronic Waste Management in Sri Lanka. International Conference on Chemical, Civil and Environmental Engineering (CCEE'2014) Nov 18-19, 2014 Singapore, 1-6.

[13]Kohler A, Erdmann L, "Expected environmental impacts of pervasive computing". Human and Ecological Risk Assessment, 10(5), 2004, 831- 852.

[14]Lepawsky J, & Mcnabb C, Mapping international flows of electronic waste. The Canadian Geographer / Le Géographe Canadien, 54(2), 2009, 177–195.

[15]Chakraborty P *et al*., Baseline investigation on plasticizers,bisphenol A, polycyclic aromatic hydrocarbons and heavy metals in the surface soilof the informal electronic waste recycling workshops and nearby open dumpsites in Indian metropolitan cities. Environmental Pollution, 248, 2019, 1036-1045.

[16]India's e-waste to sharply go up: ASSOCHAM-KPMG report

[17]Khetriwal *et al*. A comparison of electronic waste recycling in Switzerland and in India. Environmental Impact Assessment Review vol 25 (5), 2005, 492-504

[18]Wath S B, Dutt P S & Chakrabarti T, E-waste scenario in India, its management and implications. Environmental Monitoring and Assessment, 172(1-4), 2010, 249–262.

[19]DEFRA (2004). Department for Environment, Food and Rural Affairs (DEFRA) Report. March 2004.

[20]EU (2003). European Union Waste Electrical and Electronic Equipment (WEEE) Directive. Brussels: EU.

[21]Uddin M J, Journal and Conference Paper On (Environment) E – Waste Management. IOSR Journal of Mechanical and Civil Engineering, 2(1), 2012, 25-45.

[22] EEA. 2009. Waste without borders: Transboundary shipments of waste. European Environmental Agency, Copenhagen

[23] Johri R (Ed.) E-waste management, implications, regulations and management in India and current global best practices. New Delhi: Teri., 2008.

[24] I.C. Nnorom, O. Osibanjo, Overview of electronic waste (e-waste) management practices and legislations, and their poor applications in the developing countries, Resources, Conservation and Recycling, 52 (6) 2008, 843-858,

[25] Pandey, P and Govind, M, Social repercussions of e-waste management in India: a study of three informal recycling sites in Delhi, International Journal of Environmental Studies, 71(3), 2014, 241-260

[26] Sivaramanan S, E-Waste Management, Disposal and Its Impacts on the Environment. Universal Journal of Environmental Research and Technology, 3(5), 2013, 531-537

[27] Kiddee P, Naidu R, & Wong M H, Electronic waste management approaches: An overview. Waste Management, 33(5), 2013, 1237-1250.

[28] Gupta Y, & Sahay S, Review of extended producer responsibility: A case study approach. Waste Management & Research, 33(7), 2015, 595-611.

[29] Jadhav S, Electronic Waste: A Growing Concern in Today's Environment Sustainability. International Journal of Social Science & Interdisciplinary Research, 2(2), 2013, 139-147

[30] Sikdar M and Vaniya S, The New Millennium and Emerging Concerns. International Journal of Scientific and Research Publications, 4(2), 2014, 1-12.

[31] Binegde G H *et al*., Electronic Waste Generation and Its Management in Bole and Akaki Kaliti Sub cities of Addis Ababa Ethiopia. International Journal of Environmental Sciences, 4(2), 2015, 46-51.

[32] Othman N, Mohammad R, &Kamaruddin S A, Prediction of Electronic Waste Disposals From Residential Areas In Malaysia. Jurnal Teknologi, 74(10), 2015, 1-6.

[33] Atsushi T *et al*., Current Status and Research on E-Waste Issues in Asia, Journal of Material Cycles and Waste Management, No: 8, 2006, 1 – 12.