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Chapter 11

E-waste management in India

Gestión de residuos electrónicos en India

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ABSTRACT

Several studies have reported that the electronic waste generated in the past decades is harming nature and human health severely. It is toxic to the environment. Approximately 50 million tons of e-waste is produced every year which contain different types of metallic and non-metallic elements and a compound that cannot be naturally disposed of. Here we have studied the effects of e-waste on the environment and human health and methods and government policies for waste management. We have year-wise data and state-wise data as well as world data on e-waste generation. The social awareness program by NGOs plays a very important role. Awareness, proper management, and technology can be incorporated to control the e-waste problem.

KEYWORDS: e-waste management, India, effect on human health and environment.

RESUMEN

Varios estudios han señalado que los desechos electrónicos generados en las últimas décadas están dañando gravemente la naturaleza y la salud humana. Es tóxico para el medio ambiente. Cada año se generan alrededor de 50 millones de toneladas de desechos electrónicos que contienen una variedad de elementos metálicos y no metálicos y es un compuesto que no se puede eliminar de forma natural. Aquí hemos estudiado los efectos de los desechos electrónicos en el medio ambiente y la salud humana y los métodos de gestión de desechos y las políticas gubernamentales. Tenemos datos anuales y estatales, así como datos mundiales sobre la producción de desechos electrónicos. El programa de sensibilización social de las ONG juega un papel muy importante. Se puede incorporar la conciencia, la gestión adecuada y la tecnología para controlar el problema de los desechos electrónicos.

PALABRAS CLAVE: Gestión de residuos electrónicos, India, Impacto en la salud humana y el medio ambiente.

INTRODUCTION

According to the European Union (EU 2002), electronic waste is “electrical or electronic equipment that is waste, including all components, assemblies, and consumables that form part of the product at the time of disposal” (Kumar, V. et al. 2011). E-waste or e-waste means discarded electrical or electronic equipment. Although electronic waste is a general term, it encompasses a wide range of devices such as mobile phones, computers, laptops, printers, household appliances such as refrigerators, washing machines, dryers laundry, home entertainment systems, stereos, toys, toasters, kettles, etc. (Jayapradha, A. 2015). The global increase in electronic devices has revolutionized people's lives and greatly simplified them, but it has burdened the world with the problem of e-waste. India has witnessed a dramatic increase in economic growth over the past decade accompanied by digitalization (Raval, R. V. et al. 2020). The e-waste problem has reached great proportions with an estimated 50 million tons of e-waste produced worldwide each year. The Indian market is flooded with huge quantities of electrical and electronic products and gadgets, with huge internal demand. Therefore, the present study was proposed to evaluate the improvement of dentistry students' awareness of various aspects of e-waste risks and management before and after an e-waste educational intervention session (Vibhute, N. A. et al. 2021). Electrical and electronic waste (or e-waste) is the fastest growing environmental problem in the world, and China is no exception. With the rapid development of the electronics industry, the use of electrical and electronic products has become common in households, governments, institutions, organizations, and business sectors (Li, J. et al. 2006). In India, the amount of "e-waste" or e-waste has become a major problem. Disposal of electronic waste is an emerging global problem for the environment and public health as this waste has become the fastest growing segment of the official municipal waste stream in the world (Dahl R 2002). Another type of environmental pollution includes pollution of water, air, noise, soil, and pollution caused by solid waste (including toxic waste). One such waste that is growing rapidly today is e-waste (e-waste) (Singh, D. 2019). The composition of electronic waste falls into the "hazardous" and "non-hazardous" categories. Generally speaking, it consists of ferrous and non-ferrous metals, plastics, glass, wood and plywood, printed circuit boards, concrete, ceramics, rubber, and other items. Iron and steel make up about 50% of the waste, followed by plastics (21%), non-ferrous metals (13%), and other components. Non-ferrous metals are made up of metals such as copper, aluminum, and precious metals such as silver, gold, platinum, palladium, and so on. The presence of elements such as lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants above the threshold values make electronic waste dangerous. It contains over 1000 different substances, many of which are toxic, and causes severe pollution when removed. Obsolete computers pose the greatest environmental and health risk among electronic waste (Lahiry, P. 2020).

According to the World Health Organization (WHO), health risks can arise from direct contact with toxic materials leached from electronic waste. These include minerals such as lead, cadmium, chromium, brominated flame retardants, or polychlorinated biphenyls (PCBs). Hazards can result from the inhalation of toxic fumes, as well as from the accumulation of chemicals in soil, water, and food. This not only endangers humans but also land and marine animals. In developing countries, the risks are exceptionally high because

some developed countries send their e-waste there. Studies have shown that this e-waste around the world has negative consequences for the people who work with e-waste, but also for the people who live around it (What is e-waste - ewaste1.com). Negative effects on humans As mentioned, the electronic waste contains toxic components that are hazardous to human health, such as mercury, lead, cadmium, polybrominated flame retardants, barium, and lithium. The negative health effects of these toxins on humans include damage to the brain, heart, liver, kidneys, and skeleton. It can also significantly affect the nervous system and reproductive organs of the human body, leading to disease and birth defects. Improper disposal of electronic waste is incredibly dangerous to the global environment, which is why it is so important to spread awareness of this growing problem and its impending consequences. To avoid these toxic effects of e-waste, it is vital to recycle properly so that items can be recycled, refurbished, resold, or reused. The growing stream of e-waste will only get worse if not informed about proper disposal measures (Elytus. 2019). Electronic Waste (Management and Handling) Rules, 2011; E-waste fell under Hazardous Waste Management (HWM) rules. Under the Environmental Protection Act 1986, the Electronic Waste (Management and Handling) Rules 2011 were promulgated and came into force on 1 May 2012. The disposal of electronic waste (e-waste) is increasingly recognized as an urgent environmental challenge. In 2016, approximately 44.7 million tonnes of e-waste were generated worldwide, increasing to over 55 million MTS by 2020 and potentially doubling by 2045. In an EPR framework, responsibility for e-waste is shifted upstream to producers and manufacturers responsible for the entire life cycle of their products (Davis, J. M. 2021).

Figure: 1. Our E-Waste Problems

Source:https://www.wired.com/2014/12/product-design-and-recycling/

Table: 1 Global E-waste generation

Year	World million metric tones
2015	46.4
2016	48.2
2017	50

2018	51.8
2019	53.6
2020	55.5

Source: Global E-waste Monitor 2020

Table: 2 Year-wise e-waste generation in India:

Year	E-waste generation (million metric tones)
2015	1.97
2016	2.22
2017	2.53
2018	2.86
2019	3.23
2020	4.12

Source: CSE, 2020 compiled from The Global E-waste Statistics Partnership

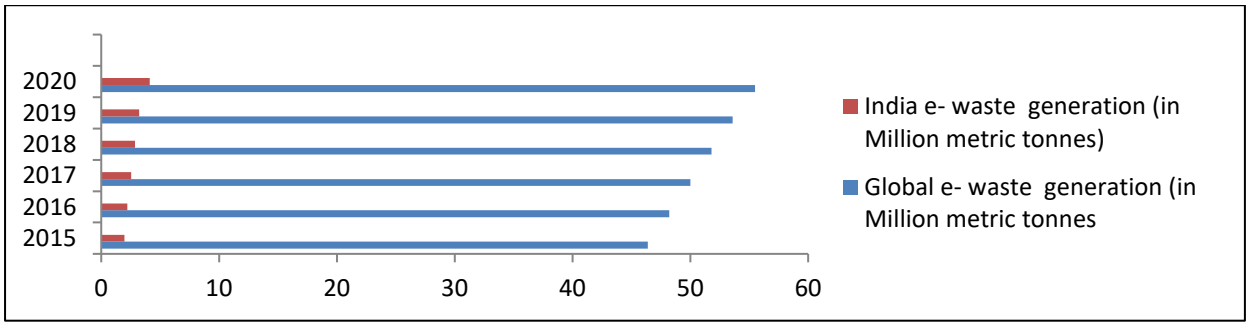

Figure: 1 E-waste generation in Global and India (mMT)

Table: 3 Percentage contribution by states to annual e-waste generation

States	Percentage contribution
Maharashtra	13.9
Tamil Nadu	9.1
Andhra Pradesh	8.7
Uttar Pradesh	7.1
West Bengal	6.9
Delhi	6.7
Karnataka	6.2
Gujarat	6.1

Madhya Pradesh	5.3
All other states	30

Source: Electrical and Electronics manufacturing in India, ASSOCHAM & NEC Technologies, 2018

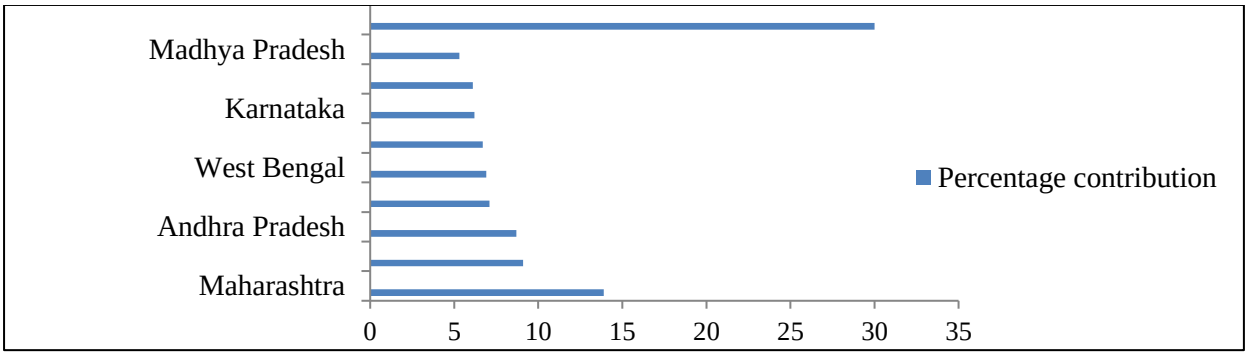

Figure: 2 Percentage contribution by states to annual e-waste generation

MATERIAL AND METHODS

The present research work is based on secondary sources of data. The data have been extracted from different government and non-government agencies like the Ministry of Environment and Climate Change, CPCB, ASSOCHAM-KPMG Joint Report, different journals, books, articles, gazetteers, etc. All the discussion and findings have been analyzed with the help of quantitative and qualitative techniques e.g., the simple percentage (S. k, M. M. et al. 2021).

WHAT IS E-WASTE MANAGEMENT?

E-Waste management is the art and science of efficaciously handling the thousands of tones of extremely harmful electronic waste increasing day by day. E-Waste is the fastest rising kind of waste in the world. It is a gigantic problem already gaining momentum at a scary speed. Yet most of us aren't cognizant of its gravity. These reasons have given rise to the necessity of E-waste management. E-waste management helps to recover and reprocess as much usable material as possible. It confirms that all the energy and water used to create these products is not futile. It also scavenges for rare metals, which are not replenish-able resources. Thus, E-waste management is not only advantageous but important (Kaushik, M. V. 2018).

E-WASTE MANAGEMENT IN INDIA

Present Scenario of E-Waste Management in India

Currently, India generates nearly 18.5 lakh tons of e-waste annually with 1.3 kg of waste generation per capita and also imports huge amounts of e-waste from other countries. Electronic waste comprises 8% of the total volume of current municipal solid waste (MSW) in India. Of all electronic waste generated, IT

equipment alone accounts for 70% of the electronic waste stream, followed by telecommunications equipment, telephones (12%), electrical equipment (8%), medical equipment (7%), and electronic equipment the waste house (ASSOCHAM-KPMG report, 2016) Global E-waste Monitor reports that in 2019 nearly 53.6 million tons of e-waste were generated, where America generated 13.1 Mt, Europe 12Mt, Asia 24.9 Mt, Africa 2.9 Mt, Oceania 0.7 Mt, and only 17% of this was collected and recycled and It also reports that a record 59 tons of e-waste, and predicts a rise to 81 tons by 2030 (Havinal, R. 2021).

1. Get neighborly: Visit every door with a small group and tell people how not to recycle; make them aware of how it will affect their future. Collect funds which can then be used to arrange a recycling program.
2. Add Community Drop-Off Locations: Provide drop off points in community. It is inexpensive and, easy to use. This will increase recycling rates.
3. Start a campaign: Take a step to start a recycling campaign. Recycling campaigns will help to increase the spreading of recycling awareness.
4. Involve local supermarkets: supermarkets can be involved to enhance the recycling activity in the neighborhood community.
5. Build a Recycling Centre: A recycling center is to be set up for every community's needs. It will help the people to meet, socialize, recycle and keep the clean environment.
6. Spread Awareness: Spread the benefits of recycling which encourages people to adopt and move towards recycling. Make banners to explain the advantages, dos, and don’ts and put them at prominent places in the community to see. This is an active approach to recycling.
7. Contact the nearby media agencies: Make use of Information technology to spread the by inviting local newspapers or TV channels. To visit the neighborhood community and interview the local authorities and publish articles in newspapers about the importance and need for recycling.
8. Arrange a funfair or carnival: Involve young minds to inculcate the concept of recycling, organize a community recycling theme fair with games and prizes.
9. Involve your local arts council: Contact the local arts people and arrange painting shows and sculptures made out of E-waste. Organize short plays which should highlight the E-waste benefits of recycling (Havinal, R. 2021).

THE E-WASTE MANAGEMENT AND HANDLING RULES, 2011:

Together with the "Environmental Protection Act of 1986", the "E-Waste (Management and Handling), 2012 rules" came into effect. As a rule, both manufacturers and importers of electronic goods had to manage their electronic waste (Hussain, C.M. 2021) Manufacturers and importers were required to set up e-waste collection points or set up a system to collect discarded materials. They were also asked to provide information to consumers on how to properly dispose of used electrical and electronic equipment, to avoid it being thrown away with household waste. In addition, industries that manufacture electronic products containing materials that can become waste must educate the public about the lethal nature of the substances they contain. Regulations must be strict for each partner involved in manufacturing, collection, management, and disposal. The regulations also required government agencies and domestic consumers to keep records of

waste generated, which had to be submitted to pollution control offices upon notification (Hussain, C. M. 2021).

DRAFT OF E-WASTE (MANAGEMENT) RULES, 2015

1. The Draft E-Waste (Management) Rules 2015 have been proposed to fill the gaps in the existing rules.
2. Some new stakeholders have been added to the new draft rules, e.g. B. Remanufacturers, Distributors, and Producer Responsibility Organizations (PROs).
3. The draft rule also included the deposit-refund system (where a portion of the sale price would be withheld by manufacturers and returned to consumers once end-of-life products are shipped in the prescribed manner).
4. The new regulations have simplified the authorization and registration formalities.
5. The penal provisions correspond to the regulations in force since 2011 (Kaur, H., & Goel, p. 2016).

RULES FOR ELECTRONIC WASTE (MANAGEMENT), 2016:

Given the growing problems of electronic waste, the national government has notified these rules in the exercise of the powers provided for in Articles 6, 8, and 25 of the 1986 Environmental Law. Rules on electronic waste (management), 2016 have replaced the rules on waste electronic (management and management), 2011 (Sharma, B. et al. 2019). It consists of 24 lines divided into six chapters and four diagrams. The rules aim to allow the recovery and/or reuse of beneficial material from electronic waste, reducing hazardous waste destined for disposal and ensuring the environmentally correct management of all types of waste from electrical and electronic equipment. These rules come into effect on 1 October 2016 (Sharma, B. et al. 2019). These rules apply to all producers, consumers, wholesalers, manufacturers, collectors, distributors, e-tailers, remanufacturers, disassemblers, and recyclers involved in the manufacture, sale, purchase, and transformation of electrical and electronic equipment, including theirs. However, the components, consumables, parts and spare parts that make the product operational do not apply to a. Lead acid batteries disposed of under the Batteries (Management and Handling) Rules 2001, prepared under the Act; b. micro-enterprises as defined in the Micro, Small and Medium Enterprises Development Act 2006; etc. Radioactive waste is covered by the provisions of the Atomic Energy Act 1962 (33 of 1962) and the regulations made thereunder. Responsibilities under the 2016 rule (Sharma, B. et al. 2019).

2018 AMENDMENT TO THE ELECTRONIC WASTE MANAGEMENT RULES AND THEIR IMPACTS:

The Electronic Waste Management Rules, 2016 were recently amended by the Centre; see G.S.R notification 261 (E), of March 22, 2018, to facilitate and effectively implement the environmentally sound management of electronic waste in India. These changes were made to route the e-waste generated in the country to licensed demolitions and recyclers to further formalize the e-waste recycling industry. The amended rules revise collection targets under the EPR provision in effect from 1 October 2017. Through revised targets and monitoring within the Central Pollution Control Board (CPCB), effective and improved management of electronic waste would be ensured. According to the revised e-waste collection targets, 10% of the amount of waste generated will be collected in 2017-2018. Additionally, there would be a 10% increase each year until

2023. After 2023, the e-waste collection target was set at 70% of the waste generated (Arora, S., & Bharti, A. 2019).

HUMAN HEALTH AND ENVIRONMENTAL IMPACT

A. EFFECTS ON HUMAN HEALTH

Prolonged exposure to hazardous substances contained in electronic waste components causes' damage to the nervous system, kidneys, bones, and reproductive and endocrine systems. Improper recycling or disposal of electronic waste in landfills and incinerators pollutes water and soil, pollutes the air, and causes irreversible damage to the environment. Electronic waste contains a significant amount of hazardous substances such as lead, cadmium, chromium, and flame retardant plastics. Frequent contact with them causes various health problems (Havinal, R. 2021).

Table: 4 Health Effects of Constituents in E-Waste (Poonam J. et al. 2012, Vats, M. C., & Singh, S. K. 2014).

Constituents	Source of Constituents	Health Effects
Mercury	Available in relays and switches, and printed circuit boards.	Cause chronic damage to the brain. Cause respiratory and skin disorders due to bioaccumulation in fishes.
Lead	Available in solder in Printed circuit boards, glass panels, and gaskets in computer monitors.	Causes damage to the central and peripheral nervous system, blood system, and kidneys. It negatively affects the development of the brain of the child, damages the circulatory system and the kidneys.
Cadmium	Available in chip resistors and semiconductors.	Irreversible toxic effects on human health. It accumulates in the kidneys and liver. ▪ Neural damage.
Chromium	Available in relays and switches, and printed circuit boards.	Cause chronic brain damage. Causes respiratory and skin diseases by bioaccumulation in fish.
Copper	Present in copper wires, printed Circuit board tracks.	It causes stomach liver damage, cramps, nausea, or Wilson's disease.

Lithium	Present in Lithium-ion battery	It can pass into breast milk and may harm a nursing baby.
Plastics and PVC	Available in Cabling and computer body.	Burning produces dioxin, which causes reproductive and developmental problems.
Beryllium	Present in Motherboards.	Inhalation of fumes and dust causes chronic beryllium disease or beryllium.
Barium phosphorus and heavy metals.	Present in front panel of CRTs.	It causes muscle weakness and damage to the liver, spleen and heart.
Nickel	Present in nickel-cadmium rechargeable batteries.	Causes skin allergy leading to dermatitis while lung allergy leads to asthma.
Brominates flame-retardant's	Available in electronic equipment and circuit Boards.	⍰ It disrupts endocrine system functions.

B. ENVIRONMENT

1. Our landfills are becoming polluted due to the toxic nature of electronic waste and these toxins are infiltrating underwater tanks. Improper disposal of electronic waste and recycling are harmful to the environment (Havinal, R. 2021).

2. Air Pollution: E-waste that is not recycled is incinerated in incinerators, producing dangerous emissions. These emissions are harmful to animals and humans. Due to this depletion of the ozone layer and the rate of greenhouse gases, the rate will increase. This contributes to changes in the Earth's temperature and climate change.

3. Soil: Electronic waste takes hundreds of years to decompose. It has a harmful and lasting effect on the environment. The breakdown of electronic components releases dangerous toxic chemicals. This contaminates the soil, plants, and trees. Lead and lithium enter the human and animal bodies via the food chain.

4. Water Pollution: Millions of tons of waste, including electronic waste, end up in the sea/ocean every year. Electric and electronic waste are not biodegradable. Therefore, dumping waste into the sea or oceans is dangerous for organisms. This disrupts biodiversity and creates an imbalance in the ecosystem.

5. Groundwater: Improper disposal of e-waste can release toxins such as mercury, lead, and cadmium into groundwater and contaminate the water. This will have dangerous effects on human health, including the reproductive system, cancer, and immune system damage (Havinal, R. 2021).

CONCLUSION

Due to the increasing number of e-waste every year, there is a lot of damage to man and the environment. And here the danger continues to grow. As long as there is a steady increase in electronic production, so will the increase in electronic waste. The presence of toxic elements in it will continue to pose a threat to humans and the environment. We need to make people aware with the help of newspapers, new channels, NGOs, and camps so that people can become aware of the harm caused by e-waste. The manufacturing company should make electronic equipment keeping in mind the problem caused by e-waste. The government should take responsibility for a good and healthy environment together with the electronic manufacturer company and common people.

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