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Electrical Waste (e-Waste): A Global Threat for Environment and Human Health

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Abstract

Electrical waste (e-waste) is obsolete and end-of-life electronic appliances, such as mobile phones, computers, laptops, solar cells, electric vehicles, televisions, generators, DVDs, freezers, and various such items that are typically discarded by their original owners due to their short lifespan. It is classified as hazardous waste and is one of the fastest and the most complex growing waste streams in the world due to the expansion of the industrialization process, technological advancements, and higher living standards that poses a hazard to the ecosystem. The e-waste can carry numerous harmful elements, such as lead, mercury, arsenic, beryllium, cadmium, polychlorinated biphenyls, brominated flame, etc. It can be refurbished, reused, resold, and recycled through material recovery. Every year more than 60 million tons of e-wastes are created with an annual growth rate of 20-25%. The present study examines the effect of e-waste in the environment and health sector, and management of it for the welfare of the global humanity.

Keywords: e-waste, environment pollution, health sector, recycling, e-waste management

1. Introduction

E-waste is any electrical or electronic equipment that has been discarded. It is also known as waste electrical and electronic equipment (WEEE) or end-of-life (EOL) electronics. It is considered as the “fastest-growing waste stream in the world” due to the explosive demand and shorter product cycles (Kahhat et al., 2008). The e-wastes contain both toxic and valuable materials (Mohajan, 2020). Potentially various harmful materials in e-wastes are lead, cadmium, mercury, beryllium, brominated flame retardants, polychlorinated biphenyls (PCBs), arsenic, etc. that can lead to adverse human health effects and environmental pollution, and also pose serious environmental risks to our soil, water, air, and wildlife (Osibanjo, 2007). It may also contain various valuable metals, such as nickel, bronze, copper, aluminum, iron, steel, lead, zinc, and cobalt; precious raw metals, such as gold, silver, neodymium, indium, platinum, and palladium that can be recovered, recycled, and used as valuable source of secondary raw materials (Yousef et al., 2017). The non-metallic components of e-wastes are plastic, glass, and rubber. Also, the rare earth elements are samarium, europium, yttrium, gadolinium, dysprosium, etc. (Ahmed, 2016).

In 2021, each person produces on an average 7.6 kg of e-waste that means a total of 57.4 million tons are generated worldwide, and only 17.4% of these are properly collected, treated, and recycled (Mohajan, 2021a). In 2022, about 62 million tons of e-waste is generated with only 22.3% formally documented as being recycled, whose value is estimated to be $91 billion (Das et al., 2022). The quantity of it is expected to rise to 82 million tons by 2030, and 132 million tons by 2050 (PACE, 2019). The total global value is $57 billion after recycling that is higher than the gross domestic product of most low- and middle-income countries (Forti et al., 2020). Recycled metals are 2 to 10 times more energy efficient than virgin metals that accounts about 7% of the world energy consumption (Debnath et al., 2018).

The 14 October is the international e-waste day that is developed in 2018 by the WEEE Forum to raise the public profile of waste electrical and electronic equipment recycling and encourage consumers to recycle. The slogan of the day is “join the e-waste hunt: retrieve, recycle, and revive!” (Forti et al., 2020).

2. Literature Review

A literature review is considered as an overview of the previously published works, such as a book, an article or a thesis on a fixed research area (Galvan, 2015). It can ensure that a proper research question has been asked and a proper theoretical framework and research methodology has been chosen. It is a basis for research in nearly every academic field (Baglione, 2012). Muskan Jain and her coauthors have tried to present a compendium of various sources of e-waste, environmental hazards, its composition and characterization, and worldwide e-waste scenarios (Jain et al., 2023). Kang Liu and his coworkers have stated that e-waste is one of the relatively fast-growing solid waste streams, with an annual growth rate of 20-25%. They have shown that the global sustainable recycling of e-waste should be supported by regional cooperation, legislative management, technology development, and eco-friendly design, and have provided a global solution for the recycling of e-waste (Liu et al., 2023).

Devin N. Perkins and his coworkers have observed that e-waste is a rapidly growing hazard that is creating problems associated with inappropriate e-waste recycling practices. They have seen that e-waste recycling is necessary, but it should be conducted in a safe and standardized manor. They have stressed on the improving occupational conditions for all e-waste workers and striving for the eradication of child labor (Perkins et al., 2014). Rahul S. Mor and his coauthor have wanted to reveal the role of e-waste management practices for environmental sustainability and explores people awareness level about e-waste management, its generation, and primary treatment practices in educational institutions (Mor et al., 2021).

Jeffrey Hsu and his coauthors have wanted to present an overview of the key considerations related to the e-waste dilemma, and also proposes issues, challenges, and solutions to addressing the problem (Hsu et al., 2024). Sushant B. Wath and his coauthors have introduced the e-waste composition, categorization, global and Indian e-waste scenarios, prospects of recoverable, recyclable, and hazardous materials found in the e-waste, best available practices, recycling, and recovery processes followed, and their environmental and occupational hazards (Wath et al., 2010).

3. Research Methodology of the Study

Research is an academic activity and an original contribution to the existing stock of knowledge making for its advancement. It is the search for knowledge through objective and systematic method of finding a solution to a problem (Silverman, 2011). Therefore, research is the systematic method of enunciating the problem, formulating a hypothesis, collecting the data, analyzing the data and reaching certain conclusions with some theoretical formulation (Franklin, 2012). Methodology is the study of research methods to the field of inquiry for the studying philosophical discussions of background assumptions associated with a variety of meanings (Howell, 2013). Therefore, research methodology is a way of explaining how a researcher intends to carry out her research. It may be qualitative, quantitative, or a combination of the two (Berg, 2009).

4. Objective of the Study

At present the fast economic development, rapid growth of IT sectors, introduces of new advanced technologies both in the public and private sectors, and improper management, the e-waste garbage is increasing very rapidly (Jain et al., 2023). In 2022, about 62 million tons of e-waste are produced worldwide, and it is expected that e-waste production will rise to 132 million tons by 2050 (PACE, 2019). Main objective of this article is to discuss the environment pollution and health effects due to rapid generation of e-waste (Mohajan, 2018). Other minor objectives of the study are as follows:

- to highlight on the source of e-wastes,
- to focus on effects of e-wastes, and
- to discuss the management strategy of e-wastes.

5. Source of e-Wastes

E-waste is being created by a variety of sources, such as government and non-government sectors, education and laboratory sectors, research and development sectors, medical and clinical sectors, household and manufacturing sectors, etc. (Tale, 2020). The electronics industry is the largest and the fastest growing industrial sector of the world. More than 7 billion people of the world use electronic equipment for their basic needs (Arya & Kumar, 2020). Some common e-wastes are home appliances, such as microwaves, home entertainment devices, electric cookers, heaters, fans, etc. (Jain et al., 2023); communications and information technology devices, such as cell phones, smartphones, desktop computers, computer monitors, laptops, circuit boards, hard drives, etc. (Liu et al., 2023); and entertainment devices, such as DVDs, Blu-ray players, stereos, televisions, refrigerators, washing machines, air conditioners, microcomputers, range hoods, electric water heaters, gas water heaters, fax machines, cellphones, standalone telephones, printers, video game systems, etc. (Duan et al., 2016).

Some other sources of e-waste are office and medical equipment, such as copiers/printers, IT server racks, IT servers cords and cables, WiFi dongles, dialysis machines, imaging equipment phone and PBX, systems audio and video equipment network hardware, such as servers, switches, hubs, etc. (Srivastav et al., 2023), and power strips and power supplies, uninterrupted power supplies (UPS), power distribution systems (PDUs), autoclave defibrillator, etc. (Abalansa et al., 2021).

6. Effects of e-Wastes

There are over 1,000 hazardous elements and compounds that cause serious harm to the global environmental and human health (WHO, 2021). There are various harmful impacts of e-waste that are related to the human health and the environment due to the improper processing and disposal of e-waste (Singh et al., 2020). The e-waste is toxic, non-biodegradable, and accumulates in the environment, such as soil, air, water and living things. It can lead to various irreversible health effects, such as cancers, miscarriages, neurological damage, and diminished memories (WHO, 2020).

6.1 Effects in Health Sector

Improper handling of e-waste adversely affects human health. Open burning of e-waste can cause an increased risk of cancer, damage the kidneys and liver, and can cause bone loss (Mohajan, 2021b). These also create various complications, such as digestion, inhalation, and most notably skin contact concerns (Köhler & Erdmann, 2004). E-waste exposure can cause expectant mothers to have premature births and stillbirth, low weight and size babies, and can impact the child born for the rest of its life (Brune et al., 2013). The amount of e-waste has been growing continuously day by day, and posing major health problems to humans and also other animals (UNEP, 2019).

6.2 Effects in Environment Sector

The disposal of hazardous e-wastes contributes to environmental degradation. Also, the e-waste recycling procedures can damage local, regional, and even global ecological environment (Bhutta et al., 2011). Burning to recover metal from wires and cables emits brominated and chlorinated dioxins that cause air pollution (Uddin et al., 2021). In 2020, management of batteries are included in the e-waste that provides the management structures for the best practices and mitigation measures to limit impacts of battery waste (Forti, et al., 2020).

7. Management of e-Wastes

The global management and recycling of e-waste is a persistent battle that cannot be effectively solved only by relying on the management decree (Mohajan, 2015). A series of substantial interventions, international cooperation, and strong goal-oriented actions for e-waste management are necessary in this regard (Awasthi et al., 2019).

7.1 Collection of e-Wastes

In developing countries, e-waste gathering, transportation, segregation, dismantling, recycling and disposal are done manually by untrained rag collectors and laborers, with low consciousness and without sensitization (Tale, 2020). In 2019, about 53.6 million tons of e-waste was generated globally, and only 17.4% of them was collected and recycled (Forti et al., 2020).

7.2 Recycling of e-Wastes

The e-waste is highly recyclable, energy-saving, and environment friendly (Mohajan, 2021c). Safe e-waste recycling is very important for economic value as well as environmental and human health (Dave et al., 2016). The e-waste is not biodegradable, and global e-waste recycling rates are low (Baldé et al., 2017). Recycling of e-waste is a significant subject not only from the point of waste treatment but also from the recovery aspect of valuable materials (Tale, 2020). It is estimated that about 35% of e-waste is officially reported as properly collected and recycled, and most of the remaining is buried under the ground for centuries as landfill, burned or illegally traded (Treblin, 2013). Low valued glass fiber, ceramics, and concrete in e-waste will eventually end up in landfills (Shen et al., 2018).

Technology development and material recovery are extremely important links in e-waste recycling. The recycling cost of metal from e-waste is more below the mining of crude ore that is an energy-saving and environment friendly approach (Thakur & Kumar, 2020). E-waste recycling project is generating income and jobs through informal markets (Sthiannopkao & Wong, 2013). Sometimes e-waste from high-income countries is exported in low- and middle-income countries illegally for recycling due to high labor cost and harmful infection (Zhang et al., 2012). At present a huge volume of e-waste is recycling due to rapid growth rate of e-waste (Awasthi et al., 2019).

8. Conclusions

E-waste is increasing drastically, with a growth rate of 20-25% annually. It contains many hazardous constituents that may negatively impact the environment and can affect human health if not properly managed. At present e-waste pollution is a global problem, and proper e-waste management is necessary for the safety of humanity. The production of e-waste is endangering the environment and human health, and needs proper treatment to achieve environmental sustainability. The drawbacks of informal e-waste recycling procedures are not increasing elaborately. Effective waste management can reduce healthcare risks, operation costs, and the need for transport and disposal. The national and international health community, researchers, and politicians, as well as governmental and non-governmental organizations must work together to make the world e-waste free. They should provide policies for the safe, regulated, and recompensed recycling of e-waste.

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