Impacts of Electronic Wastes on Environment and Human Health

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Abstract— E-waste generated by electrical and electronic devices in huge quantities is all over the planet today, and has become a worldwide sustainability issue. E-wastes are viewed as risky, as specific elements of some electronic items contain materials that are dangerous, in regards to their density and conditions. The unsafe substance of these materials represent a danger to human health as well as the environment. Its lethal substances mixed with soil, water and air causing risky impacts the entire biodiversity either directly or indirectly. The paper is based on literature review on the contents related to the impact of electronic wastes on environment and human health. It was established that there existed immense e-waste generation with lack of proper and adequate measure to manage it. Further it was established that e-waste impacts heavily on human health as well environment.

Index Terms— E-waste, electrical and electronic equipment, EEE, environment, human health.

1 Introduction

Electronic waste, mostly referred as e-waste refers to electrical and electronic equipment (EEE) that has been disposed of by the owner as waste and has no intention of re-using it [1]. This may be a complete item or parts of the item. E-waste is also known as WEEE (Waste Electrical and Electronic Equipment), or e-scrap. It incorporates a wide variety of items; practically, any business or household item that contains hardware or electrical segments with power or battery supply [2]. According to the European Directive 2012/19/EU, the EEE has six categories; monitors and visual display units, lamps, temperature exchange tools, big equipment, small equipment e.g. household appliances, and small telecommunication and IT equipment [3].

In the recent decades, EEE has been developing exponentially in the globe while the life expectancy of these items have become shorter and shorter [4] [5]. Certainly, the quantity of electrical gadgets will keep on expanding on the worldwide scale. Subsequently, the volume of WEEE increases rapidly annually and furthermore, it is considered to be among the most crucial issues in the disposal of waste in the twenty-first century [5]. This upsurge has been enhanced by the expansive economic growth combined with urbanization that demands for more consumer goods. As a result, the consumption of EEE has increased which has as well fostered the production of e-waste [4].

The ILO [3] report indicate that the materials regarded as e-waste differs from country to country since what is considered as an e-waste in one country may not be considered as one in another country. Some countries narrowly understand e-waste as electronic waste, while others broadly put it as both electronic and electrical waste. Also, Khurrum et al. [5], [6] point out that particular parts of electronic items contain dangerous substances, which can pose as a risk not only to nature but also to human wellbeing. For example, TV and PC screens ordinarily contain dangerous materials, e.g. mercury, lead among others.

E-waste differs from other types of wastes as it contains both hazardous and valuable elements, and as a result, it needs a special type of treatment. As of 2019, e-waste was approximated to be producing 2.01 billion metric tons worldwide per year [3]. This growth has been amplified by the ever rising need for electronic and electric products. Research reports estimate that around 50 billion gadgets will access the internet by 2020. This is six times more than the total human populace in the world today. Moreover, this growing demand has aggressively been fueled by the growth of the dynamic world industry of electronics [3]. As people continue using these items, both the e-waste workers and residents are uninformed of the acute environmental and human health risks that these electrical and electronic products pose.

The e-waste recycling techniques employed are frequently crude that do not provide necessary resources to shield the ecological and workers' wellbeing. These methods include: open-pit metal stripping to retrieve gold plus other metal using acid baths, heating printed circuit boards to remove electronic components, poorly ventilated plastic chipping and melting, open air burning of unwanted materials and cables to recover metals, dumping unsalvageable materials in landfills, destroying electronic hardware, selling PC screen for retrieval of copper and toner clearing [7].

In perspective on the negative impacts of risky wastes to the environment and human wellbeing, a few nations saw the need for a worldwide consent to address the issues and difficulties presented by the dangerous waste. Additionally, towards the end of 1980s, the stiffening of ecological guidelines in industrialized nations prompted a sensational increase in the cost of disposal of hazardous waste. Scanning for less expensive approaches to dispose of the wastes, the traders started transporting unsafe waste to developing nations. The international outcry following these ill-considered exercises prompted the drafting and selection of strategic plans and guidelines at the Basel Convention. This Convention had the secretariat in Geneva Switzerland that facilitated the execution of the convention and the associated agreements. The convention also offers help and regulations on lawful and technical concerns, collects statistical information, and organizes trainings on suitable management of dangerous waste [7].

2 E-WASTE GENERATION

Individual consumers, private and public sectors contribute to the generation of e-waste with 44.7M tons of e-scrap produced globally in 2016. The Global e-waste monitor [2] explains that only 20% (about 8.9 metric tons) of 44.7Mt of e-waste were recorded to be gathered and recycled appropriately, while the remaining 80% (35.8 metric tons) were undocumented. From these 80%, 4% was disposed in residual waste in higher income nations, while the remaining 74% electronic waste was unknown and it was probably disposed, exchanged or recycled in substandard situations.

Asia recorded the highest quantity of e-waste generated in 2016 of 18.2Mt, then Europe with 12.3Mt, America with 2.2Mt and Oceania 0.7Mt. It was found out that personal consumption, public and private sectors in developed nations such as in Oceania, for instance New Zealand and Australia produce more electronic waste per occupant than developing nations. Oceania is the leading e-waste producer per inhabitant with 6% collection rate, followed by Europe with of 35%, America with 17%, Asia with 15% and Africa's collection rate information is very little[2]. However, it should be noted that only 41 nations have provided official data on electronic waste. This implies that a substantial amount of data on e-waste production, management and trading is lacking. Again, e-waste does not account for the contamination and waste produced during the extraction and/or transportation of raw materials, or during the manufacture, distribution and selling of EEE. Predictably, it is anticipated to increase to 52.2M tons by 2021 with between 3% and 4% as annual growth rate [3].

3 Impact of E-waste on Human Health

E-waste poses great dangers to human health and the surrounding. This equipment contains chemicals, hazardous elements and heavy metals [3]. Additionally, e-waste workers are directly subjected to both physical and ergonomic risks than bring about injuries that are work-related and also bad health. They are not only affected by the e-waste hazardous elements but also those substances used to extract valuable elements form it [8]. For example, workers in India are endangered by huge levels of copper, rare earth metals and silver. Also, it was discovered that Philippine workers were subjected to corrosive liquids and toxic vapors from smelting which they inhaled. These workers are not informed of the risks in the nature of their work. A research finding in Nigeria disclosed that 88% of informal workers of e-waste could not pinpoint a single chemical element in the e-waste and that only 12% had a good understanding of health risks and occupational safety [9]. Informal electronic waste recycling is undertaken in small workspaces as well as in the open air. This environment is normally substandard and cannot give the necessary occupational safety. Workers here neither have the right protective gear such as nose and face masks nor proper lighting and ventilation [8], [10].

Some of the e-wastes are dumped near residential places posing a risk to people who live nearby since they can take hazardous elements through different ways. For instance, a substance like lead is highly toxic and when taken in by children, it affects their behavioral and cognitive development like diminishing their IQ. Proper e-waste recycling services are highly expensive to install and operate making it rare in developing countries. The common dangerous chemicals present in EEE are aluminum, zinc, mercury, cadmium, nickel, lead, chromium, copper, arsenic, iron and manganese [11]. Mercury is found in flat screen monitors, fluorescent tubes etc. and its side effects entails loss of memory, sensory impairment, muscle weakness and dermatitis. Acid batteries contain Sulphur which causes harm to the vital body organs. Inhaling cadmium can not only severely damage the lungs and also kidney but also lead to deficiency neuromotor skills, and learning behavior cognitive ability in children. Lead is found in CRT monitors and lead-acid batteries. Its effects are far and wide such as impaired cognitive ability, damage to the central nervous system, reproductive system [4]. Intake of mercury causes harm to several organs such the kidney and brain [7].

The recycling process causes direct effects on workers whereas intake of polluted water or through a polluted food chain brings the indirect consequences to people. Most importantly, air is the fundamental transporter of hazardous pollutants when open burning of e-waste takes place [12]. This practices generate fumes that are so dense that it affects a wide area such that persons working and living around these areas experience problems in breathing. Imran et al. [12] point out that it is of particular concern that even underage children work in these places that operate in deplorable conditions e.g. Pakistan. In China, also children and expectant women participate by removing plastic coating to obtain wires [13]. The situation in Ghana is extreme since it is mostly children and adolescents who work in sites for periods of between 10 - 12 hours a day [14] and continuously burn cables containing PVC (Polyvinyl Chloride) [15]. Continuous and prolonged burning of e-waste is associated with cardiovascular and pulmonary diseases [16].

The buildup of toxic wastes in the environment affect the adjacent lands and rivers since water flows from polluted fields. This in the long run leads to food chain pollution with massive effects on the general population who in turn suffer from food-borne ailments. The water, air and soil are ecological components through which agricultural activities such as farming of crops, vegetables and fruits, including animal feeds thrive. What's more the toxins slow down the animal metabolic rates hence, they end piling in tissues and may eventually be excreted in products such as eggs, milk and meat [7]. Residents situated along polluted rivers draw water that they directly use for washing, cooking and drinking. This water is also used in major activities like intensive farming [10].

A research carried out in India on local residents living in and around the e-waste processing facilities found shocking levels of toxic heavy metals (Nickel, copper, Zinc, and Chromium) in their blood samples. As a consequence, the study established the significant predominance of cardiovascular disease i.e. hypertension among the local residents which was associated with the constant exposure to electronic waste. It was also concluded that some of these metals had been spread in the atmosphere hence causing air contamination [17].

4 Impact of E-waste on Environment

Environment is always the host of any waste disposed. High levels of both organic and metallic contaminants have been established in the soil, air and water. Hydrochlorofluorocarbons (HCFCs), polychlorinated biphenyls (PCBs) and polychlorinated biphenyls (PCBs) are additional risky substances in e-waste which promote toxic landfills. Plastics cater for a big proportion of the e-waste and those that are retardant can be dangerous to the environment if not properly disposed [4].

The wastes from computers are dumped as landfills which produce polluted leachates that finally contaminate the underground water. Smelting of computer chips generate sludge and acids that if left on the ground, acidifies the soil. Hong Kong's Guiyu, for instance, thrives in unlawful electronic waste recycling is having severe water shortages because of the water resources have been contaminated. In the event that these electronic things are disposed of with other family trash, the toxics represent a danger to both wellbeing and imperative parts of the environment [11].

Lead-acid batteries contain Sulphur that causes acid rain when release to the environment. The European Union banned the sale of Nickel-cadmium batteries that have at least 6-8% cadmium. This is because cadmium can seep into the soil and not only cause damage to the microorganisms, but also disrupt the ecological setup of the soil if not correctly recycled [11]. Some toxins like persistent organic pollutants are non-biodegradable hence their environmental bioaccumulation signify a long-term health risk. Subsequently, prolonged exposure of soil and water to pollution elements promotes chemical loadings that eventually result in high uptake levels of toxic substances in crops [7].

Among the informal recycling techniques is the open air burning that is used for component separation such as solder recovery and copper recovery from electric cables. Open air burning has direct ecological effect such as release of several harmful substances into the air, accumulation of pollutants on the soil and water resources [18]. The remaining ash is carried on the surface waters resulting in water pollution. For instance, a research carried out on river sediments and surface soils in Vietnam in areas around and in WEEE places found high levels of toxins of dioxin-like compounds from open burning [19]. Continuous burning of e-waste and PVC cables has an immediate environmental result such that the thick black smoke engulfs the atmosphere and takes long periods to clear [14] [15].

5 Conclusion

Changes in people's lifestyles, technological advancements, and ease of accessibility of electronic devices have prompted expanded utilization rates of electronic items. Because of high production of e-waste and the absence of proper disposal frameworks for this sort of waste, it is anticipated that such waste would have some dire consequences on human health as well as nature. In this way, it is vital that the proper mitigation measures be put in place to curb the pollution levels instigated by e-waste chemicals. Various countries have accessible standardized e-waste guidelines and regulations which can be adopted. The appropriate e-waste management will assist in proficient tracking and collection from extraction to the disposal of material, ensuring that these huge piles of e-waste transform into worthwhile items and business opportunities.

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