International Journal of Advanced Research Trends in Science 1(1):14-19

A study on the problems of e-waste generation and its effects on environment

Priyanka Bala
Kalyani Government Engineering College
University of Kalyani, Kalyani, West Bengal 741235

A B S T R A C T

Modern human being is technology dependent social entity. An increased trend in technological development renders genesis of "Waste of Electronic and Electrical Equipment (WEEE)" popular by the name of e-waste by indiscriminate use of power tools as a result of population explosion. Power purchasing mentality of technology minded human population are surprisingly enhancing WEEE production rate. Result of overuse of electronic goods may become hazardous to the nature and environment. The present study deals with the progress of research and developmental activity about e-waste and its problems and prospects in future population and environment. The study is based on a literature survey of base line information and primary data about e-waste and its effects on environment. With the advancement of online network system, electronic web products are used frequently by the society dwellers and make our society as a dumping pool of unused or damaged electronic gadgets. India, as a developing country should go through a limitations or prohibition of over exposure of electronic goods and should generate legislative limitation in over production of e-waste and public awareness development programme to save the environment from its hazards. Considering the background analysis and reviews it is obvious that the problems and challenges of e-waste in India still persist. The study recommends that the processes of e-waste management in the majority of the examined areas still need improvement.

Keywords: E-waste · Environment · Toxic metals · Harmful effect · Mass awareness

1. Introduction

We are the habitat of technologically flooded era, where electronic devices such as cell phones, computers, television, headphones, inverter, refrigerator, tabloids and many more electronic gadgets are become compulsory part of our life. Improper handling and repairing converts these electronic gadgets into unused products and are thrown away by the society dwellers to the surrounding environment. These unused devices turn into electronic waste and are collected and deposited mostly by rag pickers. Starting from an electronic chip or electronic wristwatch up to freezer machines may have the potentiality to damage the spheres of environment. Improper disposal of this e-waste may act as pollutant to the earth and biota. In our society, we are the daily users of electronic equipments and are the random producer of e-waste. None other than human being are responsible for frequent and indiscriminate generation of power waste. The critical nature and complex combination makes electronic waste tough for quantification.

The emerging business strategies of branded shops like the concept of exchange offer for new device by old one generally misleads public and attracts them to rush for massive purchasing. The old and defective devices are subjected for destruction and burning by the stakeholders for collecting old metals like gold, copper, lead etc. Improper disposal of these destroyed parts of devices remain active for spreading of pollution to air, water and soil also. Pollutants like brominated dioxins, hydrocarbon compounds and different heavy particles after combustion of plastic covers affect to air also. A bunch of heavy metals like lead (Pb), mercury (Hg), chromium (Cr), gallium (Ga), beryllium (Be), cadmium(Cd), arsenic (As) and Polyvinylchloride (PVC) are the essential ingredients of the electronic devices. National economy may have significant effect by e-waste generation and distribution. The poor countries import e-waste to recover valuable elements and metals by recycling them and pollute environment in a view of cost saving. Countries like India do not have scientific regulations and protective documentation for saving human health, restoring ecosystem and protecting environment. For formal disposal of e-waste there may have certain regulations but are not followed properly. The objective of the study is to analyze the problems related to e-waste generation and to find out their effects on environment.

2. Overview of E-waste generation and its effects on environment

The particles generated by e-waste combustion may also invade into the soil and subsoil system. As one of the non-biodegradable representatives these plastic particles and hydrocarbon together with heavy metal components leads to bio magnification in aquatic and terrestrial food chain in the environment. At present, continuous generation of e-waste as a result of population explosion is in alarming condition and may cause excessive harm to the environment and entire planet if it is delay to aware human being about its wise use. Electronic products are popular in trade market because of advanced technology application and selected mostly by the

E-mail address: Priyacse.KGP@gmail.com
Received 23 October 2022; Received in revised form 10 November 2022; Accepted 26 December 2022
Published online 27 December 2022

power purchasing consumers. Environment may be affected in every steps of power consumption starting from extraction of raw materials for production of power devices up to conversion and disposal of these unused power devices into e-waste. The terminology "Waste of Electronic and Electrical Equipment" (WEEE) or popularly termed as e-waste is usually defined as "all components, subassemblies, and consumables, which are part of the product at the time of discarding" [1].

3. Research Methods

The present study adopts a qualitative research method to investigate the issues relating to heavily e-waste generation in India from existing research over the past few years to demonstrate further research in this context. The period of electronics and virtual communication fashioned the Globe with a compact network system of connectivity. Extensive application of electronic goods saved time, manpower and economy of the community. This wideness in applicability of electronic systems may help in production, distribution, consumption, communication as well as combustion mechanism also. An electronic power device transforms into e-waste due to damage, disrupted service, and loss of longevity, obsolete techniques and negligence of consumer. Several countries like India produce huge amount of domestic e-waste for rapid consumption and purchase of cheap overseas electronic devices in present decades [2]**.** E-waste generation is increasing at a rate of 15% in India. India is generating > 60% of the electronic waste from 65 big cities of 10 states like Delhi, Gujrat, Uttar Pradesh, Maharashtra, Tamilnadu, west Bengal etc. as per Central Pollution Control Board report [3, 4].

As e-waste is a category of domestic waste, it must be subjected for landfills by the way of waste disposal. Due to partial recyclability of e-waste, it faces retrieval techniques for metal and material consumption instead of treatment prior to disposal of waste management system declining Basel Convention of waste disposition [5].

One of the major components of e-waste is PC that holds about 80% contribution from business sectors and rest about 20% is from society dwellers. A waste load of about 1050 tones enters from computer per year direct from producers and retailer shops. A huge amount of e-waste is imported yearly from developed countries to India by disobeying the global agreement [6].

Delhi is the capital of India. This is the state that is highly connected with different satellite towns around this and is treating e-waste from different small units. The recycling unites collect spare electronic goods in a rate of near 70% in New Delhi as thrown out products from developed countries. The annual production rate of e-waste generation is 12,000 tones. Delhi acts not only as generator but also as processor of electronic waste in India. Normally, there is a practice of e-waste treatment in non-licensed small units devoid of regulations, health and safety measure and awareness for environment. Unavailability of proper site, inadequacy of scientific collection and improper disposal of electronic waste gives birth to various perturbations in environment [7, 8].

The economic nervous system of India is Mumbai. The city is as popular as the first port city of India. Mumbai is the center of information technology industries and generates about 20,000 tons of e-waste annually. Among the first ten cities of India, Mumbai places first in generating WEEE. The voluminous electronic goods production industries are located in the Mumbai-Pune industrial area. The largest port city is the biggest producer and consumer in one hand and the largest exporter of foreign spare electronic products. As a result, the largest industrial belt becomes the biggest contributor of e-waste in India [9].

Bangalore is the silicon capital of India, possesses a world based multi-millions market for business. Huge amount of e-waste is collected and received in Nayandahalli and Goripalyam. Dismantled, segregated and fragmented parts of e-waste are sent by the scrap dealers regularly to Mumbai and Delhi. The amounts in lakhs are earned by the recyclers by selling and sending of dismantled parts of e-waste in Delhi. In Karnataka, there are as much as 50 legal recycling centres like M/s. E-Wardd & Co., M/s. K. G. Nandini Recyclers, M/s. Ash Recyclers, and M/s. E-R3 Solutions Pvt. Ltd., etc. The Central Pollution Control Board has already been taken initiative by the project E-Parisaraa in formal sector through all over the country [10].

The emerging silicon capital of India is Hyderabad. The pink city is the popular city for tourism favoured by the natives and foreign tourists. Hyderabad contributes e-waste about 30 lakhs MT per annum. Different electronic goods like laptops, computers, mobiles, tabs etc. from communication, T.V., refrigerator, washing machine, OTGs, meter boxes, wires, cables from households, battery, inverters etc. from establishments are the composites of e-waste. The annual production of e-waste is above 1 lakh kg in Hyderabad. The main recycling activity of Hyderabad is based on segregation of e-wastes into scrap parts after size reduction [11].

In Andhra Pradesh, there are only two formal legal recycling units viz., M/s. Earth Sense Recycle Pvt. Ltd. and M/s. Ramky E-waste. All the other productions of e-waste are contribution of illegal and informal recycling unit. The huge production of e-waste and deficiency in collection, treatment and disposal facility turns e-waste a matter of profit for scrap dealers and illegal recyclers. For the sake of profit and business and ease in recycling without registered regulations led the recyclers to favour informal unrecognised e-waste reducers in India. It is high time to take initiatives to increase registered e-waste recycling units to enact guidelines of treatments of heavy metals from it [12,13]. Rising awareness among people is currently the key to success in electronic waste management in today's society [14]. Solid waste is popularly categorised as municipal waste in global system. E-waste is the major contributor of municipal solid waste. Today, e-waste in India prevails as a significant waste stream both in terms of volume and toxicity

[15,16] creating serious waste management challenges and environmental health problems.

4. Results and Discussion

Generation of e-waste is now a days a burning issue around the globe. In the era of technological advancement, habit of electronic gadgets use is more frequent in every sector of life. In present day concern, the environment including different biotic community is also suffering from severe pollution from various sources mainly by electricity based activities. The unused and damaged parts of the power system of human community are accumulating day-by-day in the same system and act as the pollutant and causing harm to human being and other biota.

4.1 Generation and Distribution of e-waste

In India, e-waste can be generated from different sources like computer and accessories, different circuits, solar panels, glass panels, chips, conductors and semiconductors, mobiles and other phones, refrigeration system, air conditioners, microwaves, batteries *etc*. India is a highly populated developing country. The waste management system is quite different from other countries. Most of the population is economically challenged and are far away from education and awareness generation. Most of them do not know about the harmful and polluting nature of electronic waste. For collection and recycling of e-waste like other categories, there are many ways of negligence in disposal of waste parts. In this case, it is very tough to quantify and to provide exact data about e-waste generation and disposal.

4.2 Effects of e-waste on environment

As a solid waste representative, e-waste bears a variety of toxic components that are capable to show visual impact to the natural clean environment as well to health of human being and other biota. The toxic elements include heavy metals cause bioaccumulation and bio magnification in aquatic and terrestrial ecosystem.

Due to complex nature of composite blend, e-waste is difficult to handle and treatment in a single method. Casual handling, improper recycling and unscientific disposal of e-waste may pose threat to the environment as well as human health. In that case there lies an importance for adoption of advanced techniques for proper disposal of toxic elements present in e-waste. Environment encompassing us are exploited regularly by improper handling and illegal management of e-waste.

Generally, e-waste recycling sites are situated in the residential area and are generating toxic effects from e-waste components to the existing population. Layman handling of these reactive components may become hazardous to human health. Ill person and child are more susceptible to the hazardous chemicals. E-waste recycling process generally produces PCDD/Fa as a byproduct that showed potential hazardous nature to human health. A heavy metal representative of e-waste is lead that showed hazardous effect on IQ level and brain development of children [17]. There are some negative impacts of e-waste on public health due to communities are exposed to a complex mixture of toxic chemicals from different sources and through various exposure routes [18].

4.2.1 Effects on air

Atmosphere is contaminated by emission of dust particles and other toxic powders like dioxins during informal recycling of e-waste through the process of fragmentation, dismantling, segregation and thermal melting. Screening of valuable metals like copper, led etc. by thermal melting gives rise fine particles and carbon dust dispersal resulting in diverse health disease like cancer, asthma *etc*. to human being and may affect to other animals also. Removal of precious metals like gold, silver by acids and different chemicals emits harmful fumes that covers extensive areas and affects human health. Pollution in air by e-waste may results extinction and endangering of wild species of animal biodiversity for its chronic effect. Pollution of air by e-waste toxic metals may finds its entry to the water and soil system and may cause irreparable damage from bioaccumulation and bio magnification in aquatic and terrestrial ecosystem by the process of inhalation and ingestion of heavy metals. This may lead to distortion in nervous system of wild animals and human being of nearest area.

4.2.2 Effects on soil

E-waste can be toxic in nature, is not biodegradable and accumulates in the soil environment. Lack of proper disposal of electronic waste material in daily waste material dumping or illegal land filling may result in heavy metal contamination by seeping of pollutants into the ground water and cause crop destruction and contamination. Open dumping, improper handling, informal recycling and disposal of e-waste lead to contaminate soil, vegetative crops, ground water table by the leakage of heavy metals and other toxic chemicals to the environment. Lithosphere contaminated by toxic metals may cause residual effect after accumulation in plant body and may cause the soil unproductive and hazardous to health. Pollutant particles released from size reduction of e-waste may contaminate soil on the basis of their weight, soil pH, size, soil porosity, soil type *etc*. Due to their half-life, the toxic metals can stay intact in soil for long time and may pose threat to soil microbes, plants and animals.

4.2.3 Effects on water

E-waste elements like lead (Pb), barium (Ba), mercury (Hg), copper (Cu), cadmium (Cd) *etc*. find their dynamic route through contaminated soil to ground and surface water by leakage from informal dumping and improper landfills. Contamination of toxic heavy metals present

in water body may exceed safety limit for acid formation and toxicity. Death of aquatic organism and ecosystem biodiversity is the result of acidification of water body by toxic metals.

4.2.4 Effects on human

Electronic waste is a combination of diverse toxic elements starting from heavy metals to light metals that have potency to damage human health. Human health effects may range from bone damage, heart attack to brain and kidney damage resulting from e-waste toxicity. The respiratory, reproductive and nervous system may also be affected from metal toxicity.

Informal recycling and disposal without proper management system may cause serious damage to human population and environment. It is in alarming condition and it is high time to aware the waste handlers to e-cycle the electronic materials for recycling and reuse in future. Proper education and strict regulations can also grip this problem and control over the unlimited generation of e-waste and their disposal. E-waste is non-biodegradable toxic element that has the potential of bio magnification in aquatic and terrestrial ecosystem. The aim of screening of valuable metals and minerals of the recyclers leads a bunch of other hazardous substances to become exposed in the environment. Those harmful elements like PAH, PCDD, lead, mercury *etc*. are non-biodegradable and their persistence may cause harmful effects on biota.

Collection, handling and recycling of e-waste in appropriately regulated management system may increase environment protection from chemical toxicity. Child health and generation of formal digital dumpsites are now matter of concern and the concept ties the recyclers, exporters, importers and the Government of India in a frame to protect environment. It is another attempt of the Government and private sector to develop health care facility to eradicate the health issues from the hazardous effects of e-waste toxicants. According to WHO, the medical sector can rule over the issue by developing e-waste health and hazard policies over medical research and development. Children of the nation are the future and have right to learn, live and breathe in a healthy environment without pollution and over population.

4.3 Waste management system

In case of electronic waste management system, the properly obeying country is Switzerland among the world. The highly developed and technologically advanced countries like USA, UK, Germany, Europe, France etc. are the largest contributors of world's e-waste and are generating about 2 to 3 million tons of e-waste per year. Switzerland, on the other hand is maintaining e-waste management rules like Extended Producer Responsibility (EPR) and Advance Recycling Fee (ARF) properly. The legislations about e-waste production and management are active in names of the Environment protection act of India, WEEE Directives and Restriction of use of Certain Hazardous Substances (RoHS) of Europe, National Electronics Action Plan in USA etc. but are also beyond application in reality. The UNEP initiative, the Basel Convention [19] is the step to restrict the international trading of hazardous waste and in the convention, India was the participant and signatory like other countries of Asia [20,-22].

Magnified concentration of toxic elements generated from e-waste can contaminate food, water, soil and other components of environment near the recycling site or community far away from the site [17]. Persistent toxic metals and organic elements generate from e-waste are non-biodegradable, bio-magnifying and resistant materials with long half-lives. Incomplete combustion of open dumped e-waste may produce poly cyclic aromatic hydrocarbons and persistent organic pollutants [23]. Combustion of electronic materials and PVC segments may generate hydrocarbons and PAHs that may affect the environment [24]. Control on over production of e-waste and its appropriate disposal is the burning issue around the world. Improper and informal land filling of computer and other electronic wastes produce leachates that escape into the soil and water body and contaminate the aquatic ecosystem. Dismantling and melting of computer chips may cause acidification of soil due to presence of acid sludge in this process [25].

5. Conclusions and recommendations

The study revealed that the majority of the studied areas in this present study are faced with an increasing amount of e-waste. The best available practices from different countries can be adopted to have a standardized e-waste management process and place. The proper e-waste management will help efficient sourcing and collection right up to extraction and disposal of material, ensure that this huge pile up of e-waste will turn into lucrative products and business opportunity. This e-waste management should cover all round efforts ranging from technological improvement, institutional arrangement, operation plan, protective protocols for workers engaged in such units and at last education of the people at large by introducing it as part of curriculum in higher secondary education. Improper handling of e-waste can cause severe harmful effects to the environment and human health because of its toxic components. Most of the e-waste finds its way to the unorganized sector with profit as the prime motivating factor, hence technical improvements of informal recycling processes coupled with proper training in handling waste electrical and electronic equipment's has to be offered to the local industry and community so to obtain better environmental performance without sacrificing the economic and social benefits. Among awareness development and initiation of new rules for controlling generation of e-waste we should have to avoid throwing of discarded devices, initiate e-waste management assistance

camp, follow e-waste data up gradation portal, and helping the Government to control over the e-waste generation and management. E-waste should be disposed properly or recycled for future use. Considering the background analysis and reviews in the previous sections, now it is obvious that the issues/problems and challenges of e-waste in India still persist. The study recommends that e-waste management processes in the majority of the examined areas still need improvement.

Conflict of interest

The author declares that there is no conflict of interest in this manuscript.

Data availability

The author confirms that all data collected or analyzed during this study are included in this published article.

References

[1] European Commission. Waste from Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU Article 3e, 2012.

[2] Brigden K., Labunska I., Santillo D. and Johnston P. 2008 Chemical contamination at e-waste recycling and disposal sites in Accra and Korforidua, Ghana. *Greenpeace Research laboratories Technical Note*. Greenpeace International, Amsterdam, the Netherlands. 1-23. http://www.greenpeace.org/international/press/reports/chemical contamination-at-e-wa.

[3] Hazardous wastes (management and handling) rules, 1989/2000/2002. http://utrenvis.nic.in/data/hazardous%20waste%20rules%201989.pdf.

[4] MoEF Guidelines for management and handling of hazardous wastes, 2021. http://moef.gov.in/wp-content/uploads/2021/03/Handbook-on-Chemicals-Hazardous-Waste-Management-Handling-in-India-CEERANLSIU.pdf.

[5] Arya S., Gupta A. and Bhardwaj A. 2020 Behaviour of Individuals Towards E-Waste Management in India. *J Optimiz. Indus. Engin*. 13(2):239 -248. DOI: 10.22094/JOIE.2020.575925.1590.

[6] Johri R. 2008 E-Waste Implications, regulations and management in India and current global best practices. TERI Press; New Delhi. 5-19.

[7] Babu BR., Parande AK. and Basha CA. 2007 Electrical and Electronic Waste: A Global Environmental Problem. *Waste Manage. Res.* 25: 307-318. http://dx.doi.org/10.1177/0734242X07076941.

[8] Agarwal A., Singhmar A., Kulshrestha M. and Mittal AK. 2005 Municipal solid waste recycling and associated markets in Delhi, India. *Resour. Conserv. Recy.* 44 (1): 73–90. DOI:10.1016/j.resconrec.2004.09.007.

[9] Kalana JA. 2010 Electrical and Electronic Waste Management Practice by Households in Shah Alam, Selangor, Malaysia. *Int. J Env. Sc.* 1 (2): 132-144.

[10] Jegatheesan A., Rajarajan G., Ravi B. and Neelakantaprasad B. 2015 A study of L-Asparagine Doped ADP single crystals. *J Chem. Pharm. Res.* 7(3): 232-238.

[11] Gaidajis G., Angelakoglou K. and Aktsoglou D. 2010 E-waste: Environmental Problems and Current Management. *J Engin. Sci. Technol. Rev.* 3 (1): 193-199.

[12] Balakrishnan RB., Anand KP. and Chiya AB. 2007 Electrical and electronic waste: a worldwide natural issue. *Diar. Waste Admin. Res.* 25: 307-317.

[13] Yoheeswaran E. 2013 Effect of Electronic waste on Environmental & Human health-A Review. *Glob. Res. Anal*. 2(4): 105-112. Doi 10.9790/2402-10090198104.

[14] Tanskanen P. 2013 Management and recycling of electronic waste. *Acta Mater.* 61(3): 1001-1011. https://doi.org/10.1016/j.actamat.2012.11.005.

[15] Dwivedy M., Mittal RK. 2010 Future trends in computer waste generation in India. *Waste Manag.* 30: 2265–2277. DOI: 10.1016/j.wasman.2010.06.025.

[16] Niza S., Santos E., Costa I., Ribeiro P. and Ferrao P. 2014 Extended producer responsibility policy in Portugal: A strategy towards improving waste management performance. *J. Clean. Prod.* 64: 277–287. https://doi.org/10.1016/j.jclepro.2013.07.037.

[17] Liu G., Niu Z., Van Niekerk D., Xue J. and Zheng L. 2008 Polycyclic aromatic hydrocarbons (PAHs) from coal combustion: emissions, analysis, and toxicology. *Rev. of Env. Cont. Toxicol.* 192: 1–28. doi: 10.1007/978-0-387-71724-1_1.

[18] Grant K., Goldizen FC., Sly PD., Brune MN., Neira M., Van Den Berg M. and Norman RE. 2013 Health consequences of exposure to E-waste: A systematic review. *Lancet Glob. Health*. 1: 350–361. http://dx.doi.org/10.1016/ S2214-109X(13)70101-3.

[19] United Nations Environment Programme (UNEP). 1989 Basel convention on the control of transboundary movements of hazardous waste and their disposal. http://www.basel.int/Portals/4/Basel%20Convention/docs/text/BaselConventionText-e. pdf.

[20] Kumar V., Garg R., Rahman Z. and Kazmi AA. 2011 Sustainability and E-waste Management Scenario in India. *The First International Conference on Interdisciplinary Research and Development,* Thailand.

[21] Johri R. 2008 E-Waste Implications, regulations and management in India and current global best practices. TERI Press; New Delhi. 5-19.

[22] Khetriwal DS., Kraeuchi P. and Schwaninger M. 2005 A comparison of electronic waste recycling in Switzerland and in India. *J Env. Imp. Ass. Rev.* 25: 492–504.

[23] Yu XZ., Gao Y., Wu SC., Zhang HB., Cheung KC. and Wong MH. 2006 Distribution of polycyclic aromatic hydrocarbons in soils at Guiyu area of China, affected by recycling of electronic waste using primitive technologies. *Chemosph*. 65:1500-09. DOI: 10.1016/j.chemosphere.2006.04.006.

[24] Wang Y., Tian Z. and Zhu H. 2012 Polycyclic aromatic hydrocarbons (PAHs) in soils and vegetation near an e-waste recycling site in South China: concentration, distribution, source, and risk assessment. *Sci. Total Environ.* 439:187–93. https://doi.org/10.1016/j.scitotenv.2012.08.018.

[25] Jinhui L., Huabo D. and Pixing S. 2011 Heavy metal contamination of surface soil in electronic waste dismantling area: site investigation and source-apportionment analysis. *Waste Manage. Res.* 29: 727–738. doi: 10.1177/0734242X10397580.