E-WASTE: GENERATION, ENVIRONMENTAL AND HEALTH IMPACTS, RECYCLING AND STATUS OF E-WASTE LEGISLATIONS

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Abstract: E-waste comprises discarded electronic appliances. E-waste contains hazardous constituents that may negatively impact the environment and affect human health if not properly managed. E-waste also contains valuable materials that have an economic value when recycled. Unfortunately, the majority of e-waste is recycled in the unregulated informal sector and results in significant risk for toxic exposures to the recyclers, who are frequently women and children. E-waste recycling has become a hotly debated global issue. Most developed countries have in place legislation mandating electronic manufacturers and importers to take-back used electronic products.
Keywords- E-waste, electronic appliances, informal sector

1. INTRODUCTION

Electronic waste, or e-waste, is a term for electronic products that have become undesirable, outmoded or archaic, and have essentially reached the end of their advantageous life. Because of technology advances, many electronic devices become “trash” after a few short years of use. E-waste is made from something electronic: computers, TVs, monitors, cell phones, PDAs, VCRs, CD players, fax machines, printers, etc.

E-waste and Waste Electrical and Electronic Equipment (WEEE) describe discarded appliances that use electricity. E-waste describes only waste electronic goods, such as computers, televisions and cell phones, while WEEE also includes traditionally non-electronic goods such as refrigerators and ovens. E-Waste is chemically and physically distinct from other forms of domastic or industrial waste; it contains both profitable and precarious materials that require special handling and recycling methods to avert environmental contamination and injurious effects on human health. Recovering of reusable components and base materials, especially Cu and precious metals can be done by Recycling . However, due to lack of facilities, high labour charges , and resilient environmental regulations, rich countries tend not to recycle E-waste. while, it is either land filled, or rich countries exported it to poor countries, where it may be recycled using old techniques and meager regard for worker safety of environmental protection (Cobbing, 2008). Although illegal under the Basel Convention of 1992 (UNEP, 2009), E-waste exportation pursuing through deceptive operations, legal loopholes, and by countries that have not ratified the convention.

This review aims to assess the global production of E-waste, The environmental impact of the processing of different electronic waste components, recycling of e –waste, E-Waste Component and their Adverse Health Effects and Status of E-waste Legislations . The paper focuses on the physical, chemical and environmental effects of E-waste. By 2025, every year the world’s cities will produce 2.2 billion tonnes of waste, more than three times the amount composed in 2009. In the world all countries combined bring about a staggering 6.1 kilogram per inhabitant (kg/inh), of e-waste annually in 2016, compared to the 5.8 kg/inh generated in 2014. This is near to 4,500 Eiffel Towers per year. The amount of e-waste is expected to increase to 6.8 kg/inh, by 2021. Globally, only 8.9 Mt of e-waste are documented to be collected and recycled, which corresponds to 20% of all the e-waste generated. 80% (35.8 Mt) of e-waste is not documented. 4% (1.7 Mt) of e-waste within the higher financial gain countries is thrown into the residual waste. The fate of 76% (34.1 Mt) of e-waste is unknown; this is likely dumped, traded, or recycled under inferior conditions. In 2016, Asia was the region that generated far and away the biggest qauntity of e-waste (18.2 Mt), followed by Europe (12.3 Mt), the Americas (11.3 Mt), Africa (2.2 Mt), and Oceania (0.7 Mt). While the smallest in terms of total e-waste generated, Oceania was the highest generator of e-waste per inhabitant (17.3 kg/inh), with only 6% of e-waste documented to be collected and recycled. Europe is the second largest generator of e-waste per person with a mean of 16.6 kg/inh; however, Europe has the highest collection rate (35%). The Americas generate 11.6 kg/inh and collect only 17% of the e-waste generated in the countries, which is comparable to the collection rate in Asia (15%). However, Asia generates less e-waste per inhabitant (4,2 kg/inh). Africa generates only 1.9 kg/inh and little information is available on its collection rate. (Baldé, C.P, et al. 2017), (International Telecommunication Union (2017a), International Telecommunication Union (2017b).

2. AN ESTIMATION OF GLOBAL E-WASTE PRODUCTION

Table 1. Global E-waste production

Indicator	Africa	Americas	Asia	Europe	Oceania
Countries in region	53	35	49	40	13
Population in region (millions)	1,174	977	4,364	738	39
WG (kg/inh)	1.9	11.6	4.2	16.6	17.3
Indication WG (Mt)	2.2	11.3	18.2	12.3	0.7
Documented to be collected and recycled (Mt)	0.004	1.9	2.7	4.3	0.04
Collection Rate (in region)	0%	17%	15%	35%	6%

The global amount of e-waste generation in 2016 was around 44.7 million metric tonnes (Mt), or 6.1 kg per inhabitant. It is calculable that in 2017, the world e-waste generation will exceed 46 Mt. The amount of e-waste is expected to grow to 52.2 Mt in 2021, with an annual growth rate of 3 to 4%. The global quantity of e-waste in 2016 is mainly comprised of Small Equipment (16.8 Mt), Large Equipment (9.1 Mt), Temperature Exchange Equipment (7.6 Mt), and Screens (6.6 Mt). Lamps and Small IT represent a smaller share of the worldwide amount of e-waste generated in 2016, 0.7 Mt and 3.9 Mt respectively. In 2016, most of the e-waste was generated in Asia; around 18.2 Mt, or 4.2 kg per inhabitant. Approximately 2.7 Mt were documented to be collected and recycled.
Oceania generated the highest quantity for each inhabitant: 17.3 Kg/inh. However, Oceania produced the lowest quantity of e-waste in the world in 2016 at 0.7 Mt, and could only document 6% of its e-waste that was documented to be collected and recycled (43 kilotons (kt). The European continent, including Russia, generated an amount of e-waste per inhabitant comparable to Oceania (16.6 Kg/inh). In total, the e-waste generation for the whole region is 12.3 Mt. Around 4.3 Mt of e-waste was collected to be recycled in Europe, showing the highest regional collection rate of 35% compared to e-waste generated. The lowest amount of e-waste per inhabitant was generated in Africa; 1.9 kg/inh. The whole continent generated 2.2 Mt of e-waste, and with current data, only 4 kt were documented as collected and recycled; this is less than 1%. In 2016, the Americas generated 11.3 Mt of e-waste: 7 Mt for North America, 3 Mt for South America, 1.2 Mt for Central America. The whole continent generated 11.6 kg/inh. of e-waste in 2016, and roughly 1.9 Mt of e-waste documented was collected and recycled.The distinction of e-waste generated in developed versus developing countries is kind of giant. The richest country in the world in 2016 generated roughly 19.6 kg/inh, whereas the poorest generated only 0.6 kg/inh.(Baldé, C.P, et al. 2017)

3. ENVIRONMENTAL IMPACT OF THE PROCESSING ON DIFFERENT ELECTRONIC WASTE COMPONENTS

Table 2 The environmental impact of the processing of different electronic waste components

S.No.	E-Waste Component	Process Used	Potential Environmental Hazard
1.	Cathode ray tubes (used in TVs, computer monitors, ATM, video cameras,)	Breaking and removal of yoke, then dumping	Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphorous
2.	Printed circuit board	Removal of computer chips; open burning and acid baths to remove metals after chips are removed.	Tin, lead, brominated dioxin, beryllium cadmium, and mercury emissions in Air and discharge into rivers of glass dust,
3.	Chips and other gold plated components	Chemical stripping using nitric and hydrochloric acid and burning of chips	PAHs, heavy metals, brominated flame retardants discharged directly into rivers acidifying fish and flora. Tin and lead contamination of surface and groundwater. Air emissions of brominated dioxins, heavy metals, and PAHs
4.	Plastics from printers, keyboards, monitors, etc.	Shredding and low temp melting to be reused	Emissions of brominated dioxins, heavy metals, and hydrocarbons
5.	Computer wires	Open burning and stripping to remove copper	PAHs released into air, water, and soil.

(Wath, S. B., Dutt, P. S., & Chakrabarti, T. (2011).

4. POTENTIAL ENVIRONMENTAL CONTAMINANTS ASSOCIATED WITH E-WASTE

E-waste is additionally noted as as WEEE (Waste Electrical and Electronic Equipment), electronic waste or e-scrap in numerous regions and underneath different circumstances in the world. It includes a wide range of products – nearly any household or business item with electronic equipment or electrical partswith power or battery offer. (Baldé, C.P, et al. 2017), the definition of e-waste is very broad. It covers six waste categories: 1. Temperature exchange equipment, more commonly referred to as cooling and freezing equipment. Typical equipment includes refrigerators, freezers, air conditioners, heat pumps. 2. Screens, monitors. Typical equipment includes televisions, monitors, laptops, notebooks, and tablets. 3. Lamps. Typical equipment includes fluorescent lamps, high intensity discharge lamps, and LED lamps. 4. Large equipment. Typical equipment includes washing machines, clothes dryers, dish-washing machines, electric stoves, large printing machines, copying equipment, and photovoltaic panels. 5. Small equipment. Typical equipment includes vacuum cleaners, microwaves, ventilation instrumentation, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring and control instruments. 6. Small IT and telecommunication equipment. Typical equipment includes mobile phones, Global Positioning Systems (GPS), pocket calculators, routers, personal computers, printers, telephones. Each product of the six e-waste classes contains a totally different life profile profile, which means that each category has different waste quantities, economic values, as well as potential environmental and health impacts, if recycled inappropriately. Consequently, the collection and logistical processes and recycling technology differ for each category, in the same way as the consumers' attitudes when disposing of the electrical and electronic equipment also vary.

The chemical composition of E-waste varies reckoning on the age and kind of the discarded item. However, most E-waste consists of a mixture of metals, particularly Cu, Al, and Fe, attached to, covered with, or mixed with various types of plastics and ceramics (Hoffmann,1992). A discarded notebook computer with a cathode-ray tube monitor usually weighs twenty five metric weight unit and consists of metal (43.7%), plastics (23.3%), electronic components (17.3%) and glass (15%) (Berkhout and Hertin, 2004). Heavy WEEE things, such as washing machines and refrigerators, which are mostly composed of steel, may contain fewer potential environmental contaminants than lighter E-waste items, such as laptop computers, which may contain high concentrations of flame retardants and heavy metals. Virtually all E-waste contains some valuable components or base materials, especially Cu. These are environmentally necessary, because they provide an incentive for recycling, which occurs predominantly in poor countries, and may result in a human health risk or environmental pollution. Platinum group metals are included in electrical contact materials due to their high chemical stability and conductance of electricity. The precious metal concentrations in printed circuit boards is more than tenfold higher than commercially mined minerals (Betts, 2008a).
Table 2 lists the potential environmental contaminants related to E-waste. Some contaminants, like significant such as heavy metals, area unit employed in the manufacture of electronic products, whereas others, such as polycyclic aromatic hydrocarbons (PAHs) are generated by the low-temperature combustion of E-waste. The burning of insulated wire, which typically occurs in open iron barrels, generates 100 times more dioxins than burning domestic waste (Gullett et al., 2007). The concentrations of environmental contaminants found in E-waste rely on the kind of item that is discarded and the time once that item was produced. E-waste composition is spatially and temporally heterogeneous. Table 2 gives the concentrations of some components in Swiss E-waste (Morf et al., 2007). Concentrations of Cd, Cu, Ni, Pb and Zn are such that were these elements released into the environment they would pose a risk to ecosystems and human health (Wilmoth et al., 1991). Using the estimation that 20 million tonnes of E-waste are produced annually, combined with the data of Morf et al. (2007), the amounts of some potential contaminants that are contained in the annual E-waste stream have been calculated (Table 2). Although recycling may remove some contaminants, large amounts may still end up concentrated in landfills or E-waste recycling centres, where they may adversely affect human health or the environment. Some 820,000 t of Cu are included in the annual flow of E-waste. Despite utilization, it would seem E-waste is a major contributor to the some 5000 t of Cu emitted into the environment annually (Bertram et al., 2002). Polybrominated diphenyl ethers (PBDEs) are flame retardants that are mixed into plastics and components. There are no chemical bonds between the PBDEs and the plastics and therefore they may leach from the surface of E-waste components into the environment (Deng et al., 2007). PBDEs are lipophilic, resulting in their bioaccumulation in organisms and biomagnification in food chains (Deng et al., 2007). PBDEs have endocrine disrupting properties (Tseng et al., 2008). Obsolete refrigerators, freezers and air conditioning units contain ozone-depleting Chlorofluorocarbons (CFCs). These gases may escape from items disposed in landfills (Scheutz et al., 2004).

5. UNUSUAL CONTAMINANTS IN E-WASTE

E-waste could contain complicated mixtures of potential environmental contaminants that are distinct from alternative types of waste. Some potential contaminants in E-waste are uncommon, even in other contaminated sites. Examples include Li (batteries), Be (contact material), Sb (flame retardant) (Ernst et al., 2003), and Ga and In (used in Si chips and LCD monitors) (Ladou and Lovegrove, 2008).

6. CHANGING NATURE OF E-WASTE

E-waste composition is dynamic with technological development and pressure on makers from regulators and NGOs. The replacement of CRT monitors with LCD displays will reduce the concentration of lead in E-waste, as each CRT tube contains some 2 kg Pb (Puckett et al., 2005). However, LCD displays contain Hg (Mester et al., 2005), In, Sn and Zn (Li et al., 2009). Similarly, fibre optics, which may replace some Cu wires (Berkhout and Hertin, 2004), can contain F, Pb, Y and Zr (Kogo et al., 1995). Rechargeable battery composition has also changed dramatically, from old Ni–Cd, to Ni metal hydrides, to Li ion batteries. NGOs have placed pressure on manufacturers to reduce or eliminate the content of potential environmental contaminants in their merchandise. Manufacturers are competing to be seen as "green" and want to remove as many toxic chemicals from products as potential (Betts, 2008b). Many producers of electronic and electrical goods have responded to pressure from NGOs and the public and are investigating innovative ways in which to reinforce safe disposal and recycling. For example, radio frequency identification tags cost 10–20 cents and provide information about the condition and composition of computer systems and other electronics products (Betts, 2008a). Such tags can alert waste managers and recyclers to valuable components and potential environmental contaminants contained within the end-oflife product (Binder et al., 2008). Producing halogen-free components would reduce polychlorinated biphenyls (PCBs) and dioxin loadings in E-waste; however, their production is more environmentally costly (Bergendahl et al., 2004). Brominated flame retardants can be replaced with more environmentally friendly phosphorus-based retardants (Dietz et al., 2004) such as aminophenyl phosphate (Mauerer, 2005). Lead-free solder may considerably scale back the environmental burden of this toxic heavy metal (Bradley, 2003); this may be enshrined in law (Herat, 2008) in many countries. In 2003, the European Union enacted the Restriction on Hazardous

Substances Directive (RoHS), limiting the concentrations in homogeneous electronic materials of Pb, Hg, Cr (IV), polybrominated biphenyls (PBBs) and PBDEs to 1000 mg/kg, and Cd to 100 mg/kg (LaDou, 2006). RoHS was met with some resistance by manufacturers due to compliance costs and technical problems, such as the use of low-Pb solders that are prone to "tin whisker" growth (Puttlitz and Galyon, 2007).

7. THE FLUX OF THESE CONTAMINANTS ON A GLOBAL SCALE: THE FATE OF E-WASTE

Most E-waste is not recycled, because E-waste items tend to go out with household waste and receive no special treatment (Ladou and Lovegrove, 2008). Of that which is collected, some 80% is exported to poor countries (Schmidt, 2006). Electronic equipment that is no longer of use to the original purchaser may be reused, effectively extending its lifespan. Reuse is ultimately the source of some E-waste in many poor countries (Puckett et al., 2005) that accept donations of equipment considered obsolete in rich countries. Old however functional equipment is usually shipped to developing countries by well-meaning donors in the West. Unscrupulous organizations in rich countries use donations of obsolete electronic equipment as a loop-hole in the Basel Convention to export both functioning and non-functioning electronic equipment (Ladou and Lovegrove, 2008); (B.H. Robinson, 2009). Brokers who arrange the export of functioning products often pad shipping containers with irreparable waste, which may account for up to 75% of deliveries. Most of this ends up in landfills and informal dumps (Schmidt, 2006). China receives some 70% of all exported E-waste (Liu et al., 2006), while significant quantities are also exported to India, Pakistan, Vietnam, the Philippines, Malaysia, Nigeria and Ghana (Puckett et al., 2005), and possibly to Brazil and Mexico. Due to the semi-clandestine nature of these operations, the actual mass of E-waste being exported is impossible to quantify. Some 500 shipping containers filled with electronic items pass through Lagos each month (Schmidt, 2006). NGOs such as Greenpeace campaign against this "hidden flow" of E-waste (Cobbing, 2008).

8. RECYCLING

Recycling is an essential element of e-waste management. Properly administrated, it ought to greatly scale back the leak of harmful materials into the environment and mitigate against the exhaustion of natural resources. However, it does need to be encouraged by local authorities and through community education. One of the major challenges is recycling the printed circuit boards from the electronic wastes. The circuit boards contain such precious metals as gold, silver, platinum, etc. and such base metals as copper, iron, aluminum, etc. One way e-waste is processed is by melting circuit boards, burning cable sheathing to recover copper wire and open- pit acid leaching for separating metals of value.(Sthiannopkao S, Wong MH. (2012) Handling e-waste in developed and developing countries: Initiatives, practices, and consequences. Sci Total Environ. Conventional method employed is mechanical shredding and separation but the recycling efficiency is low. Alternative methods such as cryogenic decomposition have been studied for printed circuit board recycling,(Yuan, C.; Zhang, H. C.; McKenna, G.; Korzeniewski, C.; Li, J. (2007). and some other methods are still under investigation. Properly disposing of or reusing electronics can help prevent health problems, reduce greenhouse-gas emissions, and create jobs.(Fela, Jen (April 2010). Reuse and refurbishing offer a more environmentally friendly and socially conscious alternative to downcycling processes.

E-waste recycling involves the disassembly and destruction of the equipment to recover new materials (Cui and Zhang, 2008). Recycling can recover 95% of the useful materials from a computer and 45% of materials from cathode ray tube monitors (Ladou and Lovegrove, 2008). In rich countries, such as Japan, high tech recycling operations function well with little environmental impact (Aizawa et al., 2008). Modern techniques can recover high-Pb glass from discarded CRT with minimal environmental impact (Andreola et al., 2007). Any ecological benefits of recycling are more than offset if the waste has to be transported long distances due to the negative environmental effects of fossil fuel combustion (Barba-Gutierrez et al., 2008). However, recycling always has a lower ecological impact than landfilling of incinerated E-waste (Hischier et al., 2005). Mechanical separation of components is the first step in E-waste recycling. Components may be separated for reuse or metallurgical processing (He et al., 2006). This process can be automated or carried out by hand. In poor countries, there is a risk that children may be employed to separate E-waste components (Ladou and Lovegrove, 2008).

9. BENEFITS OF RECYCLING

Recycling raw materials from end-of-life electronics is the most effective solution to the growing e-waste problem. Most electronic devices contain a variety of materials, including metals that can be recovered for future uses. By activity and providing employ prospects, intact natural resources square measure preserved and air and pollution caused by risky disposal is avoided.Additionally, recycling reduces the amount of greenhouse gas emissions caused by the manufacturing of new products.

Another advantage of usage e-waste is that several of the materials is recycled and re-used once more. Materials that may be recycled embody "ferrous (iron-based) and non-ferrous metals, glass, and varied styles of plastic." "Non-ferrous metals, mainly aluminum and copper can all be re-smelted and re-manufactured. Ferrous metals such as steel and iron can be also be re-used." Due to the recent surge in popularity in 3D printing, certain 3D printers have been designed (FDM variety) to produce waste that can be easily recycled which decreases the amount of harmful pollutants in the atmosphere. The excess plastic from these printers that comes out as a byproduct can also be reused to create new 3D printed creations.

Benefits of recycling are extended when responsible recycling methods are used. In the U.S., responsible recycling aims to minimize the dangers to human health and the environment that disposed and dismantled electronics can create. Responsible recycling ensures best management practices of the electronics being recycled, worker health and safety, and consideration for the environment locally and abroad. In Europe, metals that are recycled are returned to companies of origin at a reduced cost. Through a committed recycling system, manufacturers in Japan have been pushed to make their products more sustainable. Since many companies were responsible for the recycling of their own products, this imposed responsibility on manufacturers requiring many to redesign their infrastructure. As a result, manufacturers in Japan have the added option to sell the recycled metals .(http://www.eemplindia.com)

10. THE RE-EXPORTATION OF CONTAMINANTS ASSOCIATED WITH E-WASTE

The other hidden flow E-waste recycling as conducted results in the contamination of the entire region, pervading the water, air, soil and biota contained therein. Although exports to poor countries are impossible to quantify, even a small fraction of the global E-waste stream would contribute hundreds of tonnes of Pb and several tonnes of Cd, Hg and PCBs. Therefore, other products that are manufactured in E-waste processing regions may contain elevated levels of E-waste associated contaminants. Some of these products may be consumed locally. However, others may be exported to national or international markets. Weidenhamer and Clement (2007a) found evidence that Pb from E-waste was being incorporated into Chinese-manufactured jewellery for export to the United States. Wipe tests showed that this lead was potentially available for human absorption (Weidenhamerand Clement, 2007b). Reports abound of children's toys, imported from China, which contain elevated levels of lead or brominated flame retardants (Chen et al., 2009b). Although the authors did not link the source of the contaminants to E-waste, it is conceivable that recycled materials from E-waste, which may contain PBDEs or PCBs, are used in the manufacture of products for export. Zhao et al. (2009) found that polyhalogenated aromatic hydrocarbons (PHAHs) occurred in elevated concentrations in the foodstuffs produced in an E-waste processing region in the Zhejiang province of China. Ultimately, some of these food products may be exported, posing an international health risk. Regular screening tests may not detect some of the unusual contaminants associated with E-waste. The risk of re-exportation of E-waste contaminants warrants further investigation. Fig. 1 shows the fluxes of contaminants associated with E-wastes from producers to receivers and ultimately to humans. The fluxes shown in Fig. 1 are relevant at a range of scales, both national and international. Fig. 1 shows that, potentially, E-waste may affect the whole of humanity.

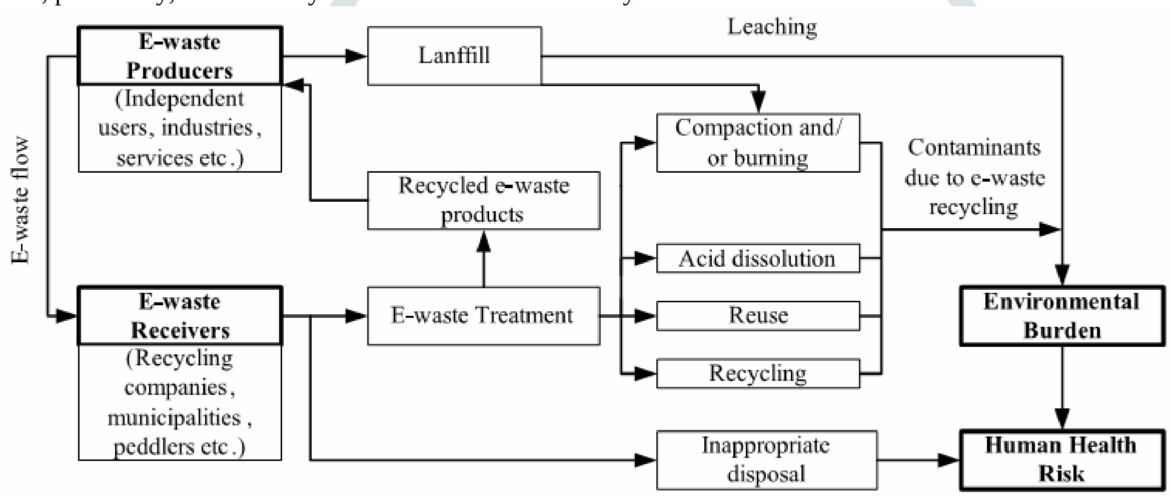

Fig 1 Fluxes of contaminants associated with E-waste

11. E-WASTE COMPONENT AND THEIR ADVERSE HEALTH EFFECTS

Table 3 E-Waste Component and their Adverse Health Effects

S.No.	E-Waste Component	Electric Appliances in which they are found	Adverse Health Effects
1.	Americium	The radioactive source in smoke alarms.	carcinogenic.
2.	Lead	Solder, CRT monitor glass, lead-acid batteries, some formulations of PVC. A typical 15-inch cathode ray tube may contain 1.5 pounds of lead,[5] but other CRTs have been estimated as having up to 8 pounds of lead.	Impaired cognitive function, behavioral disturbances, attention deficits, hyperactivity, lower IQ. (Chen, A.; et al. ,2011).
3.	Mercury	Found in fluorescent tubes (numerous applications), tilt switches (mechanical doorbells, thermostats),[92] and ccfl backlights in flat screen monitors.	Sensory impairment, dermatitis, memory loss, and muscle weakness, fetal deficits in motor function, attention, and verbal domains. (Chen, A.; et al. ,2011).
4.	Cadmium	Found in light-sensitive resistors, corrosion-resistant alloys for marine and aviation environments, and nickel-cadmium batteries.	Severe damage to the lungs and kidney. Deficits in cognition, learning, behavior, and neuromotor skills in children. (Chen, A.; et al. ,2011).
5.	Hexavalent chromium	Used in metal coatings to protect from corrosion.	A known carcinogen after occupational inhalation exposure. (Chen, A.; et al. ,2011).
6.	Sulphur	Found in lead-acid batteries.	liver damage, kidney damage, heart damage, eye and throat irritation. When released into the environment, it can create sulphuric acid through sulphur dioxide.
7.	Brominated Flame Retardants (BFRs)	Used as flame retardants in plastics in most electronics. Includes PBBs, PBDE, DecaBDE, OctaBDE, PentaBDE.	Impaired development of the nervous system, thyroid problems, liver problems. (Birnbaum, LS; Staskal, DF, 2004).
8.	Perfluorooctanoic acid (PFOA)	Found in non-stick cookware (PTFE). PFOAs are formed synthetically through environmental degradation.	Hepatotoxicity, developmental toxicity, immunotoxicity, hormonal effects and carcinogenic effects. (Wu, K.; et al. 2012).
9.	Beryllium oxide	Filler in some thermal interface materials such as thermal grease used on heatsinks for CPUs and power transistors, magnetrons, X-ray-transparent ceramic windows, heat transfer fins in vacuum tubes, and gas lasers.	Lung cancer, other common adverse health effects are beryllium sensitization, chronic beryllium disease, and acute beryllium disease. (Grant, K et al; 2013). "

12. STATUS OF E-WASTE LEGISLATIONS

When establishing a new e-waste take-back and recycling system, it is vital to consider who will retain overall control and ultimately be responsible for the successful operation of the system. An entity must therefore be responsible for coordinating the specific actions of the stakeholders who have various roles and responsibilities within the system. In addition, an entity must also ensure that the system rules are enforced and compliance is ensured.

National e-waste policies and legislation play an important role because they set standards and controls to govern the actions of stakeholders who are associated with e-waste in the public and private spheres. Moreover, these policies and legislation shall frame the setting of a workable and fair financial and economic model, which must be sustainable and function properly. It is therefore vital that policymakers, together with stakeholders, establish a financial model to cover the collection sites and logistics along with the physical recycling itself. In addition, there is the need to raise awareness of the proposed system, and ensure that stakeholders are complying with their obligations, as well as setting up IT systems to receive and process the data.

Additionally, the types of e-waste covered by legislation differs considerably across the countries. This also explains the difficulties in coordinating collected and recycled e-waste amounts. Many of the countries that have already adopted e-waste legislation can still increase the coverage to include all products. For example, in the US, the consumer electronic products included in the EPA report series are electronic products used in residences and commercial establishments such as businesses and institutions, and are categorized as video, audio, and information products (U.S. Environmental Protection Agency, 2016). Therefore, many electric and electronic appliances are out of scope in the USA, such as all cooling and freezing equipment, most large equipment like dishwashers, dryers etc, some small equipment and lamps.

13. CONCLUSION

E-waste is a serious problem at both local and global scales. It is characterised by its unusual chemical composition and the difficulties associated with determining its mass and flux. E-waste problems appeared initially in developed countries and now extend widely to other countries around the world. Contamination associated with E-waste has already caused considerable environmental degradation in poor countries and negatively affected the health of the people who live there. The volume of e-waste is growing fast because consumer technology is rapidly changing and the innovation of technology results in rapid obsolescence, thus generating massive amounts of e-waste. E-waste consists of many different materials, some of which contain a variety of toxic substances that can contaminate the environment and threaten human health, if the end-of-life management is not meticulously managed.

Cleansing of such large contaminated sites is probably unfeasible, since they have been heavily contaminated with numerous contaminants, many of which are poorly studied. However, the negative effects of the contaminants at these sites may be reduced using standard remediation technologies. There is limited knowledge on the ecological effects, human health risks and remediation options for some E-waste contaminants, such as Li and Sb, since they are not normally environmental pollutants. Rich countries have self-interest in mitigating the negative environmental effects of E-waste because it will negatively affect the quality and quantity of food and manufactured goods that are imported from poor countries.

List of abbreviations
CFC Chlorofluorocarbon
CRT Cathode Ray Tube
GDP Gross Domestic Product
LCD Liquid Crystal Display
NGO Non Governmental Organisation
PAH polycyclic aromatic hydrocarbon
PBB polybrominated biphenyl
PBDE polybrominated diphenyl ether
PCB polychlorinated biphenyl
PCDD polychlronated dibenzo-p-dioxin
PCDF polychlronated dibenzofuran
PHAH polyhalogenated aromatic hydrocarbon
PPP Purchasing Power Parity
RoHS Restriction on Hazardous Substances Directive
TCLP Toxicity Characteristic Leaching Procedure
UNEP United Nations Environment Programme
WEEE Waste Electrical and Electronic Equipment

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