E-Waste Management and its Consequences: A Literature Review

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Abstract

Central issue of the present study is electronic-waste (e-waste) that is rising as a brand new environmental challenge for twenty first century. The rapid climb of the electronic and IT trade, gift client culture, increasing rates of consumption of electronic product have lead to fateful environmental consequences. E-waste, while recycling, is also risky due to toxicity of a number of the substances which contains several cancer-causing agents. The implications and toxicity is thanks to discharge of lead, mercury, cadmium, metallic element and alternative virulent substances. Developed countries export this waste within the type of donation to developing countries. China and some Asian nations, where environmental standards are low, are the most important recipients of e-waste which, in most cases, is processed illicitly. The environmental burden of e-waste is born by people that sleep in developing countries. Despite varied laws and directives in developed countries, the e-waste management is uncontrollable. The current study focuses on the effect of usage, marketing and use of the electronic waste on the natural setting.

Key Words: *E-waste, environmental challenges, e-Electronic Scraps, e–waste management*

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INTRODUCTION

"Electronic waste" could also be outlined as discarded computers, workplace equipment, diversion device natural philosophy, mobile phones, TV sets, and refrigerators. This includes used natural philosophy that are destined for use, resale, salvage, recycling, or disposal. Others are re-usables (working and fixable electronics) and secondary scrap (copper, steel, plastic, etc.) to be "commodities", and reserve the term "waste" for residue or material that is drop by the client instead of recycled, as well as residue from use and utilization operations. as a result of many surplus natural philosophy are oftentimes commingled (good, recyclable, and non-recyclable), many public policy advocates apply the term "e-waste" broadly speaking to any or all surplus natural philosophy. Electron beam tubes (CRTs) are thought-about one in all the toughest varieties to recycle.

Sources of E-Waste:

Table 1: Effects of E-Waste constituent on health

Source of e-wastes	Constituent	Health effects
Solder in printed circuit boards, glass panels and gaskets in computer monitors	Lead (PB)	• Damage to central and peripheral nervous systems, blood systems and kidney damage. • Affects brain development of children.
Chip resistors and semiconductors	Cadmium (CD)	• Toxic irreversible effects on human health. • Accumulates in kidney and liver. • Causes neural damage. • Teratogenic.
Relays and switches, printed circuit boards	Mercury (Hg)	• Chronic damage to the brain. • Respiratory and skin disorders due to bioaccumulation in fishes.
Corrosion protection of untreated and galvanized steel plates, decorator or hardner for steel housings	Hexavalent chromium (Cr) VI	• Asthmatic bronchitis. • DNA damage.
Cabling and computer housing	Plastics including PVC	Burning produces dioxin. It causes • Reproductive and developmental problems;

		• Immune system damage; • Interfere with regulatory hormones
Plastic housing of electronic equipments and circuit boards.	Brominated flame retardants (BFR)	• Disrupts endocrine system functions
Front panel of CRTs	Barium (Ba)	Short term exposure causes: • Muscle weakness; • Damage to heart, liver and spleen.
Motherboard	Beryllium (Be)	• Carcinogenic (lung cancer) • Inhalation of fumes and dust. Causes chronic beryllium disease or beryllicosis. • Skin diseases such as warts.

MANAGEMENT OF E -WASTE

Because of uncertainty of the ways to manage, electronic junks lie unattended in homes, offices, warehouses etc. and its commonly mixed with family wastes, that are finally disposed off at landfills. This necessitates implementable management measures. In industries management of e-waste ought to begin at the purpose of generation. This will be done by waste step-down techniques and by property product style (Ramachandra T.V. & Saira Varghese K., 2004). Waste step-down in industries involves adopting:

- Inventory Management,
- Production-Process Modification,
- Volume Reduction,
- Recovery and Utilise.

Inventory management

Proper management over the materials employed in producing method is a crucial thanks to cut back waste generation (Freeman, 1989). By reducing each, the number of venturous materials employed in the method and also the amount of excess raw materials available, the amount of waste generated will be reduced. This could be tired 2 ways i.e. establishing material-purchase review and management procedures and inventory pursuit system.

Developing review procedures for all material purchased is the initiative in establishing a listing management program. Procedures ought to need that each material should be approved before purchase. Within the approval method, all production materials area unit evaluated to look at, whether they contain venturous constituents or various hazardous materials area unit obtainable.

Another inventory management procedure for waste reduction is to confirm that only required amount of a fabric is ordered. This can need the institution of a strict inventory pursuit system. Purchase procedures should be enforced to make sure that materials area unit ordered solely associate with need basis.

Production-process modification

Changes should be created within the production method, which can scale back waste generation. This reduction is accomplished by a lot of economical use of input materials within the production method. Potential waste reduction techniques are weakened into 3 categories:

- Improved operational and maintenance procedures,
- Material amendment and
- Process-equipment modification.

Improvements within the operation and maintenance of method instrumentality may result in vital waste reduction. This will be accomplished by reviewing current operational procedures and examination of the assembly method for methods to boost its potency. Instituting normal operation procedures will optimise the employment of raw materials within the production method and scale back the potential for materials to be lost through leaks and spills. A strict maintenance program, that stresses corrective maintenance, will scale back waste generation caused by failure. Nursing employee-training program may be a key component of any waste reduction program. Training ought to embrace correct operational and handling procedures, correct instrumentality use, counselled maintenance and examination schedules, correct method management specifications and correct management of waste materials.

Hazardous materials utilized in either a product formulation or a production method should be replaced with a less dangerous or non-hazardous material. Implementation of this waste -reduction technique might require just some minor changes or it should need intensive new

method instrumentality. As an example, a printed circuit manufacturer will replace solvent-based product with water-based flux and at the same time replace solvent vapor degreaser with detergent elements washer.

Volume Reduction

Volume reduction includes those techniques that take away the venturesome portion of a waste from a non-hazardous portion. These techniques area unit typically to scale back the quantity, and therefore the value of eliminating a waste product. The techniques that may be wont to cut back waste-stream volume may be divided into two general categories: supply segregation and waste concentration. Segregation of wastes is in several cases an easy and economical technique for waste reduction. Wastes containing differing types of metals may be treated one by one so the metal worth within the sludge may be recovered. Concentration of a waste stream might increase the probability that the fabric may be recycled or reused.

Recovery and use

This technique might eliminate waste disposal prices, scale back staple prices and supply financial gain from a in demand waste. Waste is recovered on-the-scene, or at an off-site recovery facility, or through put down trade exchange. Variety of physical and chemical techniques like reverse diffusion, electrolysis, condensation, electrolytic recovery, filtration, activity etc are accessible to reclaim a stuff. As an example, a printed-circuit board manufacturer will use electrolytic recovery to reclaim metals from copper and tin-lead plating bathtub. However, usage of risky merchandise has very little environmental profit if it merely moves the hazards into secondary merchandise, that eventually ought to be disposed of. Unless the goal is to revamp the merchandise to use non-hazardous materials, such usage may be a false resolution.

SUSTAINABLE PRODUCT STYLE

Minimization of venturous wastes ought to be at product style stage itself keeping in mind the subsequent factors.

Rethink the merchandise design: Efforts ought to be created to style a product with fewer amounts of venturous materials. For instance, the efforts to scale back material use area unit

mirrored in some new PC styles that area unit blandish, lighter and a lot of integration. Alternative firms propose centralized networks almost like the phone system.

Use of renewable materials and energy: Bio-based plastics created with plant-based chemicals or plant-produced polymers instead of petro-chemicals. Bio-based toners, glues and inks area unit is used a lot of times. Star computers additionally exist however, they are presently terribly expensive.

Use of non-renewable materials that area unit safer: As a result of several of the materials used area unit non-renewable, designers might make sure that the product is made for re-use, repair and/or upgradeability. Some PC makers like holler and entryway lease out their product thereby guarantee to get them back for additional upgrade and lease out once more.

LITERATURE REVIEW

In a study by Jalal Uddin (2012), Through innovative changes in product style below EXTENDED PRODUCER RESPONSIBILITY (ERP), use of environmentally friendly substitutes for dangerous substances, these impacts can be mitigated. A legal framework must be there for imposing EPR, RoHS for attaining this goal. Adoption of environmentally sound technologies for usage and employ of e-waste at the side of EPR and RoHS offers workable answer for environmentally sound management of e-waste. Manufacturers & suppliers need to set goals for reducing electronic waste. Encourage them to buy back old electronic products from consumers, disposing bulk e-waste only through authorized recyclers and send non tradable e-waste to authorized private developers for final disposal.

According to Vijay N. Bhoi *et al.* (2014), most of the waste is inherently dangerous. It will degrade to provide leachate, which can contaminate water, and make lowland gas, that is explosive. Additionally, owing to the risks related to lowland sites, there are currently terribly strict needs on the development, operation and medical care of such sites. Most designing authorities desire a figured out quarry to be used for landscaping instead of a lowland web site that nobody desires in their "back yard". Product style should be used to assist to reduce not solely the character and quantity of waste, however conjointly to maximise end-of-life utilization. Makers, retailers, users, and disposers ought to share responsibility for reducing

the environmental impacts of merchandise. A product-centred approach ought to be adopted to preserve and shield setting.

Kuehr and Williams (2003) stated that an increasing market for reused PCs in developing countries is allowing people to own PCs and access technology at more affordable prices. Moreover, charitable organizations, such as Computer Mentor, Computer Aid, World Computer Exchange, Computers for Schools and others are expanding their boundaries and providing used and refurbished computers to organizations (e.g., schools) around the world. Furthermore, reuse also reduces the environmental impacts of technological artifacts by increasing their life spans and thereby reducing the demand for new equipment.

Ramzy Kahhat, *et al.*, (2008) stated in his article that some states are adopting e-waste regulations, but so far the U.S. does not have a federal regulation that addresses the complete e-waste situation, including residential and non-residential sectors. Federal level policies and regulations present the best way to address the e-waste situation (U.S. GAO, 2005) as they will overcome the lack of regulations in most states and will standardize regulations and policies in the country. This will create a more efficient national e-waste management system. In this scenario, the e-Market for returned deposit system will be the mechanism for residential customers to dispose of their devices in a way that motivates collection, recycle and reuse of e-waste.

In a 2011 report, "Ghana E-Waste Country Assessment", found that of 215,000 tons of electronics imported to Ghana, 30% were brand new and 70% were used. Of the used product, the study concluded that 15% was not reused and was scrapped or discarded.

Sivakumaran Sivaramanan (2013) confirmed that the public awareness and cooperation of manufactures are essential for the advancement of e-waste management system. And also it is the responsibility of government to allocate sufficient grants and protecting the internationally agreed environmental legislations within their borders. Licensing of certification like estewardship may ensure the security to prevent illegal smugglers and handlers of e-waste. As e-wastes are the known major source of heavy metals, hazardous chemicals and carcinogens, certainly diseases related to skin, respiratory, intestinal, immune, and endocrine and nervous systems including cancers can be prevented by proper management and disposal of e-waste.

According to Peeranart Kiddee *et al.* (2013) e-waste can be managed by developing eco-design devices, properly collecting e-waste, recover and recycle material by safe methods, dispose of e-waste by suitable techniques, forbid the transfer of used electronic devices to developing countries, and raise awareness of the impact of e-waste. No single tool is adequate but together they can complement each other to solve this issue. A national scheme such as EPR is a good policy in solving the growing e-waste problems.

Yamini Gupt & Samraj Sahay (2015) suggested that financial responsibility of the producers and separate collecting and recycling agencies contribute significantly to the success of the extended producer responsibility-based environmental policies. Regulatory provisions, take-back responsibility and financial flow come out to be the three most important aspects of the extended producer responsibility. Presence of informal sector had a negative impact on the regulatory provisions.

In Sukeshini Jadhav (2013) observed that proper e waste management will help efficient sourcing and collection right upto extraction and disposal of material, ensuring that e-waste will turn into lucrative products and business opportunity. The manufacturers have to take responsibility for adopting the guideline for manufacturing sound environment product and sustainability management should be started from the product manufacturing stage i.e raw material selection, product and process design can be the important factors for the designed for environment practices, which can facilitate the recycling and reuse. Manufacturer should also try and initiate a take back program to handle the waste so that proper management and disposal of e-waste can be done. This way as 60% e-waste is coming from industry, can contribute to a very large part of Electronic waste management collection and establishing clean e-waste channels.

UNEP (2010) report predicts that by 2020, E-waste from old computers in India will increase to 500%; from discarded mobile phones will be about 18 times high; from televisions will be 1.5 to 2 times higher; from discarded refrigerators will double or triple; than its respective 2007 levels. Considering the growth rate, studies show that the volume of E-waste will reach nearly 2 million MT by 2025.

Samarkoon M.B. (2014) in his study states that improper handling of e-waste can cause harm to the environment and human health because of its toxic components. Although the current

emphasis is on end-of-life management of e-waste activities, such as reuse, servicing, remanufacturing, recycling and disposal, upstream reduction of e-waste generation through green design and cleaner production must be introduced to enhance a sustainable e-waste management system for Sri Lanka.

Xinwen Chi *et al.* (2010) in their study gathered information on informal e-waste management, in China and identifies some of the main difficulties of the current Chinese approach. Informal e-waste recycling is not only associated with serious environmental and health impacts, but also the supply deficiency of formal recyclers and the safety problems of remanufactured electronic products. Experiences already show that simply prohibiting or competing with the informal collectors and informal recyclers is not an effective solution. New formal e-waste recycling systems should take existing informal sectors into account, and more policies need to be made to improve recycling rates, working conditions and the efficiency of involved informal players. A key issue for China's e-waste management is how to set up incentives for informal recyclers so as to reduce improper recycling activities and to divert more e-waste flow into the formal recycling sector.

Shubham Gupta *et al.* (2014) studied that in developing countries like India, China, Indonesia, Brazil, commercial organizations tend to focus more on economic aspects rather than environmental regulations of e- waste recycling. So, for the profitable recovery of reusable materials and sustainable environment, the efficient recycling of this waste has been rendered indispensable, and is considered as a challenge for today's society.

Sikdar & Vaniya (2014) in their research stated that government should introduce some topics related to disposal of e-waste materials and its recycling and adverse effects of e-waste on health of human body in Environmental Education as a compulsory subject from lower to higher grades. The researcher realized recently that the education system alone is a powerful medium to ensure environmental protection. It should reach most parts of the population at a young age, and more e-waste friendly behavior should be practiced on daily basis.

Binegde *et al.*. (2015) studied that the repair shops of electronic goods of the study area contributed an important role in extending the life span of electronic goods and thus reduce the number of thrown away e-goods. The study indicated that the high repair cost of the electronic goods and availability of comparatively cheaper new electronic goods with more

features attracts the consumers towards the throw away culture, leading to accumulation of obsolete electronic items. Strengthening of formal recycling of e-waste is very essential for attaining sustainable development.

According to Norazli Othman (2015) the quantity of electronic wastes can be controlled if there is a sustainable integrated technique in managing the electronic waste. Sustainable integrated technique should consider electronic wastes management from the production until its disposal point. Implementation of new Legislation and Act should also be considered by the authority as to develop human capital in managing electronic waste. The combination of human capital with a sustainable technique for managing electronic waste will lead to efficiency in managing electronic wastes in the future.

Hassan Taghipour *et al.* (2012) suggested that a policy should be framed extending producer responsibility (EPR) programme in combination with a training programme at different levels of society. An approach consisting of a mandated product take back is proposed for implementing EPR in Iran. Meanwhile, the Health Ministry and the Environmental Protection Agency should strictly supervise E-waste collection, storage, and recycling and/or disposal, and the Trade and Industry Ministries must have more control over the import and production of electronic goods.

CONCLUSION

The paper aims to define and analyze the main areas of research on electrical and electronic waste, while offering a broader analysis of the relevant literature in order to summarize the information available and to create common knowledge. Based on this few key points were observed. Firstly, many countries don't have any standardized method to estimate e-waste generation. Further, there is a need to implement and frame polices for proper e-waste management in developing countries so as to solve environmental issues related to informal recycling practice. There is a need for developing a legal framework for the management of this waste fraction is one of the challenges for the policy makers in developing countries. Awareness programs should be generated and training should be provided in handling e-waste.

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