The Future of Electronic Waste Recycling

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Abstract

E- Waste or electronic waste refers to all waste formed by electronic devices such as computer, laptop, refrigerator, Smartphone etc. All these are discarded by the owner & thrown as waste. E- Waste causes E-pollution. There are many harmful materials like lead, barium. It can be prevented by 3R (reduce, reuse, recycle).

Recycling is a process where equipment is reverted to a raw material form. Part of this evolution has involved greater diversion of electronic waste from energy-intensive down-cycling processes (e.g., conventional recycling), This recycling is done by sorting, dismantling, and recovery of valuable materials. The environmental and social benefits of reuse include diminished demand for new products and virgin raw materials many company offer recycling of their product nowadays. This business is developing rapidly on large scale.

The aim of this concept review paper is to study, analyse, discuss existing E-waste recycling methodologies and conceptualize and propose some new approaches for recycling 100% of e-waste.

Keywords: *Waste, Recovery, Recycling, Pollution, Social benefit etc.*

INTRODUCTION

E-Waste refers to any discarded waste electrical or electronic equipment – basically anything that has a plug or runs on batteries. It includes all mobile phones, laptops, PCs, TVs and other electronic devices that have reached the end of their useful lives. Faster obsolescence and subsequent up-gradation, new electronic products are forcing consumers to discard old products, which in turn accumulate huge amounts of e-waste. E-waste contains hazardous materials such as brominated flame-retardants, PVCs and heavy metals like lead, cadmium and mercury, which are known to cause harm to the environment and human lives.

Hazardous substances are contained within components such as printed circuit boards(PCB), cables, wiring, plastics, casings, displays monitors, cathode ray tubes (CRT), batteries, capacitors, resistors, relays and connectors and so on the landfilling of these hazardous materials risks the leaching of heavy metals like lead, cadmium and mercury into ground water or evaporation of mercury into air. The E-waste is growing at an unsustainable rate and is the most toxic component of municipal waste.

Informal processing of electronic waste in developing countries may cause serious health and pollution problems, as these countries have limited regulatory oversight of e-waste processing. Even in developed countries recycling and disposal of e-waste may involve significant risk to workers and communities and great care must be taken to avoid unsafe exposure in recycling operations and leaking of materials such as heavy metals from landfills and incinerator ashes.

RECYCLING

Recycling is a process to change waste materials into new products to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from landfilling) by reducing the need for "conventional" waste disposal, and lower greenhouse gas emissions as compared to plastic production. Recycling is a key component of modern waste reduction and is the third component of the Reduce, Reuse and Recycle.

Audio visual components, televisions, VCRs, stereo equipment, mobile phones, other handheld devices, and computer

components contain valuable elements and substances suitable for reclamation, including lead, copper, and gold.

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, aluminium, 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. 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, and some other methods are still under investigation.

REASONS FOR RECYCLING E-WASTE

The driving forces behind recycling e-waste are economic, environmental, public health and datasecurity. A description of these factors can be found below:

Data Security Factors

Privacy protection concerns have also fueled the processing of electronic waste. Confidential and personal data must be destroyed properly in order to ensure the safety of organizations and individuals information.

Economic Factors

Electronic devices contain up to 60 different elements, many of which are valuable, such as precious and special metals, and some of which are hazardous. Precious metals are rare, naturally occurring metallic elements which traditionally have a higher melting point, and are more ductile than other metals. They have a high economic value, as demonstrated by the two most well-known precious metals; gold and silver.

Special metals include nickel, nickel base alloys, cobalt base alloys, titanium and titanium base alloys. Electronic equipment is a primary consumer of precious and special metals and therefore it is imperative that a circular flow is established in order to recover these metals and valuable elements. Investments are being made to treat e-scrap and reclaim the valuable metals, especially as raw materials become more scarce and expensive.

Environmental/Resource Factors

In addition to recovering precious metals, recycling electronics also reduces the environmental impact associated with primary production of electronic products. The primary production of precious and special metals, including energy intensive stages such as mining and smelting, has a significant impact on carbon dioxide emissions. Reuse and recovery of electronics reduces the environmental impact of these products, as well as the impact from primary production of metals and fractions found in electronics.

Public Health Factors

Discarded electronics contain a variety of toxic metals, including lead, cadmium, mercury, chromium, and polyvinyl chlorides, and thus the disposal of electronics poses a significant environmental and health risk when not properly handled. Although e-waste represents less than 2% of landfill mass, it contains 70% of the hazardous waste in heavy metals (Jiang et al). The following hazardous components can be found in e-waste.

METHODOLOGY

The first step in applying any approach and methodology is to establish the geographical boundaries of the study area. The study area included the state boundaries of Delhi, consisting of municipal boundaries, rural and urban areas, and selected areas of the NCR. The geographical boundaries were fixed considering the location of organized and unorganized markets, places where each item is unloaded, traded, transported, dismantled, recycled, reused, repaired, processed, and disposed of, starting from generation/production to its final end of life. These places were identified through a transect walk and preliminary surveys in the study area.

The EPA's most recent e-waste report shows that we got rid of (we trashed or recycled) 142,000 computers and over 416,000 mobile devices EVERY DAY!!

We generated over 3.4 million tons of e-waste in the U.S. in 2012

In 2012, we generated 3.412 million tons of e-waste in the U.S. Of this amount, only 1 million tons or 29.2 % was recycled, according to the EPA (up from 25% in 2011). The rest was trashed – in landfills or incinerators.

	2000	2005	2007	2009	2010	2011	2012
Total e-waste generated	1,900,000	2,630,000	3,010,000	3,190,000	3,320,000	3,410,000	3,420,000
E-waste trashed	1,710,000	2,270,000	2,460,000	2,590,000	2,670,000	2,560,000	2,420,000
E-waste recycled	190,000	360,000	550,000	600,000	650,000	850,000	1,000,000
Percent Recycled	10.0%	13.7%	18.3%	18.8%	19.6%	24.9%	29.20%

Figure: 1

BENEFITS OF RECYCLING

At least eight categories of benefits result from the recycling of solid waste.

Recycling

1. Reduces the need for new landfills,
2. Prevents emissions of many air and water pollutants,
3. Saves energy,
4. Supplies valuable raw materials to industry,
5. Creates jobs,
6. Reduces greenhouse gas emissions,
7. Stimulates the development of greener technologies,
8. Conserves resources for our children's future.

The traditional waste management system, involving garbage collection followed by landfilling or incineration, creates relatively few jobs. While no nationwide estimates of job creation are available, some local studies have found substantial impacts from recycling.

FUTURE SCOPE FOR RECYCLING

Future scope exists for further research for identification of comprehensive machinery and methodology for small scale industrial set up for effective e-waste recycling for environment pollution control. Scope also exists for development of suitable machinery and new extraction techniques for E-waste recycling.

The Future of E-Waste

One thing is certain electronic waste is with us to stay. And it's likely to continue increasing in volume. A serious challenge we are facing is that refurbishing and reuse of E-waste. These items will eventually be unusable, and it will be important to have programs in place that divert this waste from landfills.

The key to avoid becoming buried under mountains of discarded computers, PCB, and televisions is the development of viable markets for recycling this type of waste. The markets need to be broadly based so that people can get their electronic waste delivered to the market. What we are likely to see in the future of e-waste would be an increase in the number of businesses that will refurbish and recycle electronic equipment.

This will help keep more equipment in continued use, and out of landfills. Additional take back programs by electronic equipment manufacturers; and Greater use of alternative products, such as LCD panels and plasma screens for televisions and computers. These items contain little or no hazardous material.

Amount of E-waste Generated

Whether trashed or recycled, Amount of E-waste Generated.

E-Waste by the Ton in 2010 – Was it trashed or Recycled

(According to the EPA)

Table: 1

Products	**Total disposed****	**Trashed**	**Recycled**	**Recycling Rate**
	tons	tons	tons	%
Computers	423,000	255,000	168,000	40%
Monitors	595,000	401,000	194,000	33%
Hardcopy devices	290,000	193,000	97,000	33%

Keyboards and Mice	67,800	61,400	6,460	10%
Televisions	1,040	864,000	181,000	17%
Mobile devices	19,500	17,200	2,240	11%
TV peripherals*	Not included	Not included	Not included	Not included
Total (in tons)	2,440,000	1,790,000	649,000	27%

E-Waste by the UNIT in 2010 – Was it Trashed or Recycled (Same report as above, but reported in UNITs, not by TONS)

Table: 2

Products	**Total disposed****	**Trashed**	**Recycled**	**Recycling Rate**
	Units	Units	Units	%
Computers	51,900,000	31,300,000	20,600,000	40%
Monitors	35,800,000	24,100,000	11,700,000	33%
Hardcopy devices	33,600,000	22,400,000	11,200,000	33%
Keyboards and Mice	82,200,000	74,400,000	7,830,000	10%
Televisions	28,500,000	23,600,000	4,940,000	17%
Mobile devices	152,000,000	135,000,000	17,400,000	11%
TV peripherals*	Not included	Not included	Not included	Not included
Total (in units_	384,000,000	310,000,000	73,700,000	19%

What's included here?

Computer products include CPUs, desktops and portables.

Hard copy devices are printers, digital copiers, scanners, multi-functions and faxes.

Mobile devices are cell phones, personal digital assistants (PDAs), smartphones, and pagers

*Study did not include a large category of e-waste: TV peripherals, such as

VCRs, DVD players, DVRs, cable/satellite receivers, converter boxes, game consoles

**"Disposed" means going into trash or recycling these totals don't include products that are no longer used, but which are still stored in homes and offices.

Source: EPA 1

In Kota city every day 14.5 Tons of e waste is collected in which 10 Tons is plastic and rest 4.5 ton is Hardware part.

Source: Bajaj kata near Dakanya station road no.1, January 2015.

CONCLUSION

The following points needed to be driven for protection of eco friendliness of E-waste recycling proposal suggested in this review paper.

- E-product manufacturers that offer "take back" programs must be preferred.
- Setting up of chain of ancillary and small scale industrial belt to ensure prevention of discarded e-waste into the environment and society. At the same time entire e-waste is recycled for reuse which will be a profit making venture through employment generation.
- Government must promote businesses that accept obsolete or unwanted electronic equipment for refurbishing and reuse, or recycling of components if the equipment is no longer useable, and
- Extended producer responsibility must be encouraged whereby those who produce e-devices are responsible and to

give helping hand for the setting up of ancillary industrial set up.

- Donate computers and televisions tonon-profit organizations for use or resale.

- Consumers also have to compromise on performance factor.

- A strong standard legislation is required to be imposed on all concerned agencies.

- The government must make sure that strict laws are not only made but implemented & defaulter should be held accountable & punished according.

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