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RESEARCH ARTICLE

RECYCLING OF ELECTRONIC WASTE : A POTENTIAL, ROUTE FOR VALUE ADDED FUTURE

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ABSTRACT

Tremendous growth of electronic industry, consumer culture, increasing rates of consumption of electronic devices has sharp rise in the volume of waste that these products generate at the end of their useful life. The problem of electronic waste (e-waste) is growing at an unsustainable rate. E-waste is now the fastest growing, and most toxic, component of municipal garbage. Local governments are facing huge costs to handle e-waste, and even greater costs if they do not capture this toxic stream and handle it in an appropriate manner. This paper presents an overview of the e-waste management and reuse of it.

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INTRODUCTION

Industrial revolution followed by the advances in information technology during the last Dark side of high technological development of electronic industry, high rate miscarriage, cancer among cluster workers, polluted drinking water, waste discharges that cause harm to fish, birth defects. Waste is any material that is not needed by the owner, producer, or processor. Humans, animals, other organisms, and all processes of production and consumption produce waste. It has always been a part of the Earth's ecosystem, but its nature and scale were such that the ecosystem could use this waste in its many cycles. In fact, there is no real waste in nature. The apparent waste from one process becomes an input in another.
It is, however, better to prevent waste generation that to produce waste and then try to 'man-age' it. We cannot simply throw away waste. As they say,' There is no away in throw away.' What we dispose of remains in the ecosystem and causes some form of pollution. This pollution can have an impact that is far away from the point of waste determine the environmental problems if creates. To minimize the adverse effects of any waste, it has to be recycled, permanently isolated in storage, allowed to decompose and degrade into a harmless state, or treated to remove any toxicity it may have.

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Sources/ Classification

Most disposal wastes are in the form of solids, liquids, or slurries. E-waste is one of the disposal wastes, fastest growing waste stream, popular, informal name for unwanted electronic devices.

i) Computer peripherals (monitors, CPUs, key board, mouse, laptops, servers etc)
ii) Telecom (Phones, Cell phones, routers, fax machine, transmitters)
iii) Industrial Electronics (alarms, sensors, security devices, medical devices, automobile electronic devices)

Discard Rate of Electronics Items	
Mobile telephone	1 to 3 years
PC Every	2 years
Camera	3 to 5 years
Television	10-15 years
Refrigerator	10-15 years
Washing Machine	10-15 years
IT accessories	Very fast

Objectives

- Minimize illegal recycling / recovery operations
- Environmentally Safe & Sound Recycling by channelizing E-waste to registered E-waste recyclers

- Extended Responsibilities to producers to manage a system of E-waste collection/take back and channelizing to a registered dismantler/recycler.
- Responsibilities to Urban Local Bodies for orphan products and for waste found mixed with MSW
- To Create an E-waste collection channelization system
- Reduce Hazardous substances in Electrical and Electronic components
- To promote waste reduction, recycling and reuse/refurbish and recovery; and create public awareness on the waste management and recycling industry as well as environmental and industry concerns.
- To advance the scientific, technical and practical aspects of waste management and recycling.
- To liaise and establish affiliations with local, national, and international organizations with similar purposes and concerns

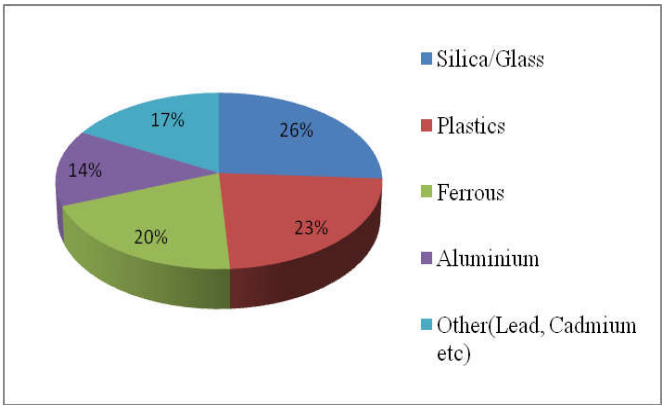


Fig.1. Material composition of personal computer

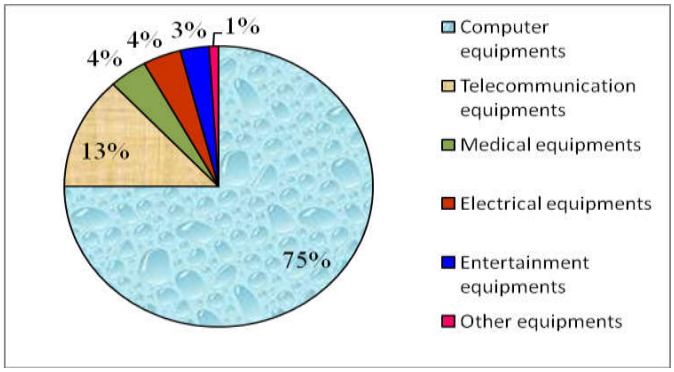


Fig. 2. Equipment composition in % (weight)

Environment effects

Non recyclable E-waste constituents are disposed in land produce contaminated leachates which pollute groundwater.

Methodology

Questionnaire survey gathers the data analysis for distribution of participants information, replacement and disposal, possession, recyclable constituents of e-waste.

E-waste is in India status

The Digital India is a programme to provide better opportunity to accessibility to governance but a hidden problem may also be visualized once we look at other side where the immense use of electronics by the government and society will lead heavy generation of Electronic waste (E-Waste). Indian government recognized this problem earlier and made E-waste (Management & handling), Rules, 2011 but due to unawareness of the government and private bodies, e-waste

Health effects

Constituent	Health Effects	Source of E-waste
Lead	Cause to damage the central and peripheral neural system, blood systems and kidney It effects badly on child brain development, damage to the circulatory system and kidney.	Available in solder in printed circuit boards, glass panels, and gaskets in computer monitors.
Cadmium	Irreversible toxic effects on human health. It accumulates in kidney and liver. Damage neural	Available in chip resistors and semiconductors.
Mercury	Cause chronic damage to the brain. Cause respiratory and skin disorders due to Bioaccumulation in fishes.	Available in relays and switches, and printedcircuit boards.
Chromium	It causes bronchitis.	Available in galvanized steel plates and decorator or hardener for steel housing.
Plastic and PVC	While burning produces dioxin that causes reproductive and developmental problems.	Available in Cabling and computer body.
Brominated flame retardants	It disrupts endocrine system functions	Available in electronic equipment and circuit Boards.
Barium Phosphorus and heavy metals.	It cause muscle weakness and damage to heart, liver, and spleen.	Present in front panel of CRTs.
copper	It causes stomach cramps, nausea, liver damage, or Wilson_s disease.	Present in copper wires, printed Circuit boardTracks.
Nickel	Causes allergy to the skin results dermatitis while allergy to the lung results in asthma.	Present in nickel-cadmium rechargeable batteries.
Lithium	It can pass into breast milk and may harm a nursing baby.	Present in Lithium-ion battery

problem is now becoming a giant challenge for us. Approximately 1.38 million personal computers become obsolete every year. In Geeta, the Holy book of Hindus, Lord Krishna goes on to equate lack of cleanliness to an asura and cleanliness as a divine attribute. In modern India, father of our nation Mahatma Gandhi was also very pragmatic on the cleanliness habits. According to him '' Everyone must be his own scavenger'' India generates e-waste up to 1500 metric kilo tonnes every year. UN predicted that by 2020 e-waste from computers would jump by 500 percent and from discarded mobile phones would be 18 times higher than 2007 level in India. Electronic waste itself does not causes direct damage to us but unscientific processing of these scraps cause a detrimental health consequences and WHO has also warned about these consequences due to e-waste in its "E-Waste and Child Health Initiative report". Now time has come when these huge e-wastes must be managed through environmentally sound process to cause least harm to human and environment and checking its diversion to land filling or incineration. National Green Tribunal has also expressed similar concern about e-waste causing broad spectrum of ecological damage.

Mobile phone subscribers

According to the report published by the Internet and Mobile Association of India (IAMAI) internet users in India has grown 17% in the initial 6 months of this year, adding 52 million new users.

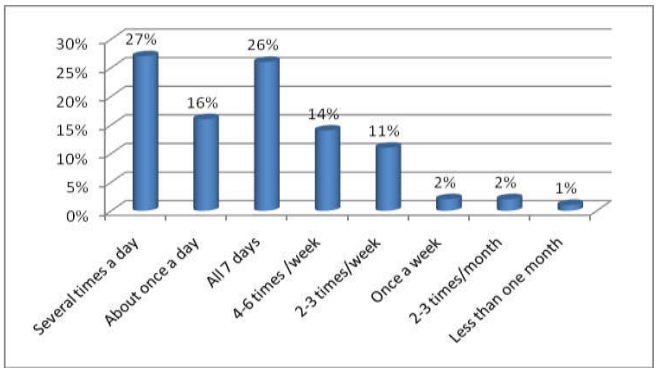


Fig.3. Internet Access in Urban India (year 2015)

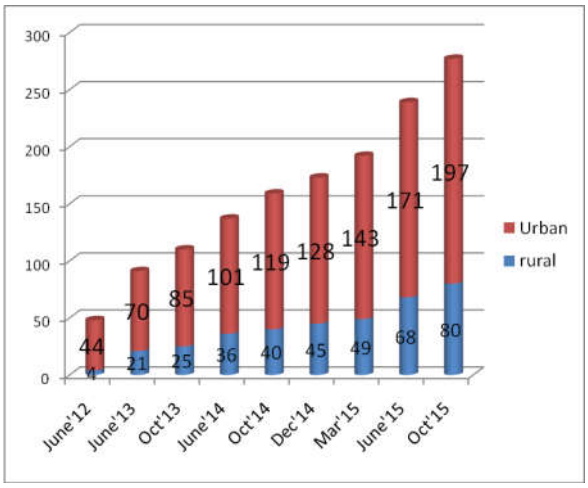


Fig. 4. Mobile internet users in India (all figures in millions)

There are 10 States in India that contribute to 70 per cent of the total e-waste generated in the country, while 65 cities generate more than 60 per cent of the total e-waste in India. Among the 10 largest e-waste generating States, Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab.

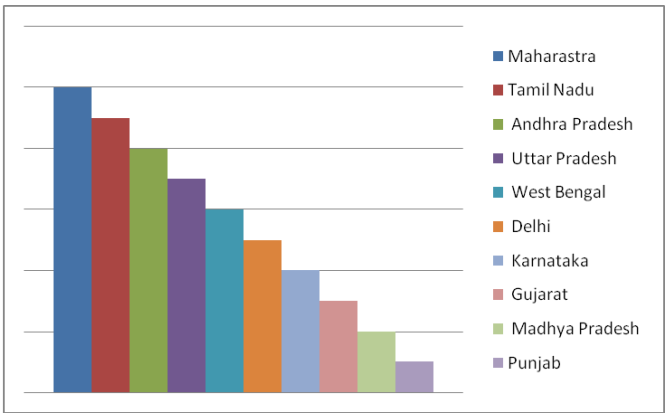
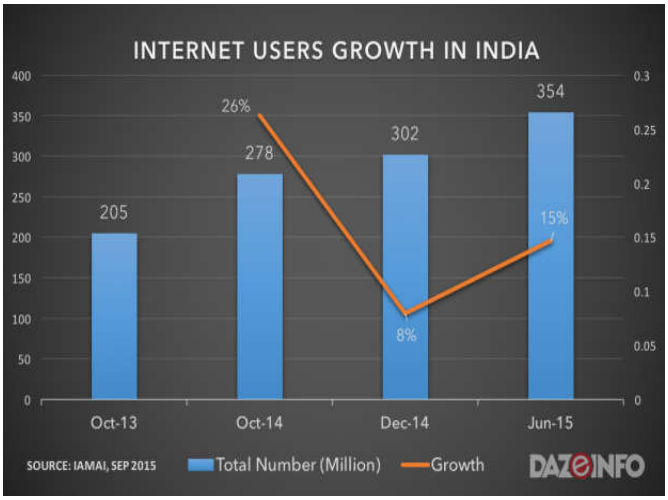


Fig.5. 10 largest e-waste generating States in India Rank wise

Increased usage of gadgets, telecom, information and technology and appliances is collectively creating nearly 13 lakh tonnes of e-Waste annually in India according to an August 2014 report by the industrial body ASSOCHAM. The report also highlighted that Delhi-NCR, Mumbai and the IT capital of India, Bengaluru collectively produce over 2 lakh tonnes of eWaste per year. Another January 2015 report from Markets and Research has forecast that the Indian e-Waste market will grow at 26.22% CAGR during 2014-2019. According to the Comptroller and Auditor- General's (CAG) report 4 lakh tonnes of electronic waste are generated in India annually. In 2005, the Central Pollution Control Board (CPCB) estimated India's e-waste at 1.47 lakh tonnes or 0.573 MT per day. India is the fifth biggest producer of e-waste in the world, discarding 1.7 million tonnes (Mt) of electronic and electrical equipment in 2014, a UN report has warned that the volume of global e-waste is likely to rise by 21 per cent in next three years. India is behind the U.S., China, Japan and Germany. Most e-waste in the world in 2014 was generated in Asia at 16 Mt or 3.7 kg per inhabitant. The top three Asian nations with the highest e-waste generation in absolute quantities are China (6.0 Mt), Japan (2.2 Mt) and India (1.7 Mt).The top per capita producers by far are the wealthy nations of northern and western Europe, the top five being Norway, Switzerland, Iceland, Denmark, and the U.K. The lowest amount of e-waste per inhabitant was generated in Africa (1.7 kg/inhabitant). The continent generated 1.9 Mt of e-waste in total. In 2014, people worldwide discarded all but a small fraction of an estimated 41.8 Mt of electrical and electronic equipment — mostly end-of-life kitchen, laundry and bathroom equipment like microwave ovens, washing machines and dishwashers. While only 7 per cent of e-waste last year was made up of mobile phones, calculators, personal computers, printers, and small information technology equipment, almost 60 per cent was a mix of large and small equipment used in homes and businesses, such as vacuum cleaners, toasters, electric shavers, video cameras, washing machines, electric stoves, mobile

phones, calculators, personal computers, and lamps. According to the Basel Convention, wastes are substances or objects, which are disposed of or are intended to be disposed of, or are required to be disposed of by the provisions of national laws. Cheap labour:-rates are approximately US-$30 computer India $2 computer.



Reuse

E-waste contains many valuable, recoverable materials such as aluminum, copper, gold, silver, plastics, and ferrous metals. In order to conserve natural resources and the energy needed to produce new electronic equipment from virgin resources, electronic equipment can be refurbished, reused, and recycled instead of being land filled. Recycling materials and products – that are considered waste - is an ancient practice which shows that in times of resource scarcity (i.e. shortage of virgin materials) societies attach more economic and societal value to their own waste. This implies that throughout time the definition of waste can change as well. Generally speaking longer use or re-use of materials and products this is often mainly to cover a society's needs. In the poorer countries, rag pickers sift through the waste, collect the reusable and recyclable material and sell it to the scrap traders. They in turn, take the materiel to the recycling units. The rag pickers(the majority of whom are woman and children) work in extremely un hygienic condition an dyet provide a great ecological service by manually separating thousands of tons of recyclable waste from the garbage dumps. To reclaim a waste material such as reverse osmosis, electrolysis, condensation, centrifugation etc. A circuit board manufacturer can replace solvent-based product with water-based flux and simultaneously replace solvent vapor degreaser with detergent parts washer.

Some of the policy level initiatives in India regarding E-waste:

a) The Hazardous Wastes (Management and Handling) Amendent Rules, 2003
b) Guidelines for Environmentally Sound Management of E-waste, 2008
c) The e-waste (Management and Handling) Rules, 2011

Recoverable quantity of materials

In a personal computer		in a Television	
Elements	Recoverable weight of element (kg)	Elements	Recoverable weight of element (kg)
Aluminium	3.084	Aluminium	0.4344
Copper	1.696	Copper	1.2308
Iron	4.455	Iron	4.344
Indium	0.00026	Lead	0.0724
Lead	0.086	Plastic	9.412
Plastics	1.251	Nickel	0.0138
Tin	0.192	Zinc	0.1086
Zinc	0.360	Gold	0.000362
		Silver	0.000724
		Glass	19.186

WEEE residues	Recycling technique	Output
Batterirs (Lead, nickel), Lead bearing residue	Recovery lead, smelting remelting	Lead
Precious metals	Au/Ag separation	Gold/Silver
Non ferrous metal scrap	Secondary copper, aluminium smelting	Copper/Alumini um
Plastic mixture	Incineration	Energy recovery

Benefits of recycle 75% of the energy needed to make steel from virgin material, 40% of the water required in production 1.28 tons of solid waste, reduction of air emissions by 86% & reduction of water pollution by 76%. Problem faced during recycling of e-waste- Presence of hazardous materials, High rate of generation, Illegal imports, Lack of awareness, Lack of proper rules, Improper recycling practices, Child labours !!!

Conclusion

Every producer of EEE shall achieve the thresh hold limits as prescribed in rule 13 (1) within a period of three years from the published notification. Imports of EEE shall be permitted only for those equipments, which are RoHS compliant.

Responsibility of each element in the e-waste Value Chain:

- Producers – Extended/Individual Producer Responsibility, Dealers, Collection agencies/ collection Centres, Dismantler, Recycler, Consumer and bulk consumers
- Procedure for Authorization of producers, collection agencies, dismantlers, recyclers and enforcement agencies
- Procedure for registration/renewal of registration of recyclers
- Regulations for import of e-waste
- Liability of producers, collection agencies, transporter, dismantlers and recyclers
- Information & Tracking
- Elimination of hazardous substances used in e-equipments
- Setting up of Designated Authority to ensure transparency, audit and inspect facilities, examine authorization/ registration etc.

Proposed solutions :Ban on total imports of e-waste, Need to address safe disposal of domestic waste, Attract investment in this sector, Promote adequate ESM technologies for recycling, Awareness program on recycling, Tax incentives for scrap

dealers, Reward and reprimand schemes for performance. The young researchers of the 'Biolicht' group have found a solution on it. They have developed biodegradable electronic components using semiconductors and dyes made from plant extracts and insulators made of gelatin. Once thrown away, the components will rot like other organics. Also they have developed organic light-emitting diodes (OLED) which can be produced easily and at a low cost. The group aims to develop biodegradable inks for compostable foils that can be used as alternatives in printer arsenals. Solar computers also exist but them currently very expensive. These researches lead us to a brighter path of e-waste free Earth through organic electronics. Though this technology is in early stages we can surely be assured of organic computers in coming years. India do have a lot of potential in combining this research as early as possible because electronic revolution in India is rooting its legs. So if this technology is cultivated in our culture as early as possible it will be easier to regulate e-waste in near future.

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