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Management of E-waste in India

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ABSTRACT

Electronic industry is one of the fastest growing manufacturing industry in India. But the increase in sales of electronic goods and their rapid obsolescence has resulted in generation of electronic waste, which is popularly known as E-waste. It includes discarded electronic and electrical equipment. Developing countries face enormous challenges which are related to the generation and management of E-waste which are either internally generated or imported illegally; India is no exception. However, the existing management practices related to E-waste in India are reasonably poor and have the potential to risk both human health and the environment. Moreover, the policy level initiatives are not being implemented appropriately. This paper reviews E-waste generation, present scenario in India, health and environmental implication of E-waste and E-waste management in India.

Introduction

The creation of innovative and new technologies and the globalization of the economy have made a whole range of products available and affordable to the people changing their lifestyles significantly. Electronics industry is the world's largest and fastest growing manufacturing industry. But on the other hand, The rapid growth of technology, upgradation of technical innovations and a high rate of obsolescence in the electronics industry have led to one of the fastest growing waste streams in the world which consist of end of life electrical and electronic equipment products. Both developed countries and developing countries like India face the problem of e-waste management.

The growing quantity of E-waste from electronic industry is beginning to reach disastrous proportions. Electronic Waste or E-waste is the term used to describe old, end-of-life electronic appliances such as computers, laptops, TVs, DVD players, refrigerators and freezers, mobile phones, MP3 players, etc.

E-waste consists of all waste from electronic and electrical appliances which have reached their end- of- life period or are no longer fit for their original intended use and are destined for recovery, recycling or disposal. It includes computer and its accessories-monitors, printers, keyboards, central processing units; typewriters, mobile phones and chargers, remotes, compact discs, headphones, batteries, LCD/Plasma TVs, air conditioners, refrigerators and other household appliances as shown in fig.1 many of which contain toxic materials. Many of the trends in consumption and production processes are unsustainable and pose serious challenge to environment and human health.

The E-waste has become a matter of concern because of the presence of toxic and hazardous substances present in electronic goods and if not properly managed, it can have adverse affects on environment and human health. In India, the E-waste market is mostly unorganized and companies are neither registered nor authorized and operate informally. At most of the places E-waste is treated As municipal waste because India does not have any dedicated legislation for management of E-waste. Currently, E-waste handling is regulated under "The Hazardous Material (Management, Handling and Transboundary Movements) Rules, 2008".

Fig 1. Componant of e-waste

However, there are some companies which are authorized by government for the scientific and environmental friendly management and treatment of E-waste. But due to the involvement of unorganized sector in management of E-waste, there is improper handling of E-waste due to involvement of unskilled workers and absence of adequate technologies. Moreover, companies are more focused on financial profits rather than social environmental concerns. Hence, there is strong need to adopt sustainability practices to tackle the growing threat of e-waste.[1-5]

Present scenario of E-waste in India

While the world is marveling at the technological revolution, countries like India are facing an imminent danger. E-waste of developed countries, such as the US, dumps their wastes to India and other Asian countries. A recent investigation revealed that much of the electronics turned over for recycling in the United States ends up in Asia, where they are either disposed of or recycled with little or no regard for environmental or worker health and safety. It happens because of cheap labour and lack of environmental legislations in developing countries and in this way the toxic effluent of the developed nations 'would flood towards the world's poorest nations.

In Indian context, the electronics industry has emerged as the fastest growing segment of Indian industry both in terms of

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production and exports. The Information Technology Revolution of the early 1990s intensified the problem of E-waste in India. Sixty-five cities in India generate more than 60% of the total E-waste generated in India. Ten states generate 70% of the total E-waste generated in India. Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab in the list of E-waste generating states in India. Among the top ten

Table no 1. E-Waste / WEEE Generation in Top Ten States cities generating E-waste, Mumbai ranks first followed by Delhi,

S. No.	States	WEEE(Tones)	Percentage %
1.	Maharashtra	20270.59	18.49
2.	Tamil Nadu	13486.24	12.30
3.	Andhra Pradesh	12780.33	11.66
4.	Uttar Pradesh	10381.11	9.47
5.	West Bengal	10059.36	9.18
6.	Delhi	9729.15	8.87
7.	Karnataka	9118.74	8.32
8.	Gujarath	8994.33	8.20
9.	Madhya Pradesh	7800.62	7.11
10.	Punjab	6958.46	6.35
	Total	109578.93	100

Source: EMPTRI

From the above table, it is noted that Andhra Pradesh and Karnataka stands 3rd and 7th respective in the list among the E-waste generators. As regards to the cities, Bangalore is 2nd and Hyderabad is 5th in generation of E- waste. Northern India is not a leading generator, it happens to be the leading processing center of E-waste in the country. There are three formal recyclers in the South of India (at Chennai, Hyderabad and Bangalore) and one in Western India.

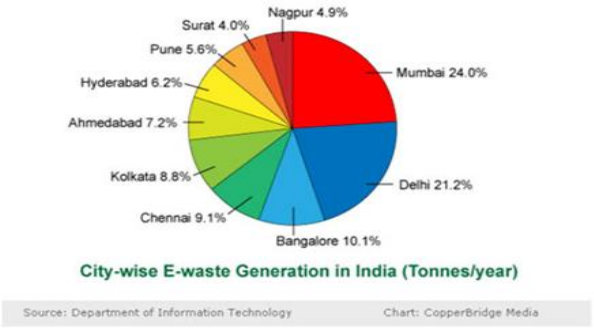
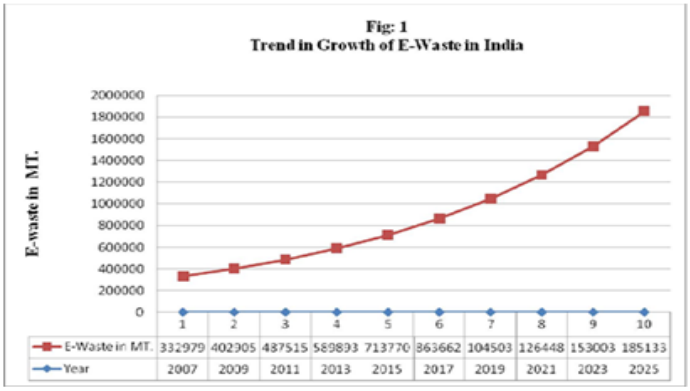


Fig 2. City wise E-Waste Generation in India

The recycling of E-waste is a major concern in India. In India most of activities like collection, transportation, segregation, dismantling, etc., is done by unorganized sectors manually. Being a rich source of reusable and precious material, E waste is also a good source of revenue generation for many people in India. The big portion (rag pickers) of the Indian population earned their livelihood by collecting and selling the inorganic waste-like plastics, polythene bags, glass bottles, cardboards, paper, other ferrous metals, etc. In India, most of the operations related to E-waste such as collections, segregation, dismantling, recycling, and disposals are performed manually. In absence of the adequate technologies and equipment, most of the techniques used for the recycling/treatments of E-waste are very raw and dangerous.

The workers in the recycling sector are dominated by the urban poor with very low literacy levels and hence they have very little awareness regarding the potential hazards of E-waste. Among the urban poor, there are a substantial number of women and children engaged in various recycling activities which further exaggerate the problem of E-waste as they are more vulnerable to the hazards from this kind of waste.

According to a Delhi-based non-governmental organization (NGO) Toxics Link, India annually generates $1.5 billion worth of E-waste domestically, with the booming IT sector being the largest contributor, as 30 percent of its machines reach obsolescence annually. Bangalore, the IT hub of India, alone generates 8,000 tons a year. Figure 1 reveals the trend in growth of E-waste in India that is continuously rising over the years.[9].



Health and Environmental Implications of E-waste

Most electronic goods contain significant quantities of toxic metals and chemicals that have adverse impacts on human health and the environment if not handled properly. Often, these hazards arise due to the improper recycling and disposal processes that are in practice in most of the developing countries including India.

Disposal of E-wastes is major problem faced by many regions across the globe. Such harmful E-waste substances leach into the surrounding soil, water and air during waste treatment or when they are dumped in landfills or left to lie around near it. Acids and sludge obtained from melting computer chips, if disposed on the ground causes acidification of soil. Sooner or later they would adversely affect human health and ecology.

Mercury leaches when certain electronic devices, such as circuit breakers are destroyed. The same is true for polychlorinated biphenyls (PCBs) from condensers. When brominated flame retardant plastic or cadmium containing plastics are landfilled, both polybrominated diphenyl ethers (PBDE) and cadmium may leach into the soil and groundwater. It has been found that significant amounts of lead ion are dissolved from broken lead containing glass, such as the cone glass of cathode ray tubes, gets mixed with acid waters and are a common occurrence in landfills.Incineration of E-waste possesses another threat. It can emit toxic fumes and gases, thereby polluting the surrounding air.In the table below the harmful elements in the compositions of electrical and electronic appliances that can be hazardous to health and environment are listed.[7,10, 13].

E-waste Management in Indian Context

In India, it has been observed that in most of the cases, electronic items are stored unattended because of lack of knowledge about their management. Such electronic junks lie in houses, offices, warehouses etc. Generally, these wastes are mixed with household wastes, which are finally disposed of at landfills. This necessitates implementation of appropriate management measures including stringent regulations. The management practices currently in operation in India have severe health and environmental implications. The composition of E-waste consists of diverse items many of which contain hazardous elements.

Table 2. 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.

Therefore, the major approach to treat E-waste is to reduce the concentration of these hazardous chemicals and elements through recycle and recovery. In the process of recycling or recovery, certain E-waste fractions act as secondary raw material for recovery of valuable items. In Indian context, primarily recycling, reuse and recovery are done as measures to treat E-waste. The recycle and recovery includes the unit operations like dismantling, segregation of ferrous metal, non-ferrous metal and plastic by shredder process, refurbishment and reuse, recycling / recovery of valuable materials and treatment/disposal of dangerous materials and waste. Dismantling includes removal of parts of the electrical and electronic equipment containing perilous substances (CFCs, Hg switches, PCB); removal of easily accessible parts containing valuable substances (cable containing copper, steel, iron, precious metal containing parts etc.). Refurbishment and reuse of E-waste has potential for those used electrical and electronic equipment which can be easily renovate to put to its original use. Recycling / recovery of valuable materials includes recycling and recovery of valuable materials from the E-waste stream like non-ferrous metals in smelting plants, precious metals in separating works. As most of the electrical and electronic equipment contain many precious metals, this process is an important step in the management of E-waste. The materials of potential hazard are disposed of in landfill sites or sometimes incinerated. However, the process of incineration is quite expensive. CFCs are treated thermally, PCB and Mercury is often recycled or disposed of in underground landfill sites.

In India, primarily two types of disposal options based on the composition are in practice. These are Landfilling and Incineration. However, the environmental risks from landfilling of E-waste cannot be neglected because the conditions in a landfill site are different from a native soil, particularly concerning the leaching behaviour of metals. In addition it is known that cadmium and mercury are emitted in diffuse form or via the landfill gas combustion plant. Although the risks cannot be quantified and traced back to E-waste, landfilling does not appear to be an environmentally sound treatment method for substances, which are volatile and not biologically degradable (Cd, Hg, CFC), persistent (PCB) or with unknown behaviour in a landfill site (brominated flame retardants). As a consequence of the complex material mixture in E-waste, it is not possible to exclude environmental risks even in secured landfilling.

Advantage of incineration of E-waste is the reduction of waste volume and the utilization of the energy content of combustible materials. By incineration some environmentally hazardous organic substances are converted into less hazardous compounds. Disadvantage of incineration are the emission to air of substances escaping flue gas cleaning and the large amount of residues from gas cleaning and combustion (Guidelines for Environmentally Sound Management of E-waste, 2008). Waste incineration plants contribute significantly to the annual emissions of cadmium and mercury.

The assessment of E-waste recycling sector in India indicates that E-waste trade starts from formal dismantling sector and moves to informal recycling sector. The entire E-waste treatment is being carried out in an unregulated environment, where there is no control on emissions. There are two E-waste dismantling facilities in formal sector in India. These facilities are M/s. Trishiraya Recycling facilities, Chennai and M/s E-Parisara, Bangalore.

Considering the severity of the problem, it is imperative that certain management options be adopted to handle the bulk E-wastes. Following are some of the management options suggested for the government, industries and the public.

Responsibilities of the Government

(i) Governments should set up regulatory agencies in each district, which are vested with the responsibility of co-ordinating and consolidating the regulatory functions of the various government authorities regarding hazardous substances.

(ii) Governments should be responsible for providing an adequate system of laws, controls and administrative procedures for hazardous waste management (Third World Network. 1991). Existing laws concerning E-waste disposal be reviewed and revamped. A comprehensive law that provides E-waste regulation and management and proper disposal of hazardous wastes is required. Such a law should empower the agency to control, supervise and regulate the relevant activities of government departments.

Responsibility and Role of industries

1. Generators of wastes should take responsibility to determine the output characteristics of wastes and if hazardous, should

provide management options.2. All personnel involved in handling E-waste in industries including those at the policy, management, control and operational levels, should be properly qualified and trained. Companies can adopt their own policies while handling Legal Provision of Waste Managementin India: **An Overview**

The Ministry of Environment and Forests ("MoEF") has issued the following notifications related to hazardous waste:

1. Hazardous Wastes (Management and Handling) Rules, 1989/ 2000/ 2002
2. MoEF Guidelines for Management and Handling of Hazardous Wastes, 1991
3. Guidelines for Safe Road Transport of Hazardous Chemicals, 1995
4. The Public Liability Act, 1991
5. Batteries (Management and Handling) Rules, 2001
6. The National Environmental Tribunal Act, 1995
7. Bio-Medical Wastes (Management and Handling) Rules, 1998
8. Municipal Solid Wastes (Management and Handling) Rules, 2000 and 2002
9. The Recycled Plastic Manufacture and Usage (Amendment) Rules 2003

The Hazardous Wastes (Management and Handling) Rules, 1989were introduced underSections 6, 8, and 25 of the Environment (Protection) Act of 1986 (referred to as "HWM Rules, 1989"). The HWM Rules, 1989 provide for the control of generation, collection, treatment, transport, import, storage and disposal of wastes listed in the schedule annexed to these rules. The rules are implemented through the various Pollution Control Boards and Pollution Control Committees in the states and union territories. There were a few inherent limitations to the implementation of the HWM Rules, 1989, which led to amendments to these Rules being introduced in 2000, 2002 and 2008, widening the definition of hazardous waste by incorporating e-waste and harmonizing the list of hazardous waste materials with that of the Basel Convention.

Besides these rules, in 1991, the Ministry of Environment and Forests (MoEF), New Delhi issued guidelines for management and handling of hazardous wastes for (a) generators of waste, (b) transport of hazardous waste, and (c) owners/operators of hazardous waste storage, treatment and disposal facilities.[9 -14]

Conclusion

Solid waste management, which is already a very complex task in India, is becoming more complicated by the generation of e-waste surmounting to unimaginable standards and with tons and tons of E-waste pouring in every other day into our country, the need of the hour is to tackle it in a tough, firm and diligent manner. Institutional infrastructures, including e-waste collection, transportation, treatment, storage, recovery and disposal, need to be established, at national and/or regional levels for the environmentally sound management of E-wastes. Establishment of E-waste collection, exchange and recycling centres should be encouraged in partnership with private entrepreneurs and manufacturers. At the grass root level although various steps are being taken by the Indian Government, the Indian Government also needs to follow the 3R principle of reduce, reuse and recycle/repair of electronics till they cease to function, which could be first implemented in the Government services. Solution for E-waste crisis can be obtained by cooperation from the manufacturers, consumers and the governments by companies removing hazardous substances to make reuse and recycling easier and safer.

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