Journal of Advances in Science and Technology

Vol. 11, Issue No. 22, May-2016, ISSN 2230-9659

A COMPARATIVE ANALYSIS ON ELECTRONIC WASTE MANAGEMENT PRACTICES IN INDIA: ENVIRONMENTAL AND HEALTH PROBLEMS

AN INTERNATIONALLY INDEXED PEER REVIEWED & REFEREED JOURNAL

www.ignited.in

Journal of Advances in Science and Technology
Vol. 11, Issue No. 22, May-2016, ISSN 2230-9659

A Comparative Analysis on Electronic Waste Management Practices in India: Environmental and Health Problems

Kolla Pushpa Nandini[1]* Dr. Shilpa Baradwaj[2] Dr. Bharat Nagar[3]

[1]Research Scholar

[2]Assistant Professor, MUIT, Lucknow

[3]Assistant Professor, Jagannath University, Jaipur

Abstract – Electronic waste or e-waste is one of the rapidly growing problems of the world. E-waste comprises of a multitude of components, some containing toxic substances that can have an adverse impact on human health and the environment if not handled properly. In India, e-waste management assumes greater significance not only due to the generation of its own e-waste but also because of the dumping of e-waste from developed countries. This is coupled with India's lack of appropriate infrastructure and procedures for its disposal and recycling. Putting the onus of recycling of electronic wastes (e-waste) on the producers, the Ministry of Environment and Forest (MoEF) has for the first time notified e-waste management rules (2011). This review article provides the associated issues and impact of this emerging problem, in the light of initiatives in India.

There is a lack of consensus as to whether the term should apply to resale, reuse, and refurbishing industries, or only to product that cannot be used for its intended purpose. Informal processing of electronic waste in developing countries may cause serious health and pollution problems, though these countries are also most likely to reuse and repair electronics. Some electronic scrap components, Such as CRTs (Cathode Ray Tubes), may contain contaminants such as lead, cadmium, beryllium, or brominated flame retardants. 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 leaching of material such as heavy metals from landfills and incinerator ashes.

The austere problem of E-waste along with its policy level implications is looked upon in the paper. During the course of the study it has been found that there is an urgent need to address the issues related to Ewaste in India in order to avoid its detrimental future consequences. We reviewed current evidence regarding the recycling conditions in communities of developing countries, and identified major environmental toxicants relevant to community exposure.

----------♦----------

INTRODUCTION

In the past decade, technological advances in electronic data management and communications have spurred economic growth and improved people's lives in countless ways. However, our growing dependence on electronic products both at home and in the workplace has given rise to a new environmental challenge: electronics waste.

A recent study by EPA shows that electronics already make up approximately 1 percent of the municipal solid waste stream. Research completed in Europe shows that electronics waste is growing at three times the rate of other municipal waste. To the extent possible, electronics waste should be prevented, and older electronics should be reused and recycled.

Although electronic waste (e-waste) seems to have only recently become a problem, this issue has been building since the electronic products and computers were first manufactured. Electronic waste includes broken or obsolete televisions, computer monitors, central processing units, phones, videocassette recorders, copiers and printers, stereos and speakers, microwaves, and other electronic equipment. As a general category, e-waste may contain significant amounts of heavy metals and other hazardous materials.

Local government has a primary role in the diversion of electronic wastes from landfills. In order to provide cost-effective and convenient service to residents, jurisdictions will want to utilize existing infrastructure resources. E-waste collection will probably be delegated to household hazardous waste programs, landfills or transfer stations, recycling centers, or solid waste haulers.

While universal waste regulations eliminate some hazardous waste regulatory requirements for the collection and transportation of waste electronics, when e-waste reaches the final destination facility, it must be managed as hazardous waste.

The best management practices for e-waste are changing on a continual basis and will evolve over time. This guide will assist local government with implementing new programs and will probably be updated based on lessons learned to improve environmentally sound management.

Presently, metals are the only materials used in electronics for which cost effective, high-volume recycle streams already exist. The infrastructure for recycling other materials contained in electronics is still emerging. Research and technology development will likely result in more cost-effective and efficient collection and recycling programs. Electronic and Electrical waste, popularly known as ewaste products, do not decompose or rot away. The information and communication technology (ICT) sector in the last twenty years or so in India has revolutionized life of one and all, ratcheting a viral effect on electronic manufacturing industries leading to phenomenal growth in terms of both, volume and applications. Digital development has become the new mantra having its all engulfing footprints everywhere.

The booming usage of electronic and electrical equipments has created a new but very dangerous stream of waste, called “electronic-waste”, or simply known as e-waste. With the presence of deadly chemicals and toxic substances in the electronic gadgets, disposal of e-waste is becoming an environmental and health nightmare. E-waste is now one of the fastest growing waste streams. Every year, hundreds of thousands of old computers, mobile phones, television sets and radio equipment are discarded, most of which either end up in landfills or unauthorized recycling yards.

According to Basel Action Network executive director Jim Puckett recycling companies might not be as honest about what they are doing with your old electronics in US, about 80 percent of that material, very quickly, finds itself on a container ship going to a country like China, Nigeria, India, Vietnam, and Pakistan where very dirty things happen to it.

Solid waste management, which is already a mammoth task in India, is becoming more complicated by the invasion of e-waste, particularly computer waste. Ewaste from developed countries finds an easy way into developing countries in the name of free trade further complicating the problems associated with waste management (Davis, Sheila, 2002). Article highlights the associated issues and impact of this emerging problem, in the light of initiatives in India.

According to a MAIT report, India in 2007 generated 380,000 tonnes of e-waste from discarded Computers, Televisions and Mobile Phones. This is projected to grow to more than 800,000 tonnes by 2012 with a growth rate of 15 % (Bridgen, *et. al.* 2005). Maharashtra generates the most waste from electrical and electronic equipments in the country. Pune, along with Mumbai, are among the top 10 cities generating E-waste .The total electronic waste generation in Maharashtra is more than 20,270 (E-waste, 2007). tonne, out of which Navi Mumbai accounts for 646.48 tonne, Greater Mumbai 11,017.06 tonne, Pune 2,584.21 tonne and Pimpri-Chinchwad 1,032.37 tonne. The estimate includes 50, 000 tonnes of such e-waste imported from developed countries as charity for reuse, which mostly end up in informal recycling yards either immediately or once the re-used product is discarded. The authorized e-waste recycling facilities in India capture only 3% of total e-waste generated; the rest makes its way to informal recycling yards in major cities like Delhi, Mumbai and Bangalore (E-Waste, 2003). As per UNEP, “currently, the available data on e-waste arising is poor and insufficient and estimation techniques are required for extension of known data to regional-global coverage. United Nations University’s estimations indicate that current e-waste arising across the twenty seven members of the European Union amount to around 8.3 – 9.1 million tons per year; global arising are estimated to be around 40 million tons per year.”

Like hazardous waste, the problem of e-waste has become an immediate and long term concern as its unregulated accumulation and recycling can lead to major environmental problems endangering human health. The information technology has revolutionized the way we live, work and communicate bringing countless benefits and wealth to all its users. 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. New electronic products have become an integral part of our daily lives providing us with more comfort, security, easy and faster acquisition and exchange of information. But on the other hand, it has also led to unrestrained resource consumption and an alarming waste generation. Both developed countries and developing countries like India face the problem of e-waste management. 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. It comprises a whole range of electrical and electronic items such as

refrigerators, washing machines, computers and printers, televisions, mobiles, i-pods, etc., 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. Optimal and efficient use of natural resources, minimization of waste, development of cleaner products and environmentally sustainable recycling and disposal of waste are some of the issues which need to be addressed by all concerned while ensuring the economic growth and enhancing the quality of life.

E-WASTE GENERATION IN INDIA

All over the world, the quantity of electrical and electronic waste generated each year, especially computers and televisions, has assumed alarming proportions. In 2006, the International Association of Electronics Recyclers (IAER) projected that 3 billion electronic and electrical appliances would become WEEE or e-waste by 2010. That would tantamount to an average e-waste generation rate of 400 million units a year till 2010.

Globally, about 20-50 MT (million tonnes) of e-wastes are disposed off each year, which accounts for 5% of all municipal solid waste. Although no definite official data exist on how much waste is generated in India or how much is disposed of, there are estimations based on independent studies conducted by the NGOs or government agencies. According to the Comptroller and Auditor- General's (CAG) report, over 7.2 MT of industrial hazardous waste, 4 lakh tonnes of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medical waste, 48 MT of municipal waste are generated in the country annually. (Keller, 2006). In 2005, the Central Pollution Control Board (CPCB) estimated India's e-waste at 1.47 lakh tonnes or 0.573 MT per day (Rochat, *et. al.,* 2008). A study released by the Electronics Industry Association of India (ELCINA) at the electronics industry expo – "Componex Nepcon 2009" had estimated the total e-waste generation in India at a whopping 4.34 lakh tonnes by end 2009. The CPCB has estimated that it will exceed the 8 lakh tonnes or 0.8 MT mark by 2012.

There are 10 States 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. Among the top ten cities generating e-waste, Mumbai ranks first followed by Delhi, Bengaluru, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur.

The main sources of electronic waste in India are the government, public and private (industrial) sectors, which account for almost 70 per cent of total waste generation. The contribution of individual households is relatively small at about 15 per cent; the rest being contributed by manufacturers. Though individual households are not large contributors to waste generated by computers, they consume large quantities of consumer durables and are, therefore, potential creators of waste5 An Indian market Research Bureau (IMRB) survey of 'E-waste generation at Source' in 2009 found that out of the total e-waste volume in India, televisions and desktops including servers comprised 68 per cent and 27 per cent respectively. Imports and mobile phones comprised of 2 per cent and 1 percent respectively.

As a large-scale organised e-waste recycling facility, the Attero Recycling Plant in Roorkee opened in January 2010. Despite 23 units currently registered with the Government of India, Ministry of Environment and Forests/ Central Pollution Control Board, as e-waste recyclers/reprocessors, having environmentally sound management facilities, the entire recycling process more or less still exists in the unorganised sector. The Cobalt-60 radiation tragedy at Mayapuri in Delhi in which one person lost his life and six persons were admitted to hospital served as a wakeup call drawing attention to the mounting quantity of hazardous waste including e-waste in the country while revealing systemic problems on the issue of waste disposal. (Sepúlveda, Schluep, *et al.*) The Ministry of Environment and Forests (MoEF) has notified the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 for effective management of hazardous wastes, including e-waste in the country. But these rules do not apply to the radioactive wastes such as Cobalt – 60 which are covered under the Atomic Energy Act, 1962.

MANAGEMENT OF E-WASTE

E-waste legislation - The issue of electrical and electronic equipment disposal, import and recycling has become the subject of serious discussion and debate among the Government organizations, environmentalist groups and the private sector manufacturers of computers and consumer electronic equipments. The Department-related Parliamentary Standing Committee on Science & Technology, Environment & Forests in its 192nd Report on the 'Functioning of the Central Pollution Control Board (CPCB)', has concluded that e-waste is going to be a big problem in the future due to modern life style and increase in the living standards of people and augmentation of economic growth. The Committee has suggested a more proactive role for the CPCB by

stating that it "should conduct studies to make future projections and devise steps to check the menace".

With the progressive stride that the country has made in the information technology sector and the electronic industry, the issue of import of e-waste and its handling and disposal has assumed significance. The issue was brought to the notice of Parliament and Government when on 23 December 2005, a Private Member's Bill on 'The Electronic Waste (Handling and Disposal) Bill, 2005' was introduced in Rajya Sabha by Shri Vijay J. Darda, Hon'ble Member from Maharashtra. The Bill had recognized that while there was no proper law or guideline on the handling and disposal of electronic waste in the country, every home had a number of electronic products. And once these goods became obsolete or discarded, they were either thrown in the garbage or found their way to scrap dealers through the Kabariwalas who then dismantled the gadgets, kept what was useful and threw the rest in landfills. Criticizing the improper way of disposal as the electronic products contain many components which are hazardous to health and environment, the Bill called for a regulation of electronic waste disposal before the situation reached alarming proportions. The Bill sought to provide for proper handling and disposal of millions of tonnes of electronic waste being generated by discarded electronic devices by prescribing norms and fixing responsibilities and duties on manufacturers, recyclers and consumers with regard to the disposal of electronic waste and for all matters connected to it.

The Bill, however, lapsed in July 2010 with the expiry of the tenure of the hon'ble member in the Rajya Sabha. In India, the Constitution assigns solid waste management as a primary responsibility to the Municipalities under the Twelfth Schedule.107 Article 243W empowers the State Legislatures to frame legislations in respect of waste management. The Municipal Solid Wastes (Management & Handling) Rules, 2000 were enacted by the Central Government which came into force from 25 September 2000. Some of the guidelines for handling municipal solid wastes provided in the Schedules are relevant for the management of e-waste and can be used as a model in the e-waste recycling and disposal scheme. The guidelines include organizing house to house collection of waste; proper collection of waste from slums and squatters, hotels, restaurants, office complexes and commercial areas; organizing awareness programmes for segregation of wastes; adopting suitable waste processing technologies; and restricting land filling for nonbiodegradable inert waste.

Regulatory regime for e-waste - While the Municipal Solid Waste (Management and Handling) Rules regulate the disposal of municipal solid wastes in an environmentally acceptable manner and the Hazardous Waste (Management, Handling & Transboundary) Rules define and regulate all aspects of the hazardous waste, there are no specific environmental laws for the management and disposal of e-waste. None of the existing environmental laws has any direct reference to the electronic waste or its handling as hazardous in nature. However, there are several provisions in these laws which have been applied to various aspects of the electronic waste.

IMPACTS OF E-WASTES

The disposal of e-waste is a particular problem faced in many regions across the globe. Environment and human health is affected by e-waste. E-waste takes up space in the communities it invades and can be very harmful to humans and animals. It is of concern mainly due to the toxicity and carcinogenicity of some of the substances if processed improperly.

E-waste is much more hazardous than many other municipal wastes because electronic gadgets contain thousands of components made of deadly chemicals and metals like lead, cadmium, chromium, mercury, polyvinyl chlorides (PVC), brominated flame retardants, beryllium, antimony and phthalates. Longterm exposure to these substances damages the nervous systems, kidney and bones, and the reproductive and endocrine systems, and some of them are carcinogenic and neurotoxic. Primitive recycling or disposal of e-waste to landfills and incinerators causes irreversible environmental damage by polluting water and soil, and contaminating air.

A study conducted by Greenpeace in 2005 in electronic recycling yards in Delhi clearly indicates the presence of high levels of hazardous chemicals including deadly dioxins and furans in the areas where this primitive recycling takes place (E-Waste, 2008). Workers in e-waste disposal sector are poorly protected against the risk of it. They dismantle e-waste, often by hand, in appalling conditions. About 25,000 workers are employed at scrap-yards in Delhi alone, where 10,000 to 20,000 tons of e-waste is handled every year, with computers accounting for 25 percent of it. Other e-waste scrapyards exist in Meerut, Firozabad, Chennai, Bangalore and Mumbai (Beary, 2005). The hazardous substances found in the ewaste includes substantial quantities of lead, cadmium, chromium and flame-retardant plastics. Cathode ray tubes and components with high lead content are considered dangerous to health. Inhaling or handling such substances and being in contact with them on a regular basis can damage the brain, nervous system, lungs, kidneys and the reproductive system Working in poorly-ventilated enclosed areas without masks and technical expertise results in exposure to dangerous and slow-poisoning chemicals. Due to lack of awareness, workers are risking their health and environment as well (Keller, 2006).

Scientists who have examined Guiyu, China (one of the popular destinations of e-waste recycling activities) have determined that because of the waste, the location has the highest levels of cancer-causing

dioxins in the world. Pregnant women are six times more likely to suffer a miscarriage, and seven out of ten kids have too much lead in their blood (Comments and Suggestions 2011). There is paucity of data on burdens of heavy metal exposure on human body in India. A large number of workers including small children are exposed to different dismantling activities of e-waste. There are no data available about the health implications of these workers. They might be ruining their lives in the lack of appropriate knowledge.

SOME INITIATIVES REGARDING E-WASTE MANAGEMENT IN INDIA

E-Parisaraa: is the first government-authorized ecofriendly recycling unit which makes full use of e-waste. The plant, which is India's first scientific e-waste recycling unit, aims to reduce pollution, landfill waste and recover valuable metals, plastics and glass from waste in an eco-friendly manner. What makes EParisaraa different is that unlike the backyard handling of e-waste, there is no melting involved in the sorting. Notably, it protects data from discarded PCs and guarantees customers' confidentiality**.**

Earth Sense Recycle Private Limited: Earth Sense Recycle Private Limited is the joint venture between the E-Parisaraa Private Limited and M/S. GJ Multiclave India Private Limited, which is a bio-medical waste handling and management company.This company came into existence in the year 2000 and they recycle all types of e-wastes including de-bound assets and other electrical and electronic equipment.

Trishyiraya Recycling India Pvt. Ltd (TPL): is the Indian company that offers safe and reliable disposal of e-waste. The Govt. of India as well as the Pollution Control Board has certified the company. It has constant surveillance mechanisms like CCTV Monitors etc.TPL feels proud of its innovative technology that helps recycle E-Waste. Adding feather to its cap is the 'Total Termination Process' that is completely pollution free. There is no contamination of water or air and, no sound pollution either.

Plug-in to eCycling: It is a partnership of Environmental Protection Agency (EPA) and consumer electronics manufacturers, retailers, and service providers that offers more opportunities to donate or recycle - to "eCycle" used electronics. ECycling includes recycling and recovers valuable materials from old electronics which can be used to make new products. It also includes reducing greenhouse gas emission, reducing pollution, saving energy and resources by extracting fewer raw materials from the Earth. Safe recycling of outdated electronic items promotes sound management of toxic chemicals such as lead and mercury and helps others.

In Bangalore city installation of e-bins to ensure safe disposal of e-waste generated at government offices in is set to become a reality shortly. Saahas, the nongovernmental organization (NGO) involved in this pioneering effort, plans to hold campaigns in government offices to create awareness about e-waste and the need to dispose it safely 12 and environment friendly disposal and recycling of e-waste. Toll-free telephone number is provided to get e-waste picked up from home and recycled.

MAIT-The Manufacturers' Association for Information Technology has incubated an Electronics Recyclers' Association (ERA) to organize electronic waste (ewaste) handling in an environment-friendly manner. ERA will initially comprise nine members, of whom six are e-waste processors and three are executive members.

NECESSITY FOR PREVENTING ELECTRONICS WASTE

Are a fast-growing waste stream- Over 20 million personal computers became obsolete in 1998. Only 13 percent were reused or recycled. Many municipalities are facing the dilemma of what to do with growing amounts of retired electronics. Rapid changes in computer technology and the emergence of new electronic gadgets exacerbate the problem.

Can contain hazardous materials- There are hazardous materials, such as lead, mercury, and hexavalent chromium, in circuit boards, batteries, and color cathode ray tubes (CRTs). Televisions and CRT monitors contain four pounds of lead, on average (the exact amount depends on size and make). Mercury from electronics has been cited as a leading source of mercury in municipal waste. In addition, brominated flame retardants are commonly added to plastics used in electronics. If improperly handled, these toxics can be released into the environment through incinerator ash or landfill leachate.

Element	Effect
Lead	A neurotoxin that affects the kidneys and the reproductive system. It affects mental development in children.
Plastics	Dioxins can harm reproductive and immune systems. Burning PVC, a component of plastics, also produces dioxins. BFR can leach into landfills.
Chromium	Inhaling hexavalent chromium or chromium 6 can damage liver and kidneys and cause bronchial maladies including asthmatic bronchitis and lung cancer.
Mercury	Affects the central nervous system, kidneys and immune system. It impairs foetus growth and harms infants through mother's milk.
Beryllium	It is carcinogenic and causes lung diseases.
Cadmium	Long-term exposure causes Itai-itai disease, which causes severe pain in the joints and spine. It affects the kidneys and softens bones.
Acid	Fumes contain chlorine and sulphur dioxide, which cause respiratory problems. They are corrosive to the eye and skin.

Table 1: Impact of hazardous substances on health and environment.

Are made with valuable materials- In 1998, over 112 million pounds of materials were recovered from electronics, including steel, glass, and plastic, as well as precious metals. Reusing and recycling the raw materials from end-of-life electronics conserves natural resources and avoids the air and water pollution, as well as greenhouse gas emissions, that are caused by manufacturing new products.

Data Security – a) Insuring all data storage devices and media in all electronics are completely sanitized as they contain critical personal, financial, legal, technical, operational, and classified information. b) Insuring all data sanitation is fully documented and auditable.

REDUCE ELECTRONICS WASTE

Reusing and Donating Electronics - Preventing waste in the first place is usually preferable to any waste management option...including recycling. Donating electronics for reuse extends the lives of valuable products and keeps them out of the waste management system for a longer time. Reuse, in addition to being an environmentally preferable alternative, also benefits society. As a household or a business, you may be able to take advantage of tax incentives for computer equipment donations.

Recycling Electronics - If donation for reuse is not a viable option, households and businesses can send their used electronics for recycling. Recycling electronics avoids pollution and the need to extract valuable and limited virgin resources. It also reduces the energy used in new product manufacturing. In addition, public and private organizations have emerged that accept computers and other electronics for recycling.

Buying Green - Environmentally responsible electronics use involves not only proper end-of-life disposition of obsolete equipment, but also purchasing new equipment that has been designed with environmental attributes.

Look for electronics that are made with fewer toxic constituents, use recycled content, are energy efficient,are designed for easy upgrading or disassembly, utilize minimal packaging, offer leasing or take-back options and have been recognized by independent certification groups as environmentally preferable.

HAZARDOUS SUBSTANCES IN E- WASTE - ENVIRONMENTAL AND HEALTH EFFECTS

E-waste is much more hazardous than many other municipal wastes because electronic gadgets contain thousands of components made of deadly chemicals and metals like lead, cadmium, chromium, mercury, polyvinyl chlorides (PVC), brominated flame retardants, beryllium, antimony and phthalates. Long-term exposure to these substances damages the nervous systems, kidney, bones, reproductive and endocrine systems. Some of them are carcinogenic and neurotoxic. A study conducted by Greenpeace in 2005 in electronic recycling yards in Delhi clearly indicates the presence of high levels of hazardous chemicals including dioxins and furans in the areas where this primitive / unauthorized recycling takes place. Disposal of e-wastes is a critical problem faced and poses a threat to both health and vital components of the ecosystem. There are number of channels through which e-waste goes to the environment. E-waste that is land filled produces contaminated leachates, which eventually pollute the groundwater. Acids and sludge obtained from melting computer chips, if disposed on the ground causes acidification of soil, leading to contamination of water resources. Incineration of e-wastes can emit toxic fumes and gases, thereby polluting the surrounding air. Improper recycling and recovery methods can have major impacts on the environment. Crude forms of dismantling can often lead to toxic emissions, which pollute the air and thereby also expose the workers to the harmful materials. The most dangerous form of recycling and recovery from e-waste is the open air burning of circuit boards (made of plastic) in order to recover copper and other metals. Extraction of metals through acid bath method or through mercury amalgamation also contributes to environmental degradation. The toxic materials present in the equipment's can be environmental as well as health hazard. Mercury will leach when certain electronic devices, such as circuit breakers are destroyed. Not only does the leaching of mercury poses problems, the vaporization of metallic mercury and dim ethylene mercury is also of concern. The same is true for polychlorinated biphenyls (PCBs) from condensers. When brominated flame retardant plastic or cadmium containing plastics are land filled, both polybrominated diphenyl ethers (PBDE) and cadmium may leach into the soil and groundwater. It has been found that significant amounts of lead 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. The rapid growth and faster change in modules of computers, cell phones and consumer electronics becomes major issue that enhances the amount of e-waste generation.

CONCLUSION

All types of waste are not only imported but generated in India hazardous industrial waste, municipal solid waste and e-waste. The quantum of wastes generated over the past several years have posed an ever increasing threat to environment and public health.

The e-waste is going to become a great challenge for environmentalists and technologists as the rate of growth is much higher than the rate it is disposed, reused or recycled. There is an urgent need for

improvement in e-waste management covering technological improvement, operation plan, implementing a protective protocol for the workers working in e-waste disposal and educating public about this emerging issue posing a threat to the environment as well as public health.

The quantum of wastes generated over the past several years have posed an ever increasing threat to environment and public health. Over eighty-eight critically polluted industrial zones have been identified by the CPCB. Due to the early stage of awareness for e-waste recycling in emerging economies, innovation hubs and centres of excellence have not been established yet.

REFERENCES

Beary, H., (2005). Bangalore faces e-waste hazards. (Website http://news.bbc.co.uk/2/hi/south_asia/4222521.stm viewed on 2007/07/14).

Bridgen, K., Labunska, I., Santillo, D. & Allsopp, M. (2005). Recycling of electronic waste in China and India: Workplace and Environmental contamination.

Comments and Suggestions made by the Ministry of Environment and Forests (2011). Government of India on the draft backgrounder titled 'E-waste in India' prepared by the Research Unit of Rajya Sabha Secretariat. O.M. No. 23-4/ 2011-HSMD, dated 19 April, 2011.

Davis, Sheila (2002). "E-Waste Contracting Alternatives: Promoting Environmental and Economic Sustainability," The Monitor of Electronics Recycling Issues, No. 3, Materials for the Future Foundation, June 2002.

E-Waste How to Guide (2003): Implementing an Effective Municipal Collection Using Best Practices, Draft - Version 2, REAP2 (Recycling Electronics and Pollution Prevention) Municipal Consortium, January 13.

E-waste management in India (2007). Pandve HT. An emerging environmental and health issue. Indian J. Occup Environ Med; 11: 116.

Guidelines for Environmentally Sound Management of E-Waste, 2008, CPCB, Ministry of Environment and Forests, Government of India, 2008, < http://www.cpcb.nic.in/latest/27.06.08%20guidelines%20for%20E-Waste.pdf>

Keller, M. (2006). Assessment of gold recovery processes in Bangalore, India and evaluation of an alternative recycling path for printed wiring boards, Master Thesis ETH and Empa, Zurich and St. Gallen/ Switzerland. pp. 105

Keller, M., (2006). Assessment of gold recovery process in Bangalore, India and evaluation of an alternative recycling for printed wire boards (Website http://www.empa.ch/plugin/template/empa/*/59244/---/l=2viewedon 2007/12/18).

Rochat, D., W. Rodrigues, and A. Gantenbein (2008). India: Including the Existing Informal Sector in a Clean e-Waste Channel. In: Proceedings of the Waste Management Conference (WasteCon2008).

Sepúlveda, A., M. Schluep, et al. A review of environmental fate and effects of hazardous substances released from electrical and electronic equipments during recycling: examples from China and India. Submitted to Environmental Impact Assessment Review.

UNEP (2007). e-waste: Volume I: Inventory Assessment Manual, Division of Technology, Industry and Economics, International Environmental Technology Centre, Osaka/Shiga.

Williams, E. (2005). International activities on E-waste and guidelines for futurework.(Websitehttp://www.it-environment.org/publications/international%20ewaste.pdfviewedon 2007/07/10).