INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, ECONOMICS & MANAGEMENT

IJRCM

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e-WASTE: A THREAT TO HEALTH AND ENVIRONMENTAL SUSTAINABILITY

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ABSTRACT

Wastes are substances or objects, which are disposed of or are intended to be disposed of by the provisions of national laws. Additionally, wastes are such items which people are required to discard, because of their hazardous properties. E-waste or electronic waste, broadly describes loosely discarded, surplus, obsolete, broken, electrical or electronic devices. 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. The quantum of e-wastes generated over the past several years in India and around the world have posed an increasing threat to environment and public health. Computers and electronics equipment are designed without giving sufficient attention to the aspects such as downstream impacts, and the ease of recycling. As long as electronic products continue to contain an assortment of toxic chemicals and are designed without recycling aspects they would pose a threat to environment and public health at their end-of-life. This paper analyses the e-waste generation in India and its hazardous impacts on the environment and public health.

KEYWORDS
e-waste, recycling, hazardous e-waste.

1. INTRODUCTION

In recent years, economists have become increasingly aware of the important implications of environmental issues for the success of developmental efforts. We now understand that the interaction between poverty and environmental degradation can lead to a self- perpetuating process in which, as a result of ignorance or economic necessity, communities may inadvertently destroy or exhaust the resources on which they depend for survival. Rising pressures on environmental resources in developing countries can have severe consequences for self-sufficiency, and future growth potential in the developing world.

The problem of e-waste has become an alarming concern as its unregulated accumulation and recycling can lead to major environmental problems endangering human health. The advancement in information technology has revolutionized the way people live and communicate, bringing several benefits. 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. At the same time, these have led to manifold problems including the problem of massive amount of hazardous waste and other wastes generated from electric and electronic products. These hazardous and other wastes pose a great threat to the human health and environment. The issue of proper management of wastes, therefore, is critical to the protection of livelihood, health and environment. It constitutes a serious challenge to the modern societies and requires coordinated efforts to address it for achieving sustainable development.

2. WHAT IS e-WASTE?

Wastes are substances or objects, which are disposed of or are intended to be disposed of by the provisions of national laws. Additionally, wastes are such items which people are required to discard, because of their hazardous properties. One of the major issues related to e-waste is that there is no standard definition of e-waste. Different countries have different definitions, interpretation and usage of the term e-waste. However, the most widely accepted definition and description of e-waste is as per the European Union directive. The Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE) covers all electrical and electronic equipment used by consumers. For the purposes of this Directive, following definitions are applied:

1. 'electrical and electronic equipment' or 'EEE' means equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields falling under the categories set out in Annex IA and designed for use with a voltage rating not exceeding 1000 Volt for alternating current and 1 500 Volt for direct current;
2. 'Waste electrical and electronic equipment' or 'WEEE' means electrical or electronic equipment which is waste within the meaning of Article 1(a) of Directive 75/442/EEC, including all components, subassemblies and consumables which are part of the product at the time of discarding.

In India, E-waste is covered in Schedule 3 of "The Hazardous Wastes (Management and Handling) Rules, 2003". Under Schedule 3, E-waste is defined as "Waste Electrical and Electronic Equipment including all components, sub-assemblies and their fractions except batteries falling under these rules". "Guidelines for Environmentally Sound Management of E-waste" formulated by the Ministry of Environment and Forest, Government of India, in the year 2008 followed the same definition.

According to the "the e-waste (Management and Handling) Rules, 2011", 'electrical and electronic equipment' means equipment which is dependent on electric currents or electro-magnetic fields to be fully functional and 'e-waste' means waste electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded.

Thus, e-waste or electronic waste, broadly describes loosely discarded, surplus, obsolete, broken, electrical or electronic devices. 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, 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. The composition of e-waste is diverse and falls under 'hazardous' and 'non-hazardous' categories. Broadly, it consists of ferrous and non-ferrous metals, plastics, glass, wood and plywood, printed circuit boards, concrete, ceramics, rubber and other items. Iron and steel constitute about 50% of the waste, followed by plastics (21%), non-ferrous metals (13%) and other constituents. Non-ferrous metals consist of metals like copper, aluminum and precious metals like silver, gold, platinum, palladium and so on. The presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants beyond threshold quantities make

e-waste hazardous in nature. It contains over 1000 different substances, many of which are toxic, and creates serious pollution upon disposal. Obsolete computers pose the most significant environmental and health hazard among the e-wastes.

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.

3. e-WASTE IN INDIA

All over the world, the quantity of electrical and electronic waste generated each year, especially computers and televisions, has assumed alarming proportions. Globally, about 20-50 MT (million tonnes) of e-wastes is 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 off, there are estimations based on independent studies conducted by NGOs or government agencies. According to the Comptroller and Auditor- General's (CAG) report, over 7.2 MT of industrial hazardous waste, four 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. 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 May 2010, 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. 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.

Mobile phone sales have highly increased in the past few years, for example, in India the current growth rate amounts to over 80%. Therefore, e-waste flows in India, which still were rather low in 2007, will be multiplied by 18 until 2020. In China mobile phone subscribers relative to the population exceed subscribers in India. For this reason e-waste flows will increase less and are estimated to be around 7 times higher than in 2007.

E-waste flows from TVs will not increase as much as flows from PCs and mobile phones, since TV markets are already closer to saturation. Unfortunately, for these countries no time series of TV sales were available.

In India and China current e-waste flows will be multiplied by a factor 1.5 to 2 by the year 2020. As already mentioned above, new technologies are resulting in the inclusion of lighter equipment, which again will cause a decrease in weight of future e-waste flows.

The main source of e-waste generated in India happens to be government institutions and public and private sector generating almost 70 per cent of the total e-waste. The e-waste generated by individual households is currently relatively small, though this is also likely to grow appreciably in future. Manufacturers of components and assemblers are another major source of e-waste generation in the country and it is extremely difficult to estimate the exact quantity of waste generated by this group. The import of e-waste, which is illegal, is another major source and preliminary estimates do point out that the quantity being brought in is very significant. This takes place both in a legal as well as quasi-legal way, since e-waste is either misclassified as 'metal scrap' or imported as second hand or 'end-of life' goods, which soon become waste.

4. ENVIRONMENTAL AND HEALTH CONCERNS

e-waste contains over 1,000 different substances and chemicals including lead, cadmium, mercury, Polychlorinated Biphenyls (PCBs), Poly Vinyl Chloride (PVC) etc., many of which are toxic and are likely to create serious problems for the environment and human health if not handled properly. Effects of some toxics are briefly summarized below:

Lead: Lead severely affects the central and peripheral nervous systems, blood systems, kidney and reproductive system in humans. It also affects the endocrine system, and retards brain development among children.

Cadmium: Acute inhalation exposure to high levels of cadmium in humans affects lungs. Toxic cadmium compounds accumulate in the kidneys that can cause kidney diseases, including proteinuria and an increased frequency of stone formation. (E.J. Calabrese end E.M. Kenyon, Air Toxics and Risk Assessment)

Mercury: Elemental and methylmurcury are toxic to the central and peripheral nervous system. The inhalation of mercury may affect nervous, digestive, immune system, lungs and kidneys and may be fatal. Inorganic salts of mercury are corrosive to the skin, eyes and gastrointestinal tract. For futuses, infants, and children, the primary health effect of methylmercury is impaired neurological development.

Hexavalent Chromium/Chromium VI 29: Chromium VI can cause damage to DNA and is extremely toxic in the environment. The respiratory tract is its major target organ. Shortness of breath, coughing and wheezing were reported in cases where an individual inhaled very high concentration of chromium trioxide. Other effects include gastrointestinal and neurological effects and skin burns. Exposure to chromium IV may also result in complications during pregnancy and childbirth.

Barium: Studies have shown that short-term exposure to barium causes brain swelling, muscle weakness, damage to the heart, liver, and spleen. (Toxics Link)

Beryllium: Exposure to beryllium can cause lung cancer. Beryllium also causes a skin disease that is characterised by poor wound healing and wartlike bumps. Studies have shown that people can develop beryllium disease many years following the last exposure.(Toxics Link)

Phosphor and additives: The phosphor coating on cathode ray tubes contains heavy metals, such as cadmium, and other rare earth metals, for example, zinc, vanadium as additives. These metals and their compounds are very toxic. This is a serious hazard posed for those who dismantle CRTs by hand. (Toxics Links)

5. ACTS & POLICIES

The management of huge and growing quantities of electronic waste is emerging as one of the most important environmental problems of developing countries, especially India. The e-waste has become more of a problem than all other wastes because of the very significant health and environment hazards associated with it. E-waste is getting generated at a 10 per cent annual growth rate which is one of the highest in the world.

The appropriate handling of e-waste can both prevent serious environmental damage and also recover valuable materials, especially for metals. The recycling chain for e-waste is classified into three main subsequent steps: (i) collection, (ii) sorting/dismantling and preprocessing (including sorting, dismantling and mechanical treatment) and (iii) end processing.

All three steps should operate and interact in a holistic manner to achieve the overall recycling objectives. The main objectives of e-waste recycling and basic considerations for innovation are to treat the hazardous fractions in an environmentally sound manner, recover valuable material maximally, create eco-efficient and sustainable business, and consider social impact and local context.

The government of India passed an "Environment Protection Act, 1986, which led clear emphasis on the dismantling, recycling, treatment and disposal of e-waste. The Act says that there should be responsibility of the producer of the electrical and electronic equipments for collection of e-waste generated ruing the manufacture of electrical equipments and channelizing it for recyclling or disposal. Collection of e-waste generated from the 'end of life' of their products in line with the plrinciple of "extended Producer Responsibility' and to ensure that such e-wastes are channelized to registered dismantler or recycler, producer shall, as necessary , ensure collection and channerlization by authorising collection agencies; setting up collection centres or take back systems either individually or collectively. Financing and organsing a system to meet the costs involved in the environmentally sound management of e-waste generatef from the end of life of tis own products and historical waste available on the date from which these rules come into force. The financing arrangements of such a system shall be transparent. The producer may choose to eshtalbish such a system either individually or by joining a collective sheme.

The rule also said that providng details such as address, telephone numbers of authorized collection centres to consumers or bulk consumers so as to facilitiate return of used electrical and electronic equipment.

There should also be responsibility of such collection centre. They have to obtain an authorization in accordance with the procedure under rule 9 from the State Pollution Control Board or Pollution Control Committee concerned as the case may be and provide details such as address, telephone numbers of such collection centre to the general public.

It should ensure that the ewaste collected by them is stored in a secured manner till it is sent to registered dismantlers or recycler as the case may be and ensure that no damange is cause to the environment during storage and transportation of e-waste[1].

Sangchari Ghosh in an article, Electronic Waste Recycling for Developing Economies, says that the backbone of electronic waste recycling is the Extended Producer Responsibility (EPR) scheme first introduced in Switzerland in 2003. It places the burden of recycling on the producers and hence delineates a recycling market as part of the intermediate goods market of the economy. Most European countries and some south-east Asian nations have followed this model while in California, where recycling has taken on an important role, the consumers have to pay a surcharge.

Experts believe that the problem of development nation's problem of e-waste is deeply rooted in the nexus between the trade environment and the economy of these nations. Like many negative Pollution externalities e-waste has been shipped to the developing nations conforming to the pollution haven hypothesis. Less stringent environmental regulations, a lethargic public attitude and relatively poor technical infrastructure have together contributed to the emergence of an informal "market" in the backyard of stores and factories where labourers work under unhygienic and adverse environmental conditions.

Switzerland has been the pioneer in the e-waste recycling field ever since it came to the forefront as a hazardous yet economic waste material that needs careful disposal. Switzerland's adoption of the EPR principle was followed by other developed nations including many in Asia. According to Khetriwal (2009), this led to environmentally and economically effective systems for reuse and recycling, and therefore, a structured market for e-waste recycling where only licensed firms (those holding government licenses for recycling can legally carry out recycling against an advanced recycling fee (ARF) payment by the producers and/or consumers. This model has been successful in Switzerland and to some extent in other countries because of consumer cooperation, low cost of compliance, regular audit of licensed recycling firms, and no monopoly creation at all due to an exogenous fee charged to name a few reasons. In the US, California has been active in implementing regulations on the commodity market itself through charging a consumer fee for electronic purchase while the study by Wagner (2009) in Maine documents the success of the extended producer responsibility principle. Maryland and Washington have their e-waste recycling regulations in place too (Thakker 2006). However, this same policy fails to perform in the developing countries due to the differences in the evolution of e-waste recycling market in these economies.

According to Toxic Links, an estimated 0.48 million e-waste is generated annually in India with 95% of the waste being handled by the informal sector. The focus here will be on an economic assessment of the e-waste recycling market and the various aspects of its working in the developing nations. The importance of setting up a formal recycling market stems from the growing problem of e-waste dumping in these pollution havens and the resultant negative health effects on the thousands of workers who engage in removal of essential parts from the waste and selling them off in the secondary market. A formal recycling market with licensed re- cyclers can mitigate the above problems by (i) setting up a legal route for export of e-waste to the developing nations and leaving it to the governments of both the exporting and importing nations to punish defaulters, (ii) creating a new industry for employment of the vast population.

United Nations Environment Programme (2009) says that the amount of appliances put on market every year is increasing both in (post) industrialized and industrializing countries. In the European Union (EU) the total weight of electronic appliances put on the market in 2005 ranged up to more than 9.3 million tons with a sensible growing rate, particularly in Eastern Europe. Electronic appliances put on the market included 44+ million large household appliances in EU, 48 million desktops and laptops, 32 million TVs, and 776 million lamps.

In the United States of America (USA), in 2006, more than 34 million TVs and displays have been placed on the market, while more than 24 million PCs and roughly 139 million portable communication devices such as cell phones, pagers or smart-phones have been manufactured. It has to be highlighted that in the last couple of years the highest growth rate has occurred in communication devices: less than 90 million were sold in 2003, whereas 152 million were sold in 2008.

India had an installed base of about 5 million PCs in 2006, which is contributing to the 25% compounded annual growth rate in the Indian PC industry. In China roughly 14 million PCs were sold in 2005, as well as more than 48 million TVs, nearly 20 million refrigerators and 7.5 million air conditioners in 2001, both growth rate and market penetration are increasing year by year.

Objective of recycling is to take care of hazardous/toxic substances contained in e-waste in an environmentally sound manner while preventing secondary and tertiary emissions. Recover valuable materials as effectively as possible and create economically and environmentally sustainable businesses (optimize eco-efficiency).

The Indian e-waste landscape has been analysed since 2003 in conjunction with the Swiss e-Waste Programme. India's e-waste recycling industry is dominated by the so-called informal sector, where tens of thousands of people are estimated to make their living from material recovery. Several attempts to define a legal framework have been unsuccessful. The identified barriers for the transfer of e-waste technology have to be understood considering these framework conditions.

e-waste recycling sector is dominated by the informal sector. Low technologies are applied by low-skilled workers, resulting in high health and environment risks, including open-sky incineration and wet chemical leaching of metals. No proper solution for hazardous fractions contained in e-waste.

Due to the early stage of awareness for e-waste recycling in emerging economies, innovation hubs are yet to be established. However, some organizations are currently establishing their e-waste competence and have a great potential to develop into innovation hubs. Multilateral institutions, mainly National Cleaner Production Centres and Basel Convention Regional Centres develop into knowledge hubs for e-waste management in some countries. The current situation in China, India and South Africa indicate that smaller and less complex economies such as South Africa's improve faster in awareness and competence.

6. CONCLUSION

Researchers opine that environment protection laws in India are not stringent enough to address the issues relating to either domestic waste or imports of hazardous waste including e-waste. We do not have appropriate technology to ascertain the quantum and quality of wastes in the imported items. For instance, it has been reported that the problem of toxic waste imports cannot be addressed properly as none of the Indian ports (except the Jawaharlal Nehru Port at Nhava Sheva) has scanners to detect the actual contents of the consignments. There are expectations that the proposed E-waste (Management and Handling) Rules, 2010 will lay down explicit laws concerning e-waste and systematize various aspects of the e-waste recycling sector. The Government has consulted various non- governmental organizations (NGOs) in the process of developing a dedicated set of rules, which would govern the management and handling of electronic and electrical waste.

Awareness of the hazardous constituents of e-waste and its management on the Producers be created. The awareness among the consumers regarding hazardous constituents of e-waste can be created through active media campaign and strong extension programmes.

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