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E-Waste: A New Environmental Challenge

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Abstract: ***Central issue of the current study is electronic-waste (e-waste) which is emerging as a new environmental challenge for 21st century. The rapid growth of the electronic and IT industry, present consumer culture, increasing rates of consumption of electronic products have led to disastrous environmental consequences. E-waste, while recycling, may be hazardous because of toxicity of some of the substances it consists of. Some of the waste has been proven to contain many cancer-causing agents. The consequences and toxicity is due to discharge of lead, mercury, cadmium, beryllium and other toxic substances. Developed countries export this waste in the form of donation to developing countries. China and India, where environmental standards are low, are the biggest recipients of e-waste which, in most cases, is processed illegally. The environmental burden of e-waste is born by people who live in developing countries, especially China and India, which processes the maximum amount of e-waste. Despite various laws and directives in developed countries, the e-waste anagement is uncontrolled. The present study focuses on the effect of usage, dumping and recycling of the electronic waste on the natural environment.***

Key Words: E-waste, environmental challenges, developing countries, India, recycle, reuse

I. INTRODUCTION

Globalization and information technology are being widely recognized as main drivers of the human civilization in the later part of twentieth century and the 21st century. The Information Technology (IT) has been the power house of the global economy particularly since early 1990s. Software and hardware part of IT has touched most of the parts of social, technical, economic and natural environment. Exponentially increasing production of computer hardware has posed major challenges of proper disposal of the waste (e-waste) produced by this industry. Current study focuses on the effect of usage, dumping and recycling of the electronic waste on the natural environment.

The paper has five sections. In the introduction section size of the global and Indian electronics market (particularly computers) has been presented. Next section is born out of hazardous impact of different chemicals disposed in environment in the process of computer usage, disposal and inefficient recycling. The third section brings out the dynamics of international trade, environmental regulations and technology transfer issues for comprehensive understanding of e-waste issues mainly caused by computers. The fourth section describes the case of India in this regard which has been presented in the above mentioned broader context. The paper is concluded with discussion, conclusion and recommendations for better management of e-waste.

II. ELECTRONICS: THE GROWING INDUSTRY

Global electronic equipment production has grown from $225 billion in 1980 to almost $1 trillion in 2000, which equates to a compound average annual growth of 7.7 percent over the past 20 years. In 1980, half of all electronics systems were manufactured in North America, one quarter in Europe and the balance split between Japan and the rest of Asia. The personal computer was just emerging and the transition to digital telecommunications switching was in full swing. A dramatic shift in production leadership occurred over the next ten years.

Several factors contributed to this rapid shift in global electronic equipment production. During the 1980s, the Japanese economy was the envy of the world. GDP per capita had risen from $5,000 in 1960 to $15,000 in 1980, and by 1990 had reached $22,000. Through the companies like Sony, Panasonic etc. of Japan had become the clear leader in innovation of consumer electronic products and high volume sophisticated electronic assembly. The combination of growing indigenous demand, global consumer electronics product leadership, and many years of investment in manufacturing technology and capacity certainly benefited worldwide electronics producers during the 1980s.

The last ten years have spawned enormous change in the global economy and in the electronics industry because of:

- Democratization of Eastern Europe and the integration of the EU economies,
- An increasingly pragmatic commercial orientation by China,
- Rapidly increasing economic growth elsewhere in Asia,
- The longest economic expansion in the USA,
- Low cost production from Japan and
- The bursting of the “bubble” economy

Asian production has continued to thrive, surpassing $200 billion in 2000 and accounts for more than 20 percent of total production worldwide. Asian production of electronics is to a large extent export-driven. But investment was focused to serve the personal computer industry, cellular telephone production, as well as fulfillment of fast-growing domestic demand for consumer and industrial electronics. This has encouraged the manufacturing base for continued expansion. China India, Brazil and other developing countries are playing an increasing role in the IT market. IT related industry is expected to grow 11% in 2006. In the last five years (1995-2000), the Indian IT industry has recorded a CAGR (Compounded Annual Growth Rate) of more than 42.4 per cent, which is almost double the growth rate of IT industries in many of the developed countries. Over the decade the industry has developed more than 150 major hardware players, supported by over 800 ancillary units and small time vendors engaged in sub assemblies and equipment manufacturing. All this has increased the installed base to more than 5 million PCs and as on December 31, 2000, the penetration rate to more than 5 PCs per 1,000 people.

III. FORMS OF E-WASTE

Electronic Waste (e-waste) is the term used to describe old, end-of-life electronic appliances such as computers, laptops, TVs, DVD players, mobile phones, mp3 players etc. which have been disposed of by their original users. Technically, electronic waste is only a subset of WEEE (Waste Electrical and Electronic Equipment). According to the OECD any appliance using an electric power supply that has reached its end-o f-life would come under WEEE. Acknowledging the benefits of IT revolution this section presents darker reality of information technology. Very speed of innovation that lies at the heart of computer manufacturer leads to the product obsolescence. The reality of computer life cycle reveals a hazardous life cycle. The dark side of high technological development of electronic industry, especially computer technology, is revealed in the form of polluted drinking water, waste discharges that cause harm to fish, birth defects, high rate of miscarriage and cancer among cluster workers. Rapid changes in computer technology and the emergence of new electronic goods, the growing dependence on information technology, increasing rates of consumption of electronic products have led to disastrous environmental consequences. This high tech benefits and boom in the market lead to extensive use of electronic goods, especially computers. All this is turning the face of the industry and collectively form a problem of electronic waste the percentage of waste that is technology-related is growing at an alarming rate. In a recent study researchers found that the volume of e-waste is increasing by 3 - 5% per year, which is almost three times faster than the municipal waste stream is growing generally (2). The lifespan of a computer has shrunk from four or five years to about two years Electronics, the largest and fastest growing manufacturing industry in the world, aggressively promotes a culture of fast obsolescence and increased consumption. Large amounts of dangerous chemicals are present in computer and other electronic goods. The toxicity is due to lead, mercury, cadmium, hexavalent chromium (ChromiumVI), brominated flame retardants, plastic, PVC etc. A typical computer monitor may contain more than 6 percent lead by weight. In general, computer and electronic equipments are complicated assembly of more than 1000 materials, few of them are highly toxic such as chlorinated and brominated substances, toxic gases, photoactive and biological active materials acids plastics and plastic additives (Clean computer campaign). Each computer display contains an average of 4-8 pound of lead (MCC: 1996). Monitor glass contains about 20 percent lead by weight. When these components are illegally disposed and crushed in landfills, the lead is released into the environment, posing a hazardous legacy for current and future generations. About 70 percent of the heavy metals including mercury and cadmium, found in landfills come from electronic equipments discarded by the users. These heavy metals and other hazardous substances found in electronics items, contaminate ground water and pose environmental and public health risks, (Poison PC and Toxic TV) A single component of computer waste, Cathode Rays Tube (CRTs), has emerged as the leading edge of hazardous waste at the local, state, national and international level. CRTs are the glass Picture Tubes in computer monitors and other video display devices that amplify and focus high energy electrons beam to create the images, which we ultimately see in our screens. In order to protect consumers from radiation damages, the glass in CRTs contain lead compasses which is approximately 20 percent of each CRT. Lead is an example of heavy metal, a metallic element that is in pure form heavy. Lead is extremely toxic, may be taken into the body, where they tend to combine with and inhibit the functioning of particular enzymes. A minute amount can have severe physiological or neurological effects. (Lead in the environment). Lead tends to accumulate in the environment and has high acute and chronic effects on plants, animals and microorganisms. It causes damage to the central and peripheral nervous system, blood system, kidney and reproductive system in human. It also affects endocrine system and brain development among the children. (E-waste India Report, 2004).

Mercury used in switches, circuit boards and in flat panel displays is released into the environment when burned or smelted into the environment. Similarly Beryllium is used in every electronic assembly which is released into the environment through dust emission, during crushing, cutting and burning operations. Circuit board and plastic casing having brominated flame retardant are source of dioxins and furans.

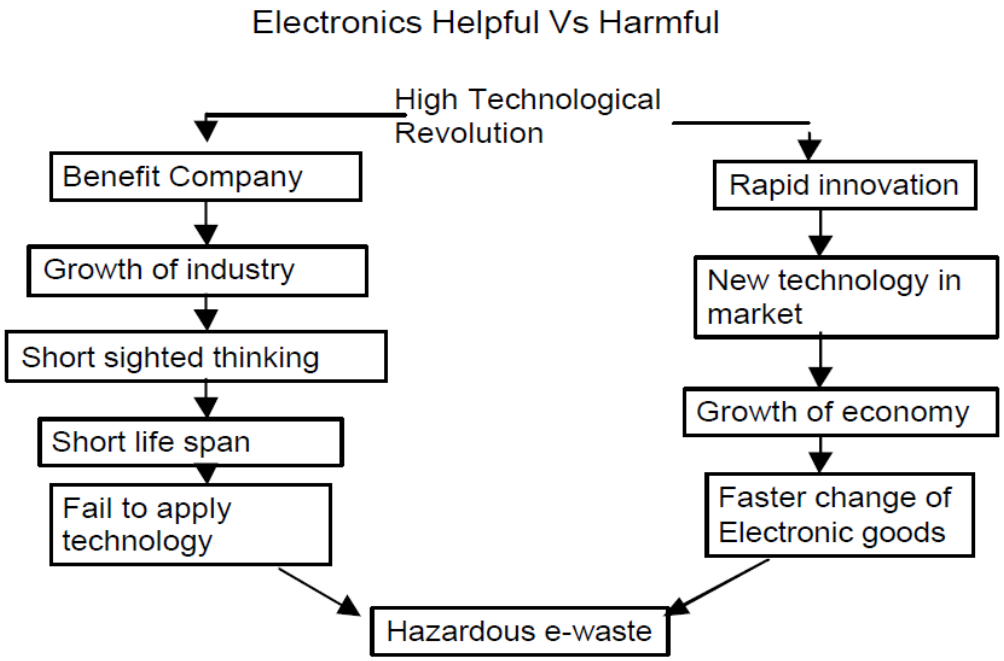
Carbon black in printers and toner is class 2b carcinogen and beryllium, commonly used in mother boards and finger clips, is a health hazard. Beryllium has, recently, beenclassified as a human carcinogen as exposure to it causes lung cancer. (Exporting Harm, 2002) BFRs are among a group of bad actors specifically known as persistent organic pollutants. Animal experiments have shown that a number of these chemicals affect thyroid function, have estrogenic effects, and act through the same receptor-mediated pathways as does dioxin, which is among the most potent animal carcinogens known. Further, environmentalists charge that electronics recyclers have not really come to grips with the special environmental problems that they say are inherent in the prolific use of BFRs in e-waste plastics. "There are presently no studies on the ultimate fate of BFRs when they are melted or burned in recycling or incineration

applications. A closer look at some of electronic waste reveals that commonly used recycling practices can harm the environment more than the waste itself. Investigation conducted by several places found that the workers often used acid bath and other metals, washing the residue directly in to nearby rivers and other water bodies. Component that cannot be recycled are sent to landfills or burned in the open, releasing additional toxins in the environment.

Extension of life span is the key strategy in managing the gamut of environment impact. Social and financial forces for computer waste management requires efficient partnership between public and private sectors as well as networked activities between scholars, business persons and policy makers around the world.

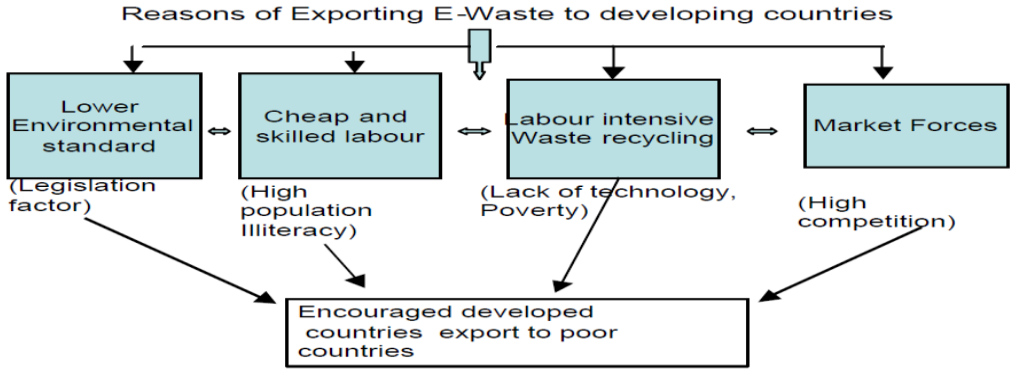
According to Xinhua News Agency, China has generated roughly 1.1 million tons of ewaste annually since 2003, including 5 million TV sets, 4 million refrigerators, 5 million washing machines, 5 million computers, and tens of millions of mobile phones and it will continue to pile up. Greenpeace estimates that by 2010, there will be 178 million new computer users in China alone.

The U.S. National Safety Council predicts that in that country alone between 315 million and 680 million computers will become obsolete within the next few years. The waste will contain more than 2 billion kg of plastic, 0.5 billion kg of lead, 1 million kg of cadmium, 0.5 million kg of chromium and nearly 200,000 kg of mercury. Environmentalists also worry that with the popularity of new liquid crystal display technology, an increasing number of old monitors using cathode ray tubes are ending up in the trash. The disposal problem regarding the tens of millions of first generation mobile phones are today's emerging challenge. · Total estimated e-waste generated from computer , television, refrigerator and washing machines is 1,46,180 tones and is expected to go up to around 1,600,000 by 2012.(CII,2006)



IV. REASONS OF THE FLOW OF E-WASTE TO DEVELOPING COUNTRIES

Due to lower environmental standards and working conditions in China and India, ewaste is being sent to these countries for processing – in most cases illegally. Uncontrolled burning and disposal are causing environmental problems due to the methods of processing the waste. The labor-intensive nature of electronic waste recycling, abundant, cheap and skilled labor force and generation of huge profits for local governments causes the authorities to turn a blind eye to this practice. Thus, they serve as passive encouragement to its spread. It is more convenient and also economical to export e-waste to the third world countries like India, rather than managing and incurring high environmental and economic cost.

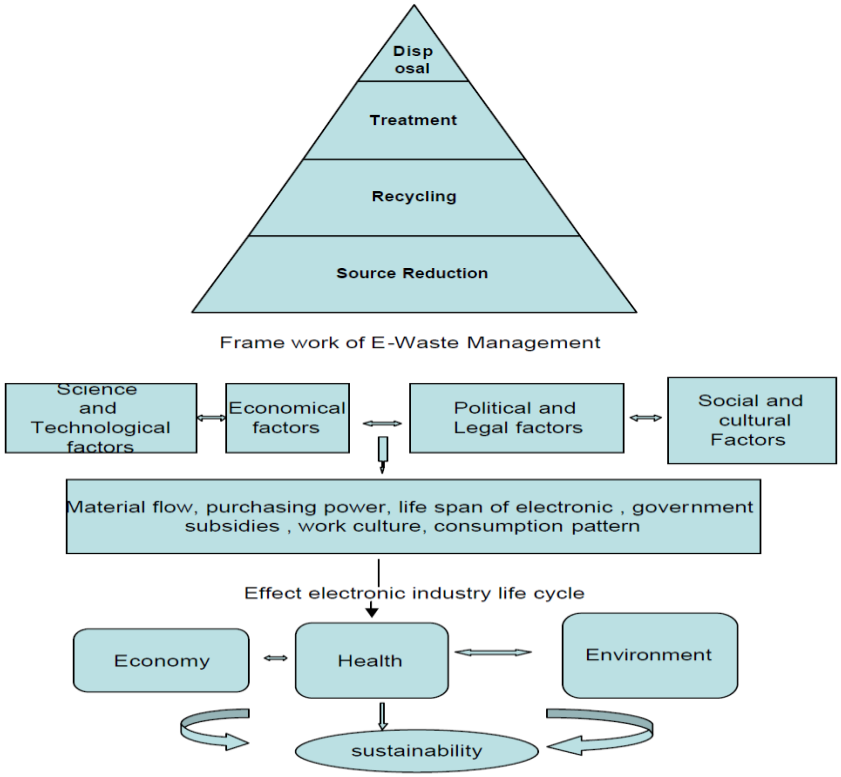


Various departments of the government, public as well as private sectors are responsible for fast feeding of old electronic appliances such as computers, telephones, mobile phone, etc, into the waste stream. Other sources of e-waste are retailers, individual households, foreign embassies, PC manufacturing units, players of the secondary market, and imported electronic scraps from other countries. Individual households have the least contribution in generating of IT product obsolescence. Most Indian households prefer to pass their obsolete technology to near and dear ones or exchange it from the retailer. It is the illegal dumping of junked computers from other parts of the world that generates the biggest part of the e-waste In India; the mountains of e-waste have not yet manifested themselves. This is because of the propensity not to throw away equipment, even if it is obsolete, till it becomes totally unserviceable. But, in the younger generation, this attitude is changing and the throwaway culture of the west is slowly permeating into the country. Another factor limiting generation of e-waste in India is that we do not have a sizeable IT hardware manufacturing infrastructure as yet. We also commenced large scale computerization a bit late in this country, compared to the developed countries.

V. TOTAL AMOUNT OF E-WASTE IN INDIA

- Around 1,050 tonnes of electronic scrap is being produced by manufacturers and assemblers in a single calendar year.
- In a single month, there is a reported case of import of 30 metric tonnes (MT) of e- waste at Ahmedabad port.
- The minimum number of computers procured by an average scale scrap dealer is 20-25 per month.
- The approximate number of scrap dealers specializing in electronics, in and around Delhi, is more than 40. This figure also includes large scale dealers who handle thousands of PCs per month.
- Approximately 1.38 million personal computers become obsolete every year.
- The IT and IT enable services are expanding at a faster rate in and around the national capital region like: Delhi, Gurgoan and Noida. Over the last five years, the Indian IT industry has recovered a compound annual growth rate of more than 42.4 %, which is almost double the growth rate of IT industry in many of the developing countries. Indian configuration of PC per 500 people is going to change to 1 for 50 by 2008.
- The total WEEE generation in India has been estimated to be 1, 46,180 tonnes per year based on selected EEE tracer items. Almost 50% of the PCs sold in India are products from the secondary market and are re-assembled on old components. The remaining market share is covered by multinational manufacturers (30%) and Indian (22%) brands.
- Mumbai currently tops the list of major cities with e-waste.
- Foreign companies helping Indian importers bypass government regulations to bring in the goods for recycling.
- Bangalore may be generating 10,000 to 15,000 tonnes of e-waste every month, according to industry sources. The Karnataka State Pollution Control Board has put it at 10,000 tonnes a month. Along with discarded obsolete hardware, many western countries are selling off their e-waste as scrap and some of this reach scraps dealers in this city. Metal components and some of the outer casings are resold, while the rest of the computers are dumped haphazardly.

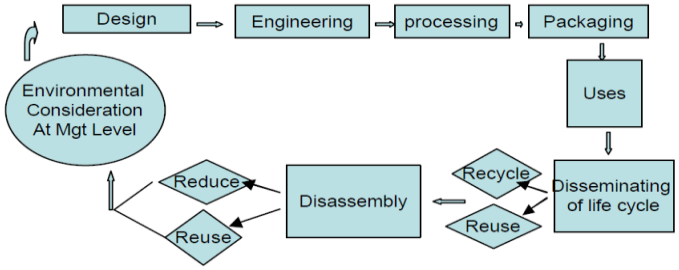
VI. POLLUTION PREVENTION HIERARCHY



VII.INTRODUCING GREEN ELECTRONICS

The most urgent challenge domestic manufacturer's face is to use "greener" design. The Legislative process embodies two considerations: one is to encourage the recycling and reuse of resources, and second the other is environmental protection, a clear principle is that sending e-waste to landfills or incinerators will be strictly prohibited.

Introducing Green Electronic



VIII. IMPLICATIONS AND SUGGESTIONS

Reusing and recycling the raw materials from end-of- life electronics conserve s natural resources and avoids solid waste, air and water pollution, as well as greenhouse gas emissions. By donating your used electronics, you allow schools, non-profit organizations, and lower- income families to use equipment that they otherwise could not afford. Regardless of whether e-waste being processed in developing countries is domestic or imported, there is a clear need for environmentally and economically effective systems for reuse and recycling. We need to improve the environmental performance of all economic operators involved in the lifecycle of the electrical and electronic equipment (EEE) and in particular operators directly involved in the treatment of WEEE through the principle of Extended Producers Responsibility, Prevention need to be promoted to contribute to the environmentally sound recovery and disposal of WEEE. Further, the use of hazardous substances needs to be regulated. It is not possible to foresee every conceivable ill and legislate accordingly. Some environmental issues are of global proportions, and the 'wait and see' philosophy is simply too dangerous because the impending environmental disaster could be beyond our means to repair. In the long-term, pro-active measures must be used which involve addressing the whole life environmental impact. Both short and long term activities can, if properly managed, lead to improved (or new) business opportunities.

Problem cannot be solved by only purchasing a few sets of fancy recycling machines from developed countries. Lacking in advanced technology yet rich in labor, India should develop a path for e-waste recycling that is suitable to its current situation; the most important thing at present is to guarantee the safety of the disassembly and treatment process, while taking full consideration of the environment and worker's health. Such reform, however, would require an overhaul of the country's labor rights structure as well as greater enforcement of environmental regulations. There is an immediate need for collaboration between industry, government, environmental groups, and citizens to solve the problems of e-waste, e-scrap, e-surplus, e-junk, and e-discards. There are two immediate solutions, which must happen through a combination of legislation and voluntary stepping up life cycle greening by the manufacturers.

IX. EXTENDED PRODUCER RESPONSIBILITY (EPR)

Before they can sell new equipment, the producers must take back old equipment for proper disposal. The cost of such "end-of- life" processing must be a part of the sale price, not listed as a separate fee. This gives manufacturers an economic incentive to devise the most efficient methods of coping with the problems of old equipment. Implementation of such measures would require the employment of large number of people, and could potentially mean the expansion of a new economic sector in developing countries. The pace of technological change requires not only constant upgrading of the chips in computers, but many of the other components as well. The new re-use technologies could provide a source of new jobs in developing countries, and call on Civil Society to help by lobbying at the national level and in international forums for recognition of the e-waste problem and potential solutions. Unless the Indian Government comes up with legislation compelling vendors to initiate a take back and recycle mechanism, the Indian IT dream could well end up in an ecological nightmare. IT advancement would, then, mean environmental disaster.

X. NEW INITIATIVES

It is desirable to maximize reuse of equipment and economic development while minimizing environmental burdens and economic costs. Multi-stakeholder aspects are also important; the issue is politically contentious, both within and between nations. It is argued that, to the extent possible, effective research requires collaboration between different regions and societal sectors, and debate on solutions should be rigorous and take place in a neutral arena. Households, companies, and governmental organizations can encourage electronics manufacturers to design greener electronics by purchasing computers and other electronic goods with environmentally preferable attributes and by requesting take back options at the time of purchase.

The Organization for Economic Cooperation and Development (OECD), which has issued guidelines for the environmentally sound management of used and scrapped PCs, described the used computer as a new business with "somewhat informal origins. The Central Pollution Control Board of India has just constituted a national-level working group with representatives from regulatory agencies, state pollution control boards, ministry of Information Technology, industry associations, and experts in ewaste, which has the task of developing guidelines for e-waste recycling and formulating.

Japan has mandated producer take-back of electrical appliances; this is now being extended to computers and other electronics. As the Japanese government requires companies to take back products containing lead, companies such as Sony, Panasonic, Hitachi, Sharp, NEC, and Toshiba are investing in lead-free technologies. Also in 1998, Taiwan started a take-back system for computers, televisions, and large home appliances that requires retailers to accept used electronics, regardless of where they were sold.

XI. CONCLUSION

Most waste is inherently dangerous. It can degrade to produce leachate, which may contaminate ground water, and create landfill gas, which is explosive. In addition, because of the dangers associated with landfill sites, there are now very strict requirements on the construction, operation and aftercare of such sites. Most planning authorities want a worked out quarry to be used for landscaping rather than a landfill site which no one wants in their 'back yard'. Product design must be employed to help to minimize not only the nature and amount of waste, but also to maximize end-of-life recycling. Manufacturers, retailers, users, and disposers should share responsibility for reducing the environmental impacts of products. Adopt product stewardship approach i.e. a product-centered approach should be adopted to preserve and protect environment.

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