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E-waste Management: A Step towards Green Computing

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Abstract

Rapid urbanisation and heavy uses of electronic gadgets during the last two decades has led to generation of a huge amount of electronic wastes resulting in soil, water and environmental pollutions. Thus pollution control and environmental safety has become the greatest concern of environmental scientists and activists worldwide. Dumping of electronic wastes, one of the by-products of this urbanisation process has become a major problem in our society. Because these wastes are not biodegradable, gradual deposition of these e-wastes leads to accumulation of various toxic metals like lead (Pb), cadmium (Cd) etc. and contaminates the soil and the ground water. Ground water contamination in turn, affects the plant animal and the living system as a whole causing severe health hazards and disorders. Therefore, proper management of these electronic wastes has become a pressing demand of the time. In this paper, we discuss about various sources of e-wastes, their effects and recommend steps for management of these toxic and hazardous wastes so as to make the development process sustainable and green.

Keywords: E-waste, metal toxicity, recycling, segregation, sustainable development.

1. Introduction

In this era of information and communication technology, the use of electronics and computational resources has grown exponentially. Excessive use of electronics equipments has given rise to a number of adversaries such as high energy

consumption, global warming, accumulation of e-wastes, environmental pollution etc. Faced with the sever realities of global warming and rising energy costs, government agencies and private firms worldwide have started examining ways to protect the environment. To address these issues, there is a growing global movement to implement more environmental friendly computing.

2. Green Computing

Green computing can be defined as the efficient use of computing resources. It is the name attached to the movement which represents an environmentally responsible way of computing through reduced power consumption. It is also associated with the proper use of computing resources and plays a prime role in minimizing their hazardous impact on environment. Two major issues associated with green computing are: reduction in energy consumption and pollution control. While the former can be achieved by proper use of electronic good and through development of energy efficient and less power consuming hardware, the later can be achieved through their reduced use, proper recycling policies and use of less toxic substances in manufacturing the equipments. Maximizing economic viability and ensuring sustainability are among the other aspects of green computing. Out of these above stated aspects of green computing, in this paper, we are focusing on issues related to waste management and recycling.

3. Waste Management

Any substance that is discarded is known as waste. It is a valuable raw material located at a wrong place. Many of the wastes, at present used in uneconomic manner or left completely unutilised, are causing great hazards to human environment. It can be converted into useful product by making use of appropriate processing technology. These wastes are of various types and can be categorized as hazardous and non-hazardous. These can be further subdivided into municipal wastes, electronic wastes, bio-medical wastes and Industrial wastes. Many studies have been carried out in various parts of the world to establish a connection between health and hazardous wastes. Certain chemicals if released untreated, e.g. cyanides, mercury, and polychlorinated biphenyls are highly toxic and exposure to these can lead to disease or death. Some studies have detected excess prevalence of cancer in residents exposed to hazardous waste.

3.1 E-waste

E-waste is one of the fastest growing waste streams in the world. In developed countries it, on an average, equals 1% of the total solid waste. The increasing “market penetration” in developing countries, “replacement market” in developed countries and “high obsolescence rate”, make e-waste one of the fastest waste streams. It includes items such as televisions (TV), computers, Liquid Crystal Display (LCD), plasma

panels, printing-scanning devices, mobile phones as well as a wide range of household, medical and industrial equipments which are simply discarded as new technologies become available. Huge quantities of these wastes are discarded every year and since these wastes contain toxic and carcinogenic compounds can pose high risk to the environment. In computer lead and cadmium are used in circuit boards, lead oxide and cadmium in cathode ray tube monitors, mercury in switches and flat screen monitors, cadmium in computer, polychlorinated biphenyls in older capacitors, transformers and batteries. At present, Indians use about 14 million PCs, 16 million mobile phones and 80 million televisions. So, there is a pressing need to address e-waste management particularly in developing countries like ours. The presence of valuable recyclable components, in electronic wastes, attracts informal and unorganised sectors towards it but the unsafe and environmentally risky practices adopted by them pose great risks to health and environment.

3.2 Problems

E-waste is a problem both at the manufactures end and at the user's levels. As improved models based on new technology hit the market, more e-waste is generated. Manufacturers also fail to take responsibility for their product once the product is sold, and disposal becomes the headache of the consumers. At present management of these electronics waste is at a very poor state. While most of it is recycled; the rest ends up in landfills. According to a report about 70% of the heavy metal found in landfills comes from electronic discards which contaminate the ground water. These wastes, if are burned instead of being buried or dumped lead to unhealthy emissions and air pollution.

Though, computer design has progressed appallingly well and surprisingly fast in terms of performance but looking at it from a green perspective, the work is yet at its epoch. Conventionally, computer manufacturing includes the use of lead, cadmium, mercury, and other toxins in general. According to green experts, a computer alone contains 4 to 8 pounds of lead and along with other electronic devices it contributes two-fifths of all lead in landfills. Not only from the hazardous waste generation point of view but also from power consumption and heat generation perspective, computers offer a great threat to the society. According to Mark Bramfitt, principal program manager at PG&E, "Data centre servers use 50 times the energy per square foot as an office does". Data centres are the main reason behind energy consumption, many companies spend more on energy than on hardware such as servers. It is predicted that energy costs, now about 10% of the average IT budget, could rise to 50% in recent year. Faster processors use more power, and their waste heat increases temperature and also causes reliability problems such as disk crash, device failure etc leading to more waste generation. To handle these issues air conditioners are used which further consume a large amount of electricity and release a lot of heat to the outer environment making the whole process a vicious cycle of waste heat generation and high power consumption. Moreover, the biggest environmental threat caused by an air conditioner is the release of cloro-fluorocarbon (CFC) which can destroy the ozone layer. To

counter all these growing pollution threats all over the world due to the growing use of electronic device in general and computers in particular there is a need to look for an eco-friendly computer.

3.3 Health Risks

Recycling of waste carries health risks if proper precautions are not taken. Workers working with waste containing chemical and metals may experience exposure to toxic substances and have sever health issues at the range of physical disorders, disabilities etc. Toxic exposure even sometimes may become fatal. Therefore, disposal of health-care wastes and toxic metal wastes require special attention in order to avoid major health hazards.

3.4 Recycling

To handle the above mentioned issues related to excessive use of electronics equipments and their effect on the environment, environmental scientists emphasise on 3R (reduce, recycle and reuse) process as an alternative to the present e-waste management practice. For a developing society like ours, reduced use of electronics equipments being not a feasible option, we, therefore, have to emphasize on reuse and recycling processes. Besides this, different companies nowadays are looking for other eco-friendly alternatives for industrialisation and sustainable development. We feel that, an integrated approach with scientific techniques can minimise the e-waste generation at the base level. Segregation of toxic substances at the root level with systematic planning can eliminate the pollution load and develop a green society. Used or unwanted electronic equipment should be discarded in a convenient and environmentally responsible manner. Computers have toxin metals and pollutants that can emit harmful emissions into the environment. Computers should never be discarded in a landfill. Computers should be recycled through manufacturer programs such as HP's Planet Partners recycling service or recycling facilities in the community. Still-working computers may be donated to non-profit agencies.

The recycling methods adopted in India include open burning of circuit boards or using acid stripes which are potentially harmful. The IP chips are reused. The parts that cannot be used are sent for open dumping to extract metals like copper. PVC-coated cables are openly burnt. Nitric acid is also used to remove Gold and Platinum. Both open burning and acid baths lead to occupational exposure to pollutants and endanger the health of nearby communities. This has been linked with various health problems like Silicosis, Respiratory irritation and pulmonary oedema.

3.5 The way out

If handled properly, electronic waste can be a valuable source of secondary raw materials. The impact of recent legislation such as the Waste Electrical and Electronic Equipment Directive (WEEE) and the "restriction of the use of certain hazardous substances in electrical and electronic equipment" directive (RoHS), and of current and future methods for treatment, recycling and disposal of this waste would ultimately

lead to a green development and eco-friendly society. At present the main emphasis given in e-equipments designing is they are energy efficient and consume less power but time has come when the manufacturers have to give due importance on developing safe electronics equipments making use of biodegradable, less toxic and eco-friendly raw materials.

The work habits of computer users and businesses can be modified to minimize their adverse impact on the global environment. Minor changes in our work habits can contribute in a larger way to the environment safety. Listed below are some small but effective steps which can be followed to make computing greener:

- Printing only what is really needed.
- Using recycled content paper whenever possible.
- Printing on both sides of the paper.
- Using recycled and used ink and toner cartridges how far it is possible.
- Going for good quality efficient energy saving equipments with higher star levels.
- Keeping the systems switched off when not in use instead of leaving them in standby mode as even in the standby mode, computers consumes around 10 watts of power.
- Going for new equipments only when they are required but not just because a new model is available in the market.
- Purchasing small systems with minimum attachments and peripherals.
- Unplugging peripherals such as printer, audio system, scanner, modem etc if these are not in use.
- Charging the UPS battery optimally instead of keeping it switched on for the whole day.

4. ECO Friendly Approach

The best practices and policies of green computing cover smart power usage, reduction of paper consumption, recommendation of new environment friendly equipments and safe recycling of old machines. In Europe, government agencies have set up a number of environmental regulations addressing waste management, recycling, disposal of certain types of waste, industrial emissions and pollution control. Electronics giants are about to come up with eco-friendly range of computers (like desktops and laptops) that aim at reducing the e-waste in the environment. Efforts are made to ensure that, besides desktops and laptops, other electronic hardware products also strictly adhere to the restricted use of hazardous substances. They are likely to be free of hazardous materials such as brominated flame-retardants, PVCs and heavy metals such as lead, cadmium and mercury, which are commonly used in computer manufacturing. The biggest single challenge before the electronics industries in the use of green materials in computer is reliability. Lead-tin solder use of today is very malleable making it an ideal shock absorber. So far, more brittle replacement solders have yet to show the

same reliability in real-world applications. Replacements like the front-runner, a tin/copper/silver alloy, also require higher melting temperatures, which can affect chip life. Here's how designers plan to make future computer more eco-friendly across its entire life span, from manufacture to recycling:

- Energy-intensive manufacturing of computer parts can be minimized by making manufacturing process more energy efficient
- By replacing petroleum-filled plastic with bio-plastics—plant-based polymers— which require less oil and energy to produce in comparison to traditional plastics with a challenge to keep these bio-plastic computers cool so that electronics won't melt them.
- Landfills can be controlled by making best use of the device, by upgrading and repairing in time. Making up-gradation and repairing processes
- easier and cheaper and by avoiding the discarding will not only control e-waste out of dumps but also save energy and materials needed for a designing and producing a whole new computer.
- High power consuming display devices can be replaced with green light displays made of OLEDs, or organic light-emitting diodes etc.
- Use of toxic materials like lead can be replaced by silver and copper that makes recycling expensive and time consuming. The process can be made more effective by recycling computer parts separately with an option of reuse or resale.

5. Perspective with Respect to Indian Scenario

For a long time, there was no considerable improvement in the growth of indigenous authentic hardware equipment manufacturer in the country and almost every company and the household customers were dependant on foreign companies who were either importing the equipments or producing part of them in Indian subsidiaries. Mainly those subsidiaries were using the low priced human resources. Lack of basic research initiative and congenial infrastructure has resulted in absence of good patents and commercial production of indigenously built equipments. Due to tax relief given by the Government in the last few years for importing computer hardware accelerated the import and resulted in the minimization of the machines, equipments and peripherals. In this situation, many small and medium scale industries were induced to start procuring the hardware at low prices and venture into the building of IT infrastructure for the company. But during the activities price was the most important criterion. At that point of time the basic objective was to build basic infrastructure without considering the principle of green computing. In the later stage when the concept of green computing has gained importance, it is not possible for most of the small and medium scale companies to redo the task of IT infrastructure development over and above bearing the cost of maintenance and procurement of software. Presently, in India the IT business is in a growth phase and the stakeholders are really concerned to

maximize the return on investment and as a result of this it will not be easy to implement the principle of green computing in the IT infrastructure.

Moreover, the human resource of the country is not very much concerned with the effect of toxic materials used in the equipments and so no public movement is visible now in regard to this object. At present if the Government through legislation make it mandatory on the part of the Companies to comply with the green standard then the green movement may start in the country in a conspicuous manner. But as in every other case, until the awareness is built up, there will be no true development of green computing in the country. The awareness programme may include the following major issues:

- Green computing minimizes the energy consumption of the organization i.e. minimizes the power bill.
- Uses of non-toxic material in the equipments make the worker safe from health problem and occupational hazards.
- In the long term these green equipment will be less costly without any hidden cost of waste and enhanced resource consumption without any detrimental effect of accuracy, performance and longevity.

6. Concluding Remarks

So far, we the consumers have only cared for the speed, price and performance aspects of the electronic gadgets but have hardly cared about their ecological impacts while buying them. But, with the growing concern on environment protection and sustainable development, people have started thinking about safer and greener models.

Proper methods of waste disposal have to be undertaken to ensure that it does not affect the environment around the area or cause health hazards to the people living there. Segregation of E-Waste into specific well defined stream at collection stage is clearly an effective approach for facilitating subsequent efficient recycling and reuse. However, the generation of highly mixed waste streams does not encourage reuse of component and recycling of added value materials. Separation of smaller e- product would make recycling much easier.

At present various companies have developed ULTRA HIGH SHEARING (UHS) technology as it can recycle a different assortment of wastes and it does not use any chemical additives. It is based on the principle of ultra-shearing, whereby a very high mechanical shear stress is generated to break chemical bonds of different polymers and form a copolymer as bridge between different polymers. The product obtained is a stabilised compound with superior quality. Some countries have introduced a directive in January 2003 on the restriction of use of certain hazardous substances in electronics goods. The eco design component of the legislation requires manufacturers to consider the entire lifecycle of specific product groups and to assess the ecological profile of the equipment.

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