Green Computing: Smart Computing to Greener Environment

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Abstract: *Green Computing is an eco-friendly use of computer and its resources. It is a smarter way to tackle environmental issues. Today when our earth is facing environmental issues like Global warming, such initiatives in this modern world full of science and technology can definitely bring a change.*

The approach towards Green Computing mainly includes: Green design, Green manufacture, Green use, Green disposal. It further aims at boosting energy efficiency, reducing the use of toxic materials in computer and its resources, recyclability of materials & components used in the devices.

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Our research project mainly focuses on gaining an insight into various aspects of Green Computing, and also assessing the awareness level of various IT organizations of Patna and implementation methods adopted by them on this issue.

Keywords: *Green Computing, Global warming, Green Design, Green Manufacture, Green use, Green disposal.*

Introduction:

The word 'Green' adds a positive dimension of compatibility with nature to any of the term, be it originating from science, technology etc.

Green Computing is a technique of using systems and technology in an eco-friendly manner. This concept uses computers and related resources in an environmentally responsible manner. It is an adoption of a holistic approach to tackle environmental issues. The main aim of Green Computing is to save the environment through intelligent use of computers. It further aims at reducing toxic materials. Now a days many devices are being manufactured which use more energy and involve toxic materials and dangerous gases. Toxic chemicals such as lead, mercury, cadmium are used in computers that create several environmental issues leading to severe health hazards. Therefore it is becoming a major issue to develop equipments by which we can minimize energy consumption, e-waste generation and create recyclability of computers and electronic goods.

The carbon emission due to search engine is approximately 7g everyday in the environment and is heavily impacting the environment. Google has figured out some data:- Search engine emits 0.2g for every search. YouTube emits 1g for every 10 minutes video watched. Gmail emits 1.2g per year for one user which is impacting the environment. Different strategies are taken into consideration while adopting the concept of Green Computing (Vishwakarma, 2015).

Approach towards Green Computing mainly includes:

- Green design
- Green manufacturing
- Green use
- Green disposal

Green design and manufacture:

Reduction of hazardous material in production and manufacture of computers and other sub parts with minimal impact on environment is green design and manufacturing.

In February 2003,The European Union passed the restriction of hazardous substances directive (Rohs). It restricts the use of six hazardous materials in manufacturing of various types of computers and their parts. Those six materials were brominated flame retardants (BFRs) in plastic casing, cadmium and selenium in circuits' boards, cathode ray tubes in monitors, lead in solder, and mercury in LCD screen back lights (Jennifer Claerr, 2011) .

Due to the effect of these hazardous materials many companies are beginning to find new ways to build greener PCs. Most companies have completely eliminated CRT monitors from their product line since it radiates phosphorus. LCD once was a popular choice but it has mercury as toxic material so LED is the latest choice for eco friendly manufacturing.

Recently, Dell, Apple and other computer makers announced their environmental strategy designed to make computer green for long time. Dell aims its new zero carbon initiative at maximizing the energy efficiency of Dell products, and overtime plans to offset their carbon impact.

Apple has begun to make many of its Green computers with recyclable materials such as aluminium and polycarbonate. Apple has also made efforts to remove toxic substances such as, polyvinyl chloride (PVC), arsenic, lead, mercury etc. from its product. Hewlett Packard (HP) is striving to use more recycled materials in its products and product packaging. HP has also instituted buy back and recycling programmes for all brands of computers, monitors and printers.

Green Electronic Council's EPEAT (Electronic Product Environmental Assessment Tool) program evaluates laptops, desktops, monitors and electronics based on their environmental attributes. In addition to this, focus is placed on the materials used in manufacturing and packaging. Recyclability and other standards that are taken into account is the entire life cycle of a computer (Hickman Matt, 2010).

A Computer with EPEAT Bronze, Silver and Gold certification contains minimal levels of toxic components like lead, mercury and PVC etc.

Efforts are being made to design solid-state alkaline batteries which are a viable alternative to lithium-ion battery. These alkaline batteries would be far safer and cheaper than today's lithium-ion batteries.

Green use: Green use of computer aims to minimize the power consumption of devices, making them energy efficient and using them in an eco-friendly manner.

Recent implementation of Green Computing involves the use of Blackle, a search engine site powered by Google custom search. When the computer screen is white presenting an empty page or Google home page, our computer consumes 74W. When the screen is black, it consumes only 59W (Murugesan San, 2008). There are other 'dark' search engines to save energy such as **Darkoogle, Greenergle.** Darkoogle has black background with green and white text whereas Greenergle displays a black background with green, blue and white text.

Another implementation of Green Computing involves virtualization which is one of the hardware reducing, cost saving and energy saving technology. On a server or a desktop PC, It allows multiple operating systems and multiple applications to run on a single computer. It is provided by VMware, Citrix, Starwind, Winimage. It results in far more efficient use of resources. Since the number of hardware devices are decreased so there is also a decrease in e-wastes.

Big changes begin from small initiatives. For instance, some simple but effective initiatives can be taken like buying energy star equipments, setting the power options on the phones and computers to switch to sleep mode when it's not active. Environmental protection agency (EPA) states that computers with a sleep mode reduces their energy use by 60-70 percent. Avoiding screensavers as it emits large amount of CO_2 reading .pdf files instead of files in other format are other such small initiatives.

Green Disposal: Proper disposal of unwanted computer equipments is one of the important aspects of Green Computing. Technological advancement in the field of IT has increased our dependency on computer and other electronic gadgets which results in generation of huge amount of e-wastes worldwide.

E-wastes are unwanted, undesirable, obsolete electronic equipments which when thrown into the environment without proper care, give rise to a number of environmental issues like soil pollution, ground water pollution and air pollution.

Various components of computers are made from heavy metals and chemicals like lead, cadmium, mercury, phosphorus, Polybrominated chemical retardants etc. CPU of a computer contains toxic materials viz. lead is found in circuit boards, beryllium is found in motherboards, chip resistors, semi-conductors, cables & wires contain cadmium, mercury powder in flat screens etc. Disposal of these e-wastes with normal trash leads to release of toxic heavy metals like lead, cadmium, beryllium and many potentially toxic chemicals. E-waste accounts for approximately 40% of lead and 70% of heavy metals found in landfills. Therefore a proper processing is essential to ensure that these materials are not released into the environment.

India is the 5th largest producer of e-waste in the world and is likely to generate 52 lakh metric tonnes of electronic waste by 2020 from current level of 18 lakh metric tonnes and more than 20 million tonnes of e-waste is generated every year(Ayyar Ranjani,2017).

As we all know E-wastes are increasing throughout the world at an alarming rate. Their management is a major concern in both developing and developed countries. Therefore better e-waste management methodology needs to be adopted.


Reduce, Recycle, and Reuse are three R's of e-waste management.

REDUCE: Reduction in our consumption can contribute to decrease in e-waste generation. Technology is changing at a faster pace and with that very pace, we are changing our computer and gadgets. This shows that we are moving towards the state of hyper consumption. Whenever a new technology comes into the market we rush to buy it without thinking whether we truly need it or not. Being answerable consumers, it is our responsibility to analyse our requirements before purchasing a new device.

REUSE: Reuse of computer equipments is another technique of e-waste management. Reuse of computer and its parts can be done with a little modification in software and hardware. EPA (Environmental Protection agency) suggests that instead of buying high end performance computers we can add up various memory and performance enhancing features to our existing computers which would boost the computer's performance. Another method of reuse can be reselling or donation of working computers to non – profitable organizations, schools, etc. It is a technique that reduces burden on landfills to some extent.

RECYCLE: Recycling of e-waste is a viable method for e-waste management. Most of the computer parts can be recycled like monitors, laptops, keyboards, hard drives, floppy drives, printers, CPU, memory chips. Recycling diverts nearly 70 million tons of e–waste from landfills and incinerators. It reduces pollution and contributes to the reduction of ten major categories of air pollutants and eight major categories of water pollutants. In India, 95% of recycling of e-waste is done by unstructured sectors which use unscientific method of recycling that causes harm to human health leading to health issues like damage of nervous system, blood system, kidney, lung cancer etc. Nearly two-thirds of e-waste workers are suffering from respiratory ailments. Recycling methods adopted by non-formal sectors are less efficient. It includes recovery of only valuable metals such as gold , silver, copper, aluminium. Other metals like cadmium, zinc, palladium, aluminium which can not be recovered and are put in landfills. Recycling e-waste in regulated sectors are done with the aim to cause minimum damage to the environment.

Statistics show that only 1.5 % of our country's e–waste is recycled due to poor infrastructure, legislation and framework. Therefore, stronger policies and strong
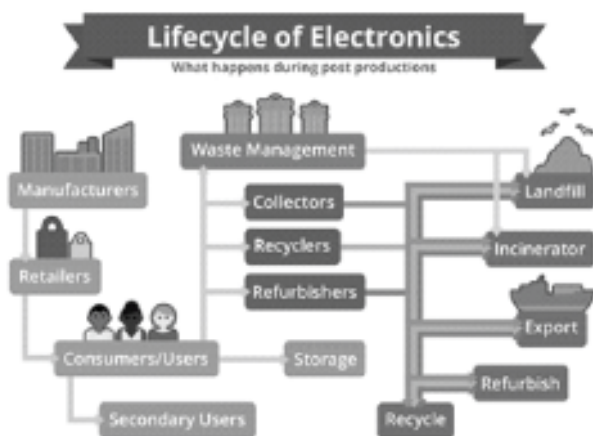
enforcement of law is essential for proper e-waste disposal system also there is a need to integrate informal waste sector to formal waste processing industry. Furthermore, many computer manufacturing companies are also contributing towards recycling of e-waste and also making effective changes in their design and manufacturing technology so that less amount of e – waste is produced. E.g.: HP is using more recycled material in its products and product packaging. It has also instituted a buy back and recycling programme for all brands of computers, monitors, printers, scanners and other computer technology.

Proper disposal of e-waste is not only a responsibility of government bodies and computer manufacturers. A part of the responsibility lies with us too. Being end users we have always focused on performance, speed, accuracy of computers without thinking about their negative impacts on environment and ecosystem. Lack of awareness and proper education among consumers has been a major factor in improper disposal of e- waste. Therefore, as consumers we can contribute towards e- waste reduction and proper disposal by taking small initiatives like participation in awareness programmes, taking care of computers by doing timely repairs, participating in exchange offers, separating e- waste from normal trash etc.

A survey was conducted to assess the awareness of Green Computing in various IT sectors in Patna.

Objectives of Research Project:

- To gain an insight into various dimensions of Green Computing.

- To assess the awareness about Green Computing in various IT sectors in Patna.

- To familiarize with environmentally sound practices which deals with e-waste generation and disposal.

Hypothesis:

It was assumed that

- IT organizations are aware of the concept of Green Computing.

- The organizations implement various aspects of Green Computing in the usage of computer resources.

Methodology:

The present study was undertaken in Private and Government IT organizations in Patna. The study was based on Primary data collected through interviews and questionnaire method with these companies. Secondary data includes textbooks, journals and websites.

Area of Study: A survey was conducted in STPI (Software Technology Park of India) housing many software development companies, Department of Science and Technology (Govt. of Bihar), Government Polytechnic College, Patliputra, Sai Corporate Park, Aztech Technology and Engineer's Pvt. Ltd. etc.

Sample size and sampling method: The sampling procedure adopted for the purpose of research was Judgement sampling as researcher's judgement was used for selecting the items which were considered as representative of the population. 19 organizations were approached, out of which one representative from 15 organizations responded to our queries.

Tools and techniques: Articles & reports from Magazines, Journals and Websites etc were referred to collect secondary data on the topic. Questionnaire, Interviews and Group discussions were used for collecting primary data.

Methods of Data Analysis: Data was compiled and analyzed using MS-Excel and MS-Word. The contents of research paper were modified and the Presentation was prepared using MS-PowerPoint.

Findings and observations:

The observation from the research study highlighted following facts:
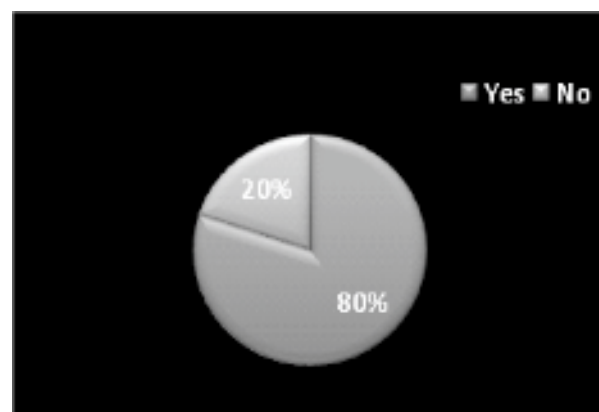
1. Awareness level of organization:

Fig. 1. Awareness about the term green computing

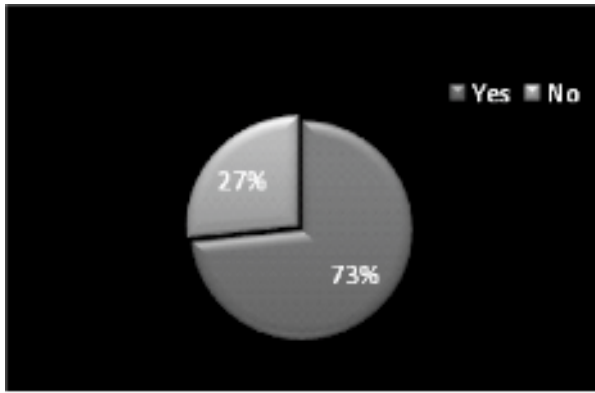| Yes	12
No	3

Fig. 2. Knowledge about EPEAT certified computers

Yes	11
No	4
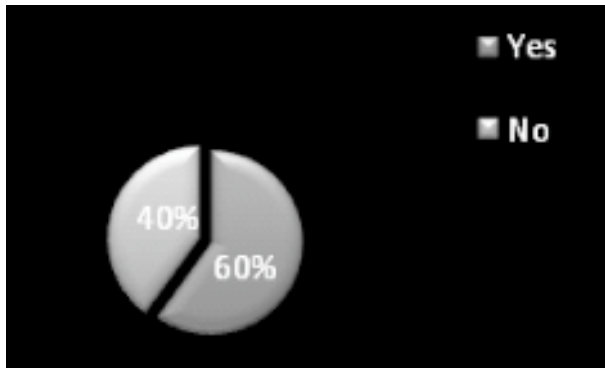
Fig. 3. Awareness about CO_2 emission from computers.

Yes	9
No	6
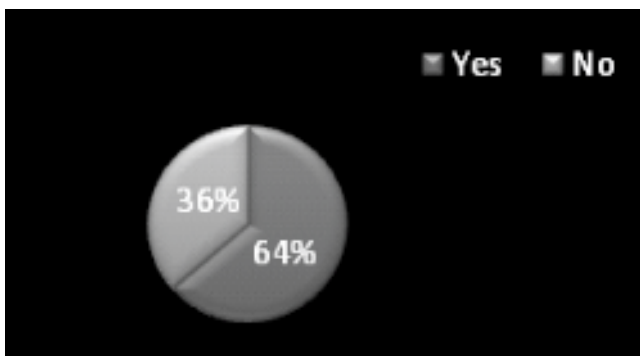
Fig. 4. Knowledge about health hazards associated with e-waste.

Yes	9
No	6

From above figures (1-4) , it may be concluded that IT Organisations were aware of the concept of Green Computing and its various aspects .
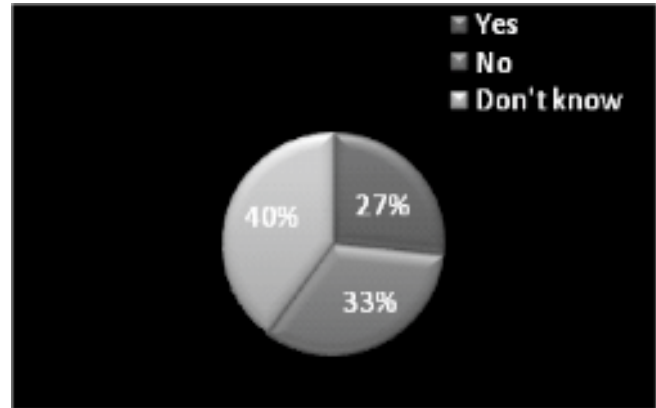
2. Implementation:

Fig. 5. Usage of EPEAT certified computers.

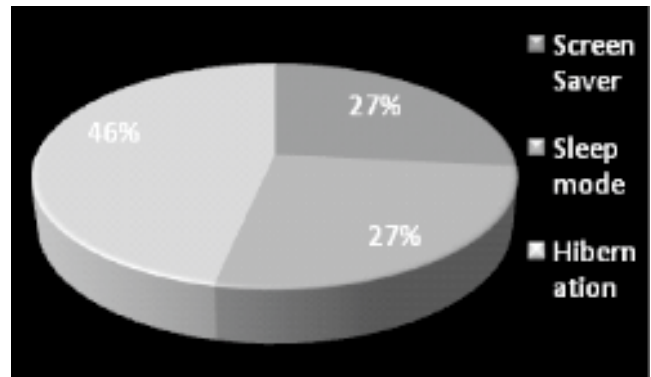| Yes	4
No	5
Don't know	6

Fig. 6. What they prefer while not using computers?

Screen saver	4
Sleep mode	4
Hibernation	7
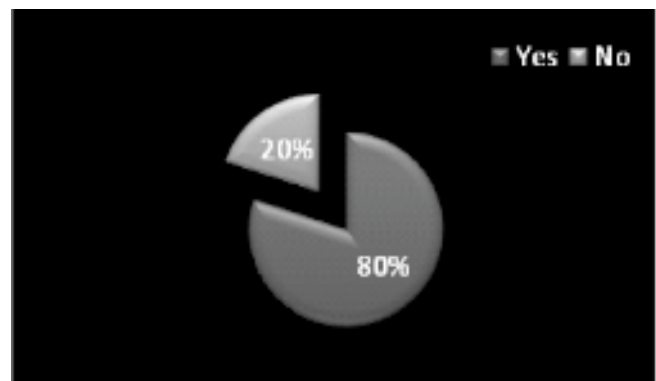
Fig. 7. Purchase of new gadgets even if older ones are working.

Yes	12
No	3
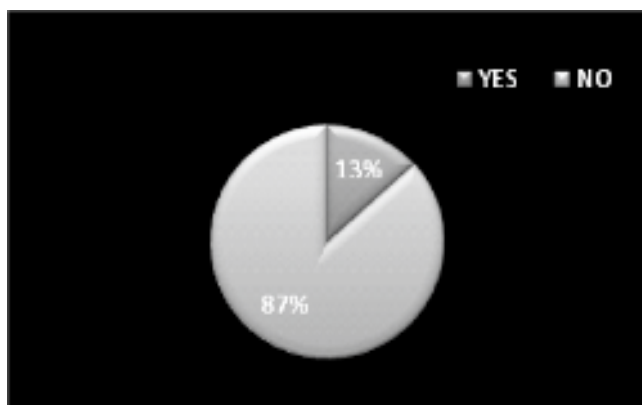
Fig. 8. Knowledge of e-waste disposal centre in Patna.

Yes	2
No	13
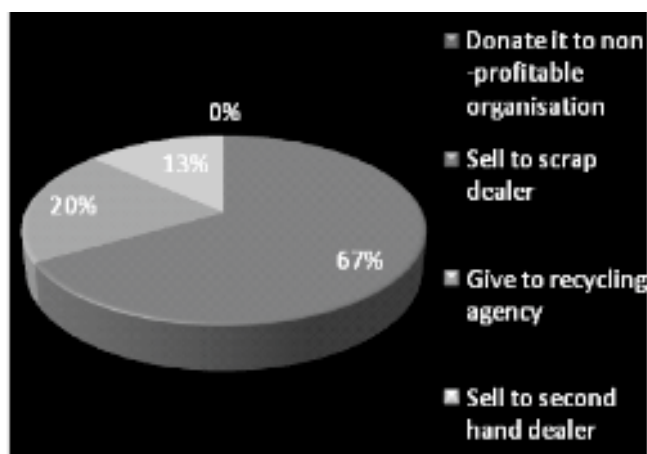
Fig. 9. Method of disposal of e-waste

Donate to NGOs	0
Sell to scrap dealer	10
Give to recycling agency	3
Sell to second hand dealer	2

From the above figures (5-9), it may be concluded that implementation of different aspects of Green Computing was partial due to constraints such as:

1. High start up and implementation cost of new technology.

2. With reference to e-waste management, lack of techniques and unavailability of recycling centres in Patna.

3. Casual approach of resource usage without considering its environmental impacts.

Conclusion:

It is concluded that theoretical awareness and willingness of IT cells to contribute towards the eco-friendly use of computers and their resources was there, but the implementation was partial due to certain constraints such as non availability of technological support, high implementation cost of complex technology involved, non availability of e-wastes recycling centres etc. in Patna.

The present scenario portrays a dismal picture of environmental degradation.

To change the scenario, the IT organizations should abide by the general rules practiced for the purchase, use and disposal of computers and other peripherals. Govt. initiatives like conducting awareness programmes, encouragement and support to technologically green organizations, development of e-waste disposal and recycling centres, enforcement of stringent laws against violators is required. As an individual, a holistic approach towards the conservation of environment should be focused while we use computers.

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