RUNNING HEAD: IT ENVIRONMENTAL IMPACT

Impact of Information Technology on the Environment- A Critical Analysis

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ABSTRACT

Our planet is facing environmental crisis. The researchers around the world have started recognizing a relationship between the deteriorating earth's environment with the human behaviour .1400 years back Hazrat Mohammad (PBUH) raised the same concept and gave mankind the message of love, harmony and respect towards the nature, mankind and all of the creations. Environment deterioration is a challenge the world is facing as a whole. We are living in the age of information and technology, a lifestyle with speed, luxury and comfort. Technology is changing very fast to bring economical growth i.e. increase in the level of living standard of the people of the world. The countries that are more technologically advanced are economically strong nations of the world. The darker side of the story is that with the advancement of technology and its careless use, there is an increase in the environmental related problems. Significant material, electricity and water consumption by the IT industry is an add-on to the environmental problems.

This paper is an attempt to explore the environmental related problems pertaining to information technology. For this purpose, I have used information oriented sampling for selecting the case for conducting the research. The case of IBM is selected because IBM is one of the best rated Green IT companies providing green solutions to almost every aspect of life and linking different stakeholders at nationals and international levels.

Keywords:

Green IT, IT industry, Consumption, Environment deterioration

PAPER OBJECTIVES

Objectives of the paper are as follow:

1. To explore environmental concerns regarding the information technology.
2. To explore material consumption, energy consumption, water consumption of IT operations

RESEARCH METHODOLOGY

The purpose of the research is to explore the "Impacts of Information Technology on the Environment" so the research nature is Exploratory Research. This paper required a case study approach because of the following reasons:

1. To investigate green IT aspects in its real-time context.
2. To get real time in-depth knowledge about the environmental impacts of computing.

The case study approach didn't limit us to conduct qualitative analysis but we have also performed quantitative analysis on the real time data of water consumption, electricity consumption.

INTRODUCTION

Human beings have the right to get the benefit from the resources on the earth like fire, water, lands, forest, sea, sunlight, oceans etc. But the usage of the resources subject to establishing the degree of need and the impact of usage on the environment. Earth is created in balance. There are biogeochemical cycles going on the earth and because of these cycles life on earth has become possible. Natural cycles like oxygen cycle, carbon cycle, and nitrogen cycle are perfect example of the well balanced systems on earth due to which life on earth becomes possible but from last few decades with the careless use of resources by mankind these well balanced systems are disturbed giving birth to the problems like increased pollution.

We are living in the age of information and technology, a lifestyle with speed, luxury, comfort. Human being is now able to cover the distance of months in hours with the help of airplanes, weeks in hours with the help of cars and motor vehicles and can make eatables quickly and in less time in microwaves. Technology is changing so fast that every day we are having exciting and new models of mobile phones, computers and laptops and every kind of electronics with new functionalities. Communication is so easy that even our relatives are far away we can see them through webcam and talk to them through mobile phones and voice chats and e-mails. Due to globalization and ease of doing work there are just no boundaries left for doing business. One being living in Pakistan can conduct business in USA. We have fans and air-conditioners to safe ourselves from the outside heat; cool breezes are just click away even in

scorching heat in the summer. The list of benefits enjoyed by human beings now-a-days goes on and on and can never end so do the impacts on environment caused by these activities.

Today, the increased technology needs in everything we use has resulted in increased number of IT companies which is economical very good and has created lots of job opportunities worldwide but the other side of mirror is darker as it has led to increased carbon emissions in the atmosphere. Carbon emissions are not only limited to factories, agriculture but sectors like Information Technology, telecommunication, film industry, hospitals or any kind of business is responsible for the emissions of greenhouse gases in atmosphere and other environment problems. There is no single sector that can be excluded from being responsible towards environment and so is the case with Information Technology. The need for the instant access to the information has resulted in the growing demand of hardware, software and IT services.

Because the virtual nature of IT based processes, IT industry is considered to be environmental friendly but the fact is IT industry's own global footprint is currently 2% of the global emissions reported by Gartner. Contribution of air traffic in green house gas emission is also 2 %.

(Book Green IT, Kelly Chain) Being an IT engineer one may feel that he is not involved in the crime of murdering the earth environment but he has no idea how his organization is involved and what role it is playing in deteriorating the earth's green environment so it's not okay to just feel happy that you are not the part of those polluting factories. It is very much important to know that IT industry is too harming the environment of the earth. Ignorance is a curse and awareness is a blessing. Because if you do not know the problem, you can't find the solution so identifying the problem is always the first step. The question is where the problem exists and how an IT organization is discharging pollution in the environment. All the desktop PCs, servers, switches in the organization use electricity to run. The electricity not only result in huge bills but it also result in the use of more fossil fuels to generate electricity which means more greenhouse gases in the environment. It may sound that IT industry has indirect relationship with the deteriorating earth's atmosphere. But this is not the case, let's see how.

IT operations are not only crucial aspects of the IT organizations alone but almost every kind of organizations depends on information systems to run their businesses. Where Internet is needed by all kind of businesses, individuals around the world and that too for 24/7 and the availability of data and information makes the server's availability mandatory. In other words business continuity is one of the main concerns that make the information systems and their availability very important. If information system gets down it can partially or completely shut down the operations of the organization and this makes the power usage by the IT operations a

first and foremost issue as its impact is significantly large and this is how it is directly deteriorating earth's atmosphere. [1]

DISCUSSION

Impact of Information Technology on the Environment

According Gartner, there are 1 billion PCs in use worldwide and this is expected to increase to 2 billion PCs in use worldwide in 2014.With this we expect that ratio of IT contribution towards the emission of green house gases is expected to increase at an alarming rate. As reported by Gartner PCs and monitor contribute to 39 % of total ICT contribution in carbon emissions which is equal to 49.3 million cars on the road.[2]

(Wikipedia, 27 July 2010) A typical PC consumes half of the power for its operations and waste the rest half as "HEAT" and for the typical server 30% to 40 % of the energy consumed is wasted. Now this surely is not a small amount when in the organization thousands of the PC, Laptops are running and data centers in which number of servers are operating. The heat emitted as waste arises the demand of air-conditioning which in turn increase the power requirements and the bill associated with it. The more equipment you have that is less efficient the more heat it will generate and that means that more electricity will be required to cool those equipments. May be the facts and figures above are surprising but the more surprising thing is that this heat can be utilized as well. As Engineers we should find the opportunities in every problem. The Switzerland Company utilized the heat generated from their data centers to heat the nearby swimming pool; now this is called resource utilization. The other reason is improper power management. Improper power management is utilizing the power more than it is required. It can be due to human negligence of utilizing the power more than their requirements e.g. not switching off the lights, AC, computers and laptops when they are not using them and it can be due to the inefficient design of the electronic devices .e.g. consuming a lot of power to operate or not able to recognize when the system is in idle state.[3]

(Sustainable Information Technology, 2005)UN Studies revealed that a single Computer Screen Manufacturing consumes 530 pounds of fossil fuels, 48 pounds of chemicals and 3000 pounds of water. The total material consumed in manufacturing is more than the weight of the average car i.e. 3000 pounds. One of the Most Toxic material is lead, about 4 to 8 pounds of lead is

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[1] **Green IT :** *http://books.google.com.pk/books?id=xPQZqKrJN7oC&printsec=frontcover&dq=green+IT&source=bl&ots=vn5v_U3E1u&sig=rYq2R6TFvYTcBp3XN5qvCJso5xc&hl=en&ei=UAsXTLW1D821rAfzqYmyCg&sa=X&oi=book_result&ct=result&resnum=5&ved=0CDwQ6AEwBA#v=onepage&q&f=false*

[2] **PC Energy Report 2009:** *http://www.1e.com/energycampaign/downloads/PC_EnergyReport2009-US.pdf*

[3] **Climate Saver Computing Initiative:** *http://en.wikipedia.org/wiki/Climate_Savers_Computing_Initiative*

present in each computer display. Environment issues related to lead are many. It can damage blood and nervous system of humans.[4]

ANALYSIS AND RESULTS

Chemical Consumption and it's Environment Impact

The semi conductor manufacturers are very confident when it comes to their manufacturing environment. The semi conductor industry association's head of health, safety and environment said that their operating environment is cleaner than operating room of a hospital. The fact is that chemicals being used in the chip making process are very toxic to human health and this poses a great danger to the workers.

Case Study Analysis – IBM Semiconductor Manufacturing

There are many incidents related to the harmful effects of toxic chemicals on the workers. Some of them which were headlines in the newspaper are as follow:

*Case A:*In 1996, IBM ex-workers and families of the ex-workers who died because of the cancer filled cases against the chemical manufacturing companies, that they faced adverse health problems due to the exposure to toxic chemicals on the job.

Case B: In an another incident , a group of ex-workers of IBM filed a case against the IBM that they were exposed to hazardous chemicals during their job due to which they developed cancer. Because of the arising concerns a committee was formed by the health and safety executive to investigate the claims. The committee found that there was high rate of cancers among the employees working at National Semiconductor's fabrication. The finding was huge setback for the company and industry.

RESULTS

Chemicals used in semiconductor manufacturing are dangerous to human health especially for the workers of semi-conductor manufacturing companies and the claims about the operating rooms of semiconductor manufacturing companies is not that true because the purpose of the operating rooms are not to protect their employees from the chemicals but to protect silicon wafers from the employees in order to safe silicon wafers from dust, hairs, skin of the employees.

Water Consumption by IT Operations and it's Environmental Impacts

Due to climate change dry areas are getting less rainfall and wet areas are getting more.
Climate change is affecting the availability of water worldwide. 2/3 of the earth is covered with

[4] **Sustainable IT :** *http://www.greenit.net/downloads/GreenIT-EnvIssues-PCs.pdf*

the water but the reality is that only 1% of the water is usable. The ever increasing population led to increase demand of water utilization. Water scarcity has gripped the world and it occurs when the demand increases the available quantity or when the quality of water restricts it use.

The main culprits in the wasteful use of water are

- Beverage industry – examples are PepsiCo and Coco cola
- Semi conductor industry – examples are IBM and Toshiba

Microelectronics operations of IBM are water intensive operations. Vast amount of clean water is required in semi-conductor manufacturing making the situation of water scarcity worst

Table 1 : Analysis of Water Consumption by IBM

Microelectronics Operations	Water Consumption	Equivalent Water Consumption	Assumptions
	Gallons[1 Gallon= 3.78 liters]	(no of houses)	
Average water utilization at IBM per day	8,503,698[5]	24,296	Average household water use daily = 350 gallons
Average Water Utilization at IBM worldwide annually	3,061,754,074	24,033	Average household water use annually = 127,400 gallons

Result

[5] Water consumption of IBM: http://www.ibm.com/ibm/environment/conservation/

In one day only IBM utilizes clean water that can be used by 24,296 # of houses in a day and in one year IBM utilizes clean water that can be used by 24,033 # of houses in one year.

Electricity Consumption By IT Operations and it's Environmental Impact

A typical PC consumes half of the power for its operations and waste the rest half as "HEAT" and for the typical server 30% to 40 % of the energy consumed is wasted. Now this surely is not a small amount when in the organization thousands of the PC, Laptops are running and datacenters in which number of servers are operating. The heat emitted as waste arises the demand of air-conditioning which in turn increase the power requirements and the bill associated with it. The more equipment you have that is less efficient the more heat it will generate and that means that more electricity will be required to cool those equipments. Electricity consumed by a typical PC per hour is 250 watts; it means 125 watts of energy is wasted as heat. For that matter, equipment should be energy efficient to avoid electricity to be wasted as heat.

Table 2 : Analysis of Electricity Consumption by IT Product and Service

Entity	Electricity Consumption	Equivalent Co2 Emissions and Equivalent Electricity Consumption	Assumptions
	(watts/kilowatts)/ (no of Google search clicks)	(Grams and no of houses)	
PC	250 watts/ hour by 1 PC	155.25 grams	Assumption by Sarah Rigg: 250 watts/hour may be utilized if the person is using the PC in power intensive tasks e.g.

			surfing the internet, playing graphic intensive games etc.[6] Assumption by Kimberly Crandel: 1.37 pounds of CO2 is released per kWh[7]
	3000 watts/ day by 1 PC	1 863 grams	Assuming that PC is on for 12 hours
	3 billion kilowatts/day by 1 billion PCs	1 863 000 000 000 grams and 4,16,666 homes	(Reported by CNET NEWS): There are one billion users of PC by the end of 2010.[8] (Assumption based on the electricity consumption of my house): Electricity consumption of a single house 7 200 Kilowatt/hour per month

[6] **How much electricity a computer use?** *http://www.ehow.com/about_4693473_much-electricity-does-computer-use.html*
[7] **I Wanna go green:**h*ttp://www.science20.com/science_mom/i_wanna_go_green_so_show_me_the_math*
[8] **I billion PC users on the way:** *http://news.cnet.com/A-billion-PC-users-on-the-way/2100-1003_3-5290988.html*

The Product use services e.g. computers, laptops, mobile devices uses internet services, telecommunication services etc. Today there is an increase use of internet based communication and internet. Information security is biggest threat as we are living in the information age as now revolution is brought by information. The information service providers e.g. Google maintain information on the servers and whenever the customer requires information, information is retrieved from the servers and is provided to the customers. A Data center is a facility equipped with one or more connected servers, used for processing or transmitting data. The Data center operations are energy intensive data center consumes a lot of energy and companies are looking and searching for number of ways to reduce the energy requirements of their data centers and the cost associated with the energy use.

Table 3: Analysis of Electricity Consumption by IT Product and Service

Entity	Electricity Consumption	Equivalent Co2 Emissions and Equivalent Electricity Consumption	Assumptions
	(watts/kilowatts)/ (no of Google search clicks)	(Grams and no of houses)	
Google Search	0.3 watts/ 1 Google search click	0.2 grams	(Reported by Google) Google itself reported that its data center utilizes 0.3 watts of electricity and release 0.2 grams of CO2 emissions. [9]

[9] **Efficient Computing :** *http://www.google.com/corporate/datacenter/efficient-computing/*

	3 * 10 ^ 8 watts/ by 1 billion Google search clicks	2 * 10^8 grams and 42 houses	(Reported by CNET NEWS): There are one billion users of PC by the end of 2010.[10]

Results

Most of the researches show that there are 1 billion of users that use PC daily. If these 1 billion of PCs are shut off for 1 day, the electricity will be enough to light 4, 16,666 # of homes per month.

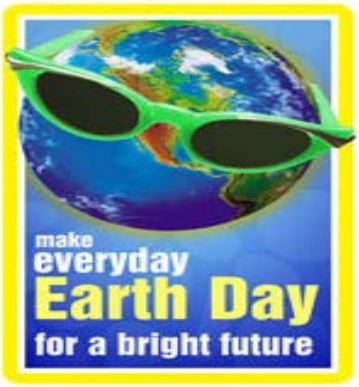
Electricity consumed by 1 Google search by 1 billion of PC users emits 200,000,000 grams CO2 emissions and electricity consumed i.e. 300,000,000 watts will be enough to light 42 houses in a month.

Table 4 - Main Results	
Type of Consumption	Results
Chemical	Darker Side of Semi-conductor Manufacturing Companies Chemicals used in semiconductor manufacturing are dangerous to human health especially for the workers of semi-conductor manufacturing companies and the claims about the operating rooms of semiconductor manufacturing companies is not that true because the purpose of the operating rooms are not to protect their employees from the chemicals but to protect silicon wafers from the employees in order to safe silicon wafers from dust, hairs, skin of the employees.
Water	In one day only IBM utilizes clean water that can be used by 24,296 # of houses in

[10] **I billion PC users on the way:** *http://news.cnet.com/A-billion-PC-users-on-the-way/2100-1003_3-5290988.html*

	a day and in one year IBM utilizes clean water that can be used by 24,033 # of houses in one year.
Electricity	Electricity Consumption by IT Products is Significant: Most of the researches shows that there are 1 billion of users that use PC daily. If these 1 billion of PCs are shut off for 1 day, the electricity will be enough to light 4, 16,666 # of homes per month. IT Services like Single Google Search Consume Significant Amount of Electricity due to Huge Data Canters: : Electricity consumed by 1 Google search by 1 billion of PC users emits 200,000,000 grams CO2 emissions and electricity consumed i.e. 300,000,000 watts will be enough to light 42 houses in a month.

CONCLUSION



April 22 is the Earth day that is celebrated throughout the world. The intention is to spread awareness throughout the world about the importance of environment and its protection. We conclude that everyday should be an earth day. And this can only happen if human beings realize the importance of natural resources by not polluting and wasting them, and using them in the best possible way.

Most of IT professionals have no idea what green computing is all about. Most of them does not even knew what green or sustainability is all about and what climate change has to do with the way we are living which is indeed a serious concern and because an alarming less rate of literacy, even the educated ones are unaware towards a very significant topic.

There are two side of the coin, if IT is facing a challenge to reduce its own carbon footprints; it also has an opportunity to help other industries to reduce their carbon footprints by introducing green solutions and technologies. Young minds are of great help to bring about new eco-technology to help the environment as well as the society. For this matter, it is important to plan their training accordingly. Around the world, MSC in green computing is being offered and sustainable IT research is being conducted. Well renowned universities like Oxford and Harvard are giving special importance to sustainable training.

Green IT experts are required. T shape expert is the one who has knowledge of more than one field with board knowledge in many fields and deep knowledge in one field. To cope with technological changes and their impact on the environment green IT specialist are required who have deep knowledge of Information technology and have boarder knowledge of the environment related problems. Interdisciplinary IT education i.e. mixing of IT and environmental knowledge is important to develop innovative green solutions. Green IT specialists are required for critical thinking, green IT innovations, global and technological awareness. Universities should provide tools to the students that help can students to make decisions regarding their careers and to have an idea for the potential of success in the interdisciplinary fields.

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