Analysis of Greening of Information Technology Systems in IT Organizations in Sri Lanka

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Abstract - *Computers and other IT infrastructure consume significant amount of electricity, increasing day by day, placing a heavy burden on our electric grids and contributing to greenhouse gas emission. Information technology now has a new role to play in creating a greener, more sustainable environment for the future generation. Green IT is an umbrella term referring to environmentally sound information technologies and systems, applications and practices. It refers to the efficient and effective design, manufacture, use and disposal of IT equipment with no or minimal impact on the environment. This research analyses the current level of Greening of Information Technology systems in IT organizations in Sri Lanka based on their purchasing, usage, disposal and the technology usage as the Green enabler of IT systems. This research is targeted to chief information officers or equivalent officers. The results show that the organizations have implemented energy saving mechanisms for some extent and adopted some of the state-of-the-art Green technologies. However, life cycle approach that includes purchasing, reuse, recycle and disposal of Green IT equipment was not followed.*

Keywords— *Green IT; Green; Greening of IT; Green purchasing; Green disposal; Technology as green enabler.*

I. INTRODUCTION

Since its inception, the IT industry has focused on the development and deployment of IT equipment and services that was capable of meeting the ever-growing demands of business customers. Therefore, industry focused on processing power and systems spending. Less attention was given to infrastructure issues which include energy consumption, cooling, and space for data centres, since they were assumed to be always available and affordable. Over the last few decades these issues have become limiting factors in determining the feasibility of deploying new IT systems, while processing power is widely available and affordable [1].

IT affects our environment in several different ways. Each stage of a computer's life, from its production, throughout its use, and into its disposal, presents environmental problems [2] Studies have shown that, globally, the electricity consumption of Personal Computers (PCs) is growing by 5 per cent annually. In an average Small-to-Medium-sized Enterprise (SME) electricity consumption accounts for 10 per cent of an IT department's budget, alarmingly rising to over 50 per cent in some extreme cases. Studies have also found that the cost of electricity to run a typical computer over its lifetime is now even greater than its purchase price [3]. PCs on average use only about 100 watts of power, but there are well over a billion of them in the world, so the combined electrical requirement is large. [4]

The total electrical energy consumption by servers, computers, monitors, data communications equipment, and cooling systems for data centres is steadily increasing. This increase in energy consumption results in increased greenhouse gas emissions. Each PC in use generates about a ton of carbon dioxide every year [2]. Gartner estimated that IT industry accounts for approximately 2% of global carbon dioxide (CO2) gas emission [5]. The increasing accumulation of greenhouse gases is affecting the climate and weather pattern. It increases the global temperature and causes global warming [2].

The importance of Green IT is strongly recognized in the Chief financial officer (CFO) Research services report [6] and in information system research [7]. There are two challenges for IT managers [8]. First they need to reduce the IT related energy use, greenhouse gas emissions, inefficiency in equipment usage and wastes. Then they are expected to provide IT solutions to improve their environmental footprint, in their business and supply chains. Some of the world leading companies such as Dell, Wal-Mart have adopted initiatives on Green practices and force their suppliers to adopt environmentally friendly practices [2].

While reducing the greenhouse gas emission by IT, there is another problem arises due to the electronic waste (e-waste); the disposal of IT equipment. Global electronic waste (e-waste) is growing by about 40 million tons a year [9]. Green IT should play a major role to tackle all of these issues.

Thus analysing the Greening of IT systems in organizations helps to understand how well companies are preparing for future. Knowing the importance of environmental issues and the potential of IT in advancing ecological sustainability, it is sensible to investigate the current level of Greening of IT systems.

This research was carried out to survey and identify the factors involving in Greening of Information Technology systems. The following objectives were made for the research. It is important to identify the

factors of Greening IT systems, to lay the foundation for this research. Then it analyses the current level of Greening of IT systems of Sri Lankan IT organizations based on the above identified factors with the expectation of improving Green IT level in those organizations in the future. The significance of this research is cost reduction of IT organizations. The direct benefit of adopting Green practices in the organizations is the cost reduction and the environmental preservation for the future generations.

II. LITERATURE REVIEW

A. Green IT

The term "Green IT" is widely used by the industry and in the media. The Gartner definition, within the context of an enterprise is "optimal use of information and communication technology (ICT) for managing the environmental sustainability of enterprise operations and the supply chain, as well as that of its products, services and resources, throughout their life cycles."[10] Lamb defines Green-IT as "the study and practice of using computing resources efficiently" [11] and Webber and Wallace define Green-IT as "the reduced environmental impact from running an information technology (IT) department" [12] San Murugesan states that "It's the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems—efficiently and effectively with minimal or no impact on the environment [2]. Green IT includes the dimensions of environmental sustainability, the economics of energy efficiency, and the total cost of ownership, which includes the cost of disposal and recycling.

Cutting costs and improving environmental performance are not mutually exclusive topics. Adopting Green IT practices offers businesses and individuals financial and other benefits. IT operations achieve better energy efficiency through Green initiatives, which financially benefit them, especially when electrical energy is at a premium and energy prices are rising. [10]

The first wave of Green IT is more focused on the virtualization, data centre infrastructure, power management, and new technology on the desktop computers [6]. It focused on decreasing IT's data centre and desktop footprint, increasing the efficiency of IT infrastructure, and managing and reducing IT's consumption of electricity. These early efforts are primarily technical solutions that can be deployed through improvements in equipment. They include adoption of basic energy management practices, use of IT gear that is more efficient than older equipment, and deployment of software as a tool to track the efficiency of operations.

The next wave of Green IT focused on the broader change in processes, behaviour, and company culture [6]. There are a lot of challenges in investments,

strategy, risk, and social commitments, as well as the efficiency and cost savings. It is often the chief financial officer (CFO) who drives [Green] initiatives across a company, but usually on the basis of money-saving [13]. Companies can take internal steps to improve processes and cut waste, but the breakthrough will come from more environmentally sensitive solutions coming to market for them to employ.

B. Holistic Approach

To comprehensively and effectively address the environmental impacts of IT, we must adopt a holistic approach that addresses the problems along the following four complementary paths [2]

•   Green use. Reduce the energy consumption of computers and other information systems and use them in an environmentally sound manner.

•   Green disposal. Refurbish and reuse old computers and properly recycle unwanted computers and other electronic equipment.

•   Green design. Design energy efficient and environmentally sound components, computers, servers, and cooling equipment.

•   Green manufacturing. Manufacture electronic components, computers, and other associated subsystems with minimal or no impact on the environment

By considering these four aspects of Green IT, we can achieve total environmental sustainability from the IT side and make IT greener throughout its entire lifecycle.

C. Green Use

Much effort has gone into making PCs more energy- efficient, but it is not just the power used by office desktop computers that places massive burdens on electricity supplies. The networks, servers and storage resources they connect to – plus the printers, scanners, photocopiers, phone handsets, and other electronic office equipment that supplement them – all contribute toward increasing IT's carbon footprint.

PCs, printers and other client devices can be significantly improved through the application of basic good practices. We can significantly reduce energy consumption by making small changes to the ways we use computers. Most personal desktop computers run even when they aren't being used, wasting electricity. When we think of a PC, it seems not much, but the combined savings for hundreds of computers in an enterprise is considerable. Without sacrificing performance, we can program computers to automatically power down to an energy-saving state when we aren't using them.

Turning off the system when not in use is the most basic energy conservation strategy for most systems. Many people believe the misconception that a computer's life is shortened by turning it on and off, so they leave their computers on all the time. The electronic equipment's life span depends on its cumulative operational time and its temperature.

Turning it off reduces both of these factors, increasing the life of the equipment. Users can choose to employ thin-client computers, which draw about a fifth of the power of a desktop PC [2].

These measures, though easily adoptable, wouldn't become a practical reality without users' wholehearted willingness and active participation. To make these efforts a success, enterprises must educate their employees to save energy by changing their computer habits. Enterprises must seek their employees' feedback, address their concerns, and encourage them to join in Green computing efforts.

It is estimated that potential power cost and CO emission reductions of 50% are available [14]. The market is growing for power management tools to help enterprises enforce power management policies and better understand the potential for savings. We anticipate the entire area of energy-monitoring tools will grow tremendously during the next two years. The tools are important, but much of the challenge and the solutions will be behavioural [10].

D. Green Disposal

Unwanted computers and monitors shouldn't be thrown away in rubbish bins, as they will then end up in landfills causing serious environmental problems. Instead, we should refurbish and reuse or recycle them in environmentally sound ways

• Reuse. We should make use of an older computer if it meets our requirements. Otherwise, we should give it to someone who needs it or use functional components from a retired product.

• Refurbish. We can refurbish and upgrade old computers and servers to meet new requirements. We can make an old computer and other it hardware almost new again by reconditioning and replacing their parts.

• Recycle. When we can't reuse computers, we must dispose of them properly in environmentally friendly ways. Most unwanted computers and electronic goods end up in landfills.

E. Green Design

Green computer design aims to reduce the environmental impact of computers by adopting new technologies and using new techniques and materials while balancing environmental compatibility with economic viability and performance. Green design is quickly becoming a necessary business practice. Many computer manufacturers are in the process of making Green PCs using nontoxic materials that consume less electrical power and are easily reassembled.

F. Green Manufacturing

Manufacturers now apply power-reduction techniques commonly used for laptops, such as screens that darken the backlight and lighten the display palette as well as flash memory caches for hard disks, desktops, and servers. IT vendors are now investing significant resources in Green initiatives such as developing energy-efficient servers, data centre cooling solutions, and new materials and design options.

G. Technology as the Green enabler

IT Clients are affected by the increasing costs of corporate travel and employee commuting costs. Rising airline ticket prices have resulted in many organizations looking at options such as telecommuting and teleworking and deploying the newer IP-based "telepresence" solutions [15].

As an alternative to flying personnel to meetings, companies are turning to technology-based solutions to bring down their travel costs. In some cases, older technologies such as teleconferencing and videoconferencing are being put into more active use. In other cases, organizations are implementing solutions that capitalize on mobile, IP, web and video-based technologies. A few of the more common that underpin Green IT travel reduction strategies include the use of web-enabled voice and video conferencing using meeting-ware products to provide presentation sharing and discussion capability.

New in this area of technology are the enhanced, IP-based videoconferencing "telepresence" solutions that use large flat panel monitors with full-motion video and life-sized images to create a lifelike, real-time, meeting experience. While these solutions are targeted more toward reducing air travel costs, other initiatives focus on technologies that enable employees to work remotely to cut down on daily commute time and costs. In addition to their impact on global greenhouse gas emissions, these programs are designed to improve loyalty and morale, thereby improving productivity and overall retention.

III. METHODOLOGY

A. Scope

Green IT is a very vast area and it is applicable almost all of the organizations. But we narrowed down the research to a particular area and left the room for future research. Green IT is applicable for all organizations that use IT in any of their business processes; however this research focuses on the IT organizations in Sri Lanka, because IT and IT equipment are heavily used in these types of organizations when compared to other types of organizations. In each IT organizations, IT managers are the target groups of this research as this research wants to explore the Greening of IT systems in the organizations. IT Software industry and IT Business Process Outsourcing (BPO) organizations are considered IT organizations in this research as their core business is Information Technology.

B. Conceptual Model

Based on the literature review, holistic approach of Greening of IT systems has four major components. Green use, Green disposal, Green design and Green manufacturing. This research was targeted to Sri

Lankan IT software and BPO organizations. These Sri Lankan organizations don't manufacture IT equipment. Instead they purchase the required IT equipment. So our concept model consists of Green purchasing of IT systems instead of Green manufacturing of IT systems. Sri Lankan IT organizations don't design computers or IT equipment. Instead they apply the state-of—the-art technologies as the Green enabler in their organizations to design their IT business processes. The derived conceptual model is shown in Fig. 1.
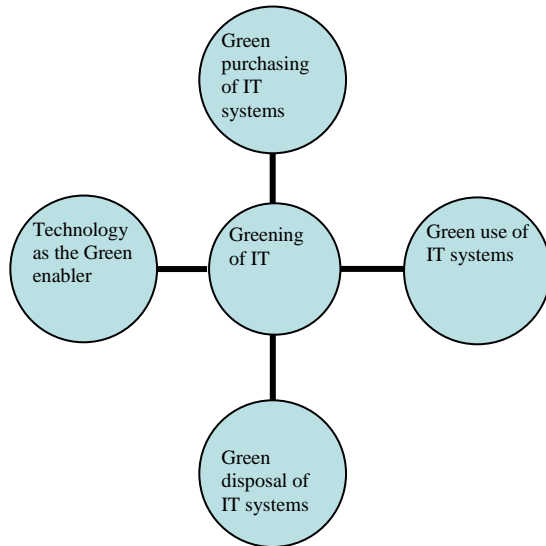
Fig. 1 Greening of IT Concept Model

C. Research Method

In order to achieve the objectives of the research, a survey method is followed among the Chief Information Officers (CIO) or equivalent IT managers of the IT organizations in Sri Lanka. Greening of IT system Likert scale survey is used to quantitatively determine the current level of Greening of IT systems. To determine Greening of IT systems level, a survey is the best choice, because senior IT managers would not like to spend time with a long and time-taking questionnaire, and Likert scale based responses make it easier for them to answer a long questionnaire. Survey helps to capture a picture of a situation at a specific point of time and the possibility of large sample size allows making generalizations [16].

D. Survey

Based on the above conceptual model, a survey was prepared in a way that all the components of the conceptual model was included in that questionnaire. In addition, this survey questionnaire includes items to capture the profile of respondents' company such as number of personal computers, and total number of employees. The survey is used to analyse the current level of Greening of IT systems in IT organization in Sri Lanka. It was carried out as a web based survey. The force choice Likert scale questionnaire was created as an online questionnaire using Google form.

The questionnaire was targeted to reach CIOs or their equivalents to answer.

E. Forced Choice Likert Scale

Likert Scaling is a bi polar scaling method, measuring either positive or negative response to a statement. Normally five point (odd-point) scales is used. Toner reported that acquiescent response bias (the tendency to say "Yes" indiscriminately in answer to questions) could be shown to constitute a serious problem. He suggests that we might generally in the future avoid such problems by using forced-choice scales [17].

In this research, a forced choice Likert scale method is used. Four point scales (even-point) is used, where the middle option of "Neither agree nor disagree" which is available in five point Likert scale is not available. The neutral option can be seen as an easy option to take when a respondent is unsure, and so whether it is a true neutral option is questionable. This research enforces the respondents to take a decision on their Greening of IT systems.

F. Data Sample

As this research is focused on the IT organizations in Sri Lanka, the list of IT organizations data were collected from one of the IT organizations association in Sri Lanka. The database contained the details around 151 Sri Lankan IT organizations. IT organizations those have been considered in this research have two major categories; IT Companies and IT Business Process Outsourcing (BPO)/ IT Enabled Services Sector (ITES) Companies.

IV. ANALYSIS OF THE RESULTS

The data collection of this research was done through an online survey directed at CIOs or their equivalents. A total of 151 CIOs or their equivalent was invited to complete the online survey. A total of 72 contacts bounced back because of delivery failure, out of office, or invitees declining to complete the survey. A total of 32 responses were received. The response rate of this research is 21%, which is lower than a suggested good response rate of 36% (+/-13%) [18]. However, the rate is in line with majority of research carried out with CIO level employees [19] [8] [20]. When compared to these results, the 21% response rate is better with earlier results carried out with CIO level employees.

A. Respondent Analysis

The number of PCs used in the organizations surveyed is displayed in Fig. 2. Personal computers are one of the main IT equipment used in the IT organizations. The distributions looks fairly distributed among the organizational sizes.
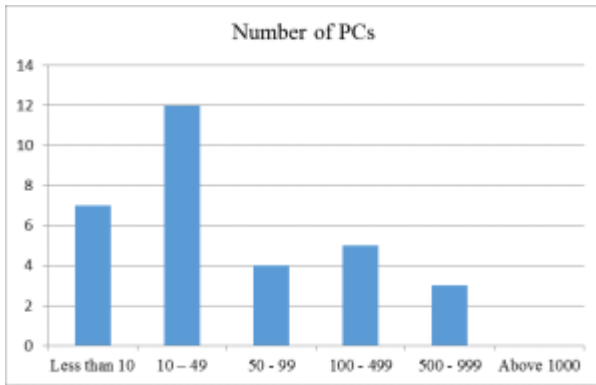
Fig. 2 Number of PCs used in the organizations

B.   Green Purchasing of IT Systems

The response of the Green purchasing of IT systems is shown in Fig. 3. 23 organizations do not adopt environmental friendly IT purchasing policy. Less than 10% of the organizations implemented some sort of environmentally friendly purchasing of IT systems. Most of the IT organizations (26 out of 31 – 84%) are not adopting the preference of IT suppliers with Green track record. The same amount of organizations are not adopted Green supply chain management policy. Most of the IT organizations (more than 60%) didn't consider environmental performance of IT suppliers. Around 60% don't give weight to environmental considerations in IT procurement.
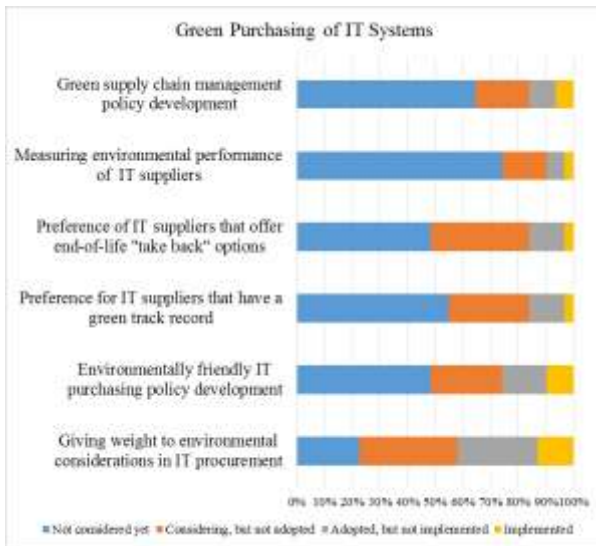

Fig. 3 Green Purchasing of IT Systems

Sri Lankan IT organizations. 26 out of 31 (84%) IT organizations have replaced their CRT monitors with the flat screen monitors and considered it as a best practice in their organizations. 23 IT organizations (75%) are using low watt personal computers and most of them (16 organizations) have considered it as a best practice for their organization. Around 70% of the organizations are powering down PCs when not in

use and switching off data centre lights when not in use. Around 60% of the organization considering to implement power saving settings at the PC level. Over 60% of the organizations have adopted or implemented power saving mechanisms in the organizational level. 18 out of 31 (58%) organizations implemented the server power saving to minimize the energy cost of servers. Same amount of companies did not consider about networking components those could reduce power consumptions such as power over Ethernet solutions.
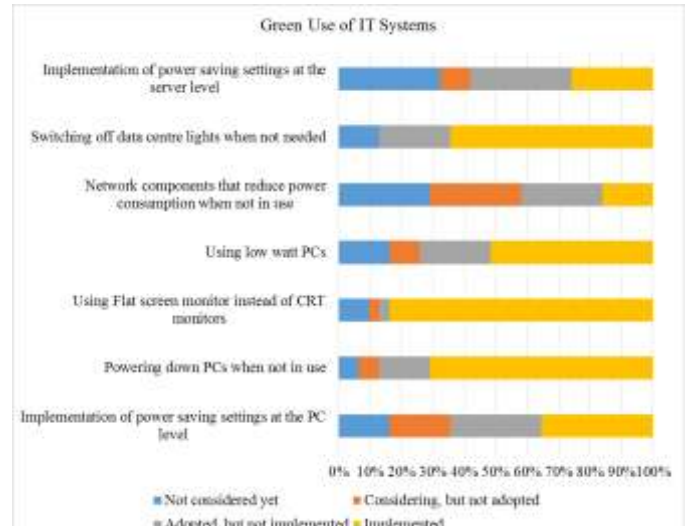

Fig. 4 Green Use of IT Systems

D.   Technology as the Green Enabler

The use of state-of-the art-technologies to design IT systems in the Sri Lankan IT organizations are shown in the Fig. 5. 26 out of 31 (84%) organizations adopted teleconferencing practice to cut down the travelling cost and 25 (80%) organizations adopted remote services (cloud computing). Almost all of the organizations considered the usage of remote services and on-line collaboration tools. More than 50% of the organizations implemented telecommuting in their organizations. Usage of online collaboration tools are in the higher level of implementation. More than 80% have adopted the state-of-the-art technologies to design their organizational systems. These tools are to cut down travelling cost and to reduce the space and other facilities needed in an organization.
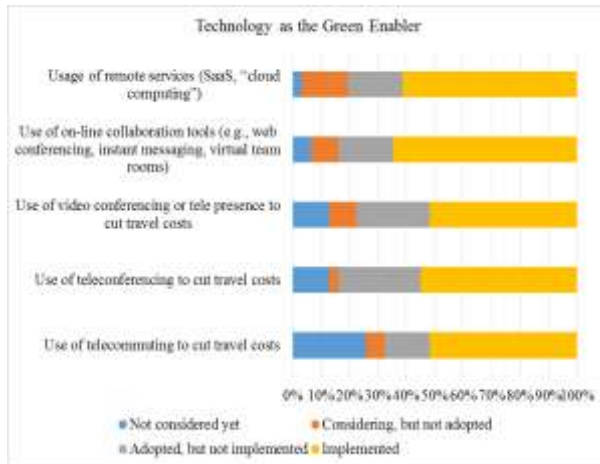
Fig. 5 Technology as the Green Enabler

E.   Green Disposal of IT Systems

Green disposal is shown in the Fig. 6. 18 out of 31 (58%) of organizations adopted printer cartridge recycling, 55 % of them adopted printer paper recycling and 55% of them adopted removing energy inefficient system from their organizations. 30% of the organizations discarded or recycled CRT monitors. More than 60% don't have concern policy development for electronic waste. Same percentage of organizations don't think to dispose IT equipment in environmentally friendly manner. More than 60% of the organizations did not have mechanisms to manage electronic waste.
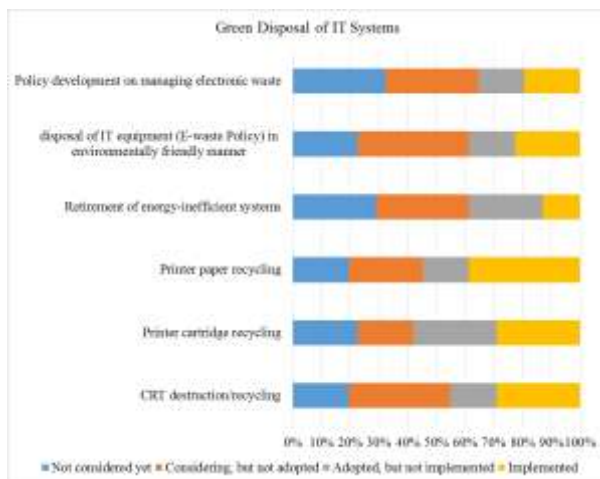

Fig. 6 Green Disposal of IT Systems

V.   DISCUSSION AND CONCLUSION

Based on the analysis in Sections IV Sri Lankan IT organizations have adopted some of the energy saving mechanisms to reduce power consumption of the IT systems. Organizations have focused on their energy reduction mechanisms by replacing old inefficient systems such as CRT monitors and they have adopted some good practices in their organizations. Sri Lankan IT organizations have implemented the new technologies and they are considering new technology trends as best practices. The fast adoption of state-of the-art technologies imply that organizations are flexible enough to adopt Green technology.

However, on the other hand Organizations do not consider the Green IT as an application to the whole system. They don't give priority for Green on purchasing IT equipment. They don't consider Green track record of IT suppliers. Sri Lankan IT organizations are lacking in measuring environmental performance of the IT suppliers and measuring the environmental impact of their IT usage. Organizations did not have mechanisms to manage electronic waste, environment friendly IT purchasing policy and Green supply chain management policy. They have not looked at Green IT as a path to minimize the environmental impacts. They think Green only as an energy saving mechanism.

This implies that the IT organizations handle their IT equipment to be energy efficient in their own organizations. But they did not consider Green IT as a whole life cycle approach of equipment. This is in line with the conclusion of the paper "Green Computing" [21]. Rather than considering only the minimum cost involved in purchasing, organizations need to think of the total cost of ownership; the total cost throughout the lifetime use of that equipment. It includes purchasing cost, energy cost and disposal cost of that equipment at the end of the lifetime of it.

VI.   REFERENCES

[1]   R. R. Harmon and N. Auseklis, "Sustainable IT services: Assessing the impact of green computing practices," in Portland International Conference on Management of Engineering Technology, 2009. PICMET 2009, 2009, pp. 1707–1717.

[2]   S. Murugesan, "Harnessing Green IT: Principles and Practices," IT Professional, vol. 10, no. 1, pp. 24–33, 2008.

[3]   M. O'Neill, Green It for Sustainable Business Practice: An Iseb Foundation Guide. Swindon: BCS, 2010.

[4]   S. Ruth, "Green IT More Than a Three Percent Solution?," IEEE Internet Comput., vol. 13, no. 4, pp. 74–78, Jul. 2009.

[5]   I.□ : Gartner, "Gartner Estimates ICT Industry Accounts for 2 Percent of Global CO2 Emissions," 2007.

[6]   K. S and L. PB, "The Next Wave of Green IT: IT's role in the future of enterprise sustainability," Boston, 2009.

[7]   J. Dedrick, "Green IS: Concepts and Issues for Information Systems Research," Commun. Assoc. Inf. Syst., vol. 27, no. 1, Aug. 2010.

[8]   A. Molla, V. Cooper, and S. Pittayachawan, "The Green IT Readiness (G-Readiness) of Organizations: An Exploratory Analysis of a Construct and Instrument," Commun. Assoc. Inf. Syst., vol. 29, no. 1, Aug. 2011.

[9]   M. Schluep, "Recycling - from e-waste to resources, Sustainable innovation and technology transfer industrial sector studies," 2009. .

[10]   "Green IT: The New Industry Shock Wave." [Online]. Available: https://www.gartner.com/doc/559709/green-it-new-industry-shock. [Accessed: 12-Jul-2015].

[11]   J. Lamb, The Greening of IT: How Companies Can Make a Difference for the Environment, 1 edition. Upper Saddle River, NJ: IBM Press, 2009.

[12]   L. Webber and M. Wallace, Green Tech: How to Plan and Implement Sustainable IT Solutions, 1 edition. New York: AMACOM, 2009.

[13] M. Courtney, "Now green IT gets personal," Eng. Technol., vol. 5, no. 17, pp. 48–51, Nov. 2010.

[14] "PC Power Management Activation Leads to Significant Power and Cost Savings." [Online]. Available: https://www.gartner.com/doc/517818/pc-power-management-activation-leads. [Accessed: 12-Jul-2015].

[15] "Emerging Trends in Green IT," 01-Mar-2010. [Online]. Available: https://www.cgi.com/en/node/2238. [Accessed: 14-Jul-2015].

[16] R. Galliers, Ed., Information Systems Research: Issues, Methods and Practical Guidelines. Oxford: Alfred Waller Ltd, 1992.

[17] B. Toner, "The Impact of Agreement Bias on the Ranking of Questionnaire Response," J. Soc. Psychol., vol. 127, no. 2, pp. 221–222, Apr. 1987.

[18] Y. Baruch, "Response Rate in Academic Studies-A Comparative Analysis," Hum. Relat., vol. 52, no. 4, pp. 421–438, Apr. 1999.

[19] A. Molla, V. Cooper, and S. Pittayachawan, "IT and Eco-sustainability: Developing and Validating a Green IT Readiness Model," ICIS 2009 Proc., Jan. 2009.

[20] L. Fink and S. Neumann, "Gaining Agility through IT Personnel Capabilities: The Mediating Role of IT Infrastructure Capabilities," J. Assoc. Inf. Syst., vol. 8, no. 8, Aug. 2007.

[21] Biswajit Saha."Green Computing". International Journal of Computer Trends and Technology (IJCTT) V14(2):46-50, Aug 2014. ISSN:2231-2803. www.ijcttjournal.org. Published by Seventh Sense Research Group.