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Taxonomy of sustainable IT values

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Taxonomy of sustainable IT values

by

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ABSTRACT

Sustainable IT is the effort towards design, manufacture, use and disposal of computer hardware efficiently and effectively with minimal or no impact to the environment. This implies biodegradability of defunct products and factory waste and energy efficiency. The performance of Green IT is a function of the 'green' steps taken towards sustainable IT. The development of green IT is a dynamic process and in the future may also have to address human health concerns. Several educational institutions of higher learning and technology companies have pioneered sustainable IT initiatives to achieve environmental and organizational sustainability.

This study is a modest attempt towards classification of green IT initiatives and indicators, provision of taxonomy of sustainable IT values incorporated by businesses and educational institutions and analysis of their impacts on environmental, social and economic performance of organizations. The study examined the green IT initiatives undertaken by a sample of 20 Universities and 15 Corporates and identified the following sustainable IT values as responsible for sustainable IT: 1) Green Computing and Infrastructure Management, 2) Reducing carbon foot print, 3) Greening IT supply chain and sustainable software development, 4) Environment friendly electronic waste disposal, and 5) Institutions facilitating green IT and organizational sustainability. The study inter alia, recommends investment of 10% of corporate profits towards Sustainable IT Solutions; incentives for outstanding employees and their contributions towards green IT in firm's promotion policy; creating awareness among employees regarding innovative sustainable practices as well as E-Governance to incorporate sustainable IT solutions.

CHAPTER I: INTRODUCTION

Advances in Information Technology (IT) and an increasing dependence on IT-enabled services and products have made it *sine qua non* for the existence, expansion, profitability, efficiency and sustainability of organizations worldwide. The efficiency, effectiveness, flexibility and user-friendliness offered by IT have made it indispensable for governments, businesses and organizations of higher learning playing a crucial role in governance. Information and Communication Technologies (ICT) account for two percent of the global CO_2 emissions, equivalent to those generated by the aviation industry (Christopher, 2007). However, if indirect energy use were included, ICTs account for as high as 14% of the global total carbon emissions. While the role of information technology in running successful organizations has been ever expanding and exciting, over-dependence on IT has also undesirable implications on energy, health and the social fabric (Horio & Watanabe, 2008). Unsustainable trends in the consumption of IT services are responsible for ICTs overall environmental and economic impact. The relationship between information technology, energy consumption and environmental sustainability is currently a reigning topic of discussion, and the catch-all phrase for this relationship, has been coined as green information technology (Green IT).

Climate change, increased CO_2 emission, and depletion of non-renewable sources of energy are now conspicuous, with IT being acknowledged as both a part of the problem as well as the solution. Currently, the net environmental effect of the use of IT is nebulous. Sustainability of IT remains unresolved albeit endless debates have been partially successful in shifting the focus of environmentalism from one of crisis to that of

opportunity (Mulvihill & Milan, 2007). A large number of organizations are thus examining ecological concerns as well as social concerns, the binding concepts of green IT for organizational sustainability. In this regard, the key trigger is to explore the green IT initiatives to achieve environmental and organizational sustainability for economic and social welfare. Academic and industry researchers have addressed several such green IT initiatives via independent streams (Mulvihill & Milan, 2007). However, since IT is interdisciplinary, spanning virtually every industry, a multi-layered notion of sustainable IT / Green IT is required. This has necessitated an in-depth examination of the efforts made by IT companies and educational organizations which have expressed an explicit commitment to achieving environmental and organizational sustainability through the greening of their IT products and services. Hence the need for an analysis of the IT companies and Universities committed to environmental and organizational sustainability through implementation of green IT technologies.

Objectives

There are several aspects of 'greening' the ICT that are common to various organizations, and several initiatives differ across organizations. This study aims to contribute towards the conceptual classification of noteworthy green IT practices followed by leading IT companies and institutions of higher learning. From this classification, IT users and providers can obtain cues to create green IT strategies for environmental and organizational sustainability.

With this backdrop of the effects of ICT signifying ecological and social concerns, the specific objectives of the study are to extend the extant literature pertaining to sustainable IT by -

1. Examining and classifying the current diverse set of green IT initiatives and indicators.

2. Providing taxonomy of sustainable IT values incorporated by businesses and educational institutions.

3. Showcasing noteworthy and successful green IT practices through an analysis of their impacts on environmental, social and economic performance of organizations chosen for the study.

This study aims to analyze the pros and cons of green IT initiatives and to reinforce the dual objective of green IT; of achieving environmental sustainability with organizational sustainability. Results of this study are expected to provide an empirical framework for organizations to follow and successfully initiate sustainable IT best practices. This paves the way to create awareness about the negative impact of over-dependence on IT, facilitating initiatives to reduce such impact, thereby defining organizations' strategies for a sustainable development.

CHAPTER II: LITERATURE REVIEW

Literature review for this study spans the definition of sustainability, how it applies to the field of information technology, sustainable IT efforts of corporations, educational organizations, and consumers of IT products and services.

Defining Sustainability

Perhaps the most widely accepted definition of sustainable development is the Brundtland Commission report of 1987, which states that "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (United Nations General Assembly (March 20, 1987). Sustainability, in this context, is relevant both literally and metaphorically (Mulvihill & Milan, 2007). Sustainability has historically been associated with forming goals for the future, hence; the most widely accepted definition is relevant to date. However, the Brundtland Commission definition has since been modified, incorporating a view of sustainability in both operational and organizational contexts. The Sustainability Handbook (Blackburn, 2007) indicates the business variant of the Brundtland commission as "Adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing human resources and natural resources that will be needed in the future".

Organizational sustainability can be defined as an organization's capability to survive crisis situations during its life cycle, beyond the conventional end-of-life state (van Eijnatten, Putnik, & Sluga, 2007). Sustainable development implies development of

strategies that enable environmental and organizational sustainability. Organizations have used the term sustainability interchangeably with organizational social responsibility or global corporate citizenship (Blackburn, 2007).

Sustainable development has no substitute (Nidumolu, Prahalad, & Rangaswami, 2009), and hence can no longer be perceived as an idea stemming from organizational philanthropy alone. Sustainability has attained a wider connotation, addressing normative and technical concerns.

Green IT literature

Green" IT is a catch-all term used to describe the manufacture, management, use and disposal of information technology in a way that minimizes damage to the stakeholders of IT and the environment. As a result, the term has different interpretations, depending on its reference to a manufacturer, manager or user of technology" (Walsh, 2007). A number of authors have analyzed the relationship between IT and sustainability, examining the role of IT in conserving the environment as well as the negative impact of IT on the environment (DiRamio, 2009; Grier, 2008; Sinnett; Stamper). Due to its interdisciplinary nature, quantifying the efficiency of green IT is challenging. Literature, to date, indicate that specific sustainable IT efforts have been undertaken by businesses from a vendor or IT provider's perspective and by educational organizations from an end-user's perspective, (Horio & Watanabe, 2008; Nidumolu et al., 2009), emphasizing the importance of Green IT.

Green Computing

Existing literature on Green IT has also focused on the challenges of green computing. Conventional approaches to increasing the power and performance of computing to fulfill the demands of a growing business have been deemed less efficient with the advent of green computing. Green computing practices entail supporting business critical computing needs with minimal use of power without sacrificing the overall performance (Harmon & Auseklis, 2009; Wang, 2007). Efficient use of power, efficient cooling of data centers, virtualization, cloud computing and use of power management software have been recognized as the top 'first wave' factors of green computing which most IT-centric organizations have now adopted (Harmon & Auseklis, 2009; Nordman & Christensen, 2009; Pratt, 2008). Harmon et.al, have assessed the importance of 'second wave' green computing practices such as IT services which are essential to business success driven by environmental reporting standards (Harmon & Auseklis, 2009). As countries worldwide are drafting regulations concerning environmental sustainability, Nidumolu et al., argue that viewing compliance as an opportunity will allow organizations to meet the requirements, thus helping them gain time to experiment, rethink and improve processes.(Nidumolu et al., 2009)

Environmental concerns

The concept of green computing came into existence when 'Energy Star' was launched by the US Environmental Protection Agency in 2006 as a voluntary labeling effort to recognize any equipment's energy efficiency characteristics (Ruth, 2009). It is crucial to note that the cost savings on the sale of computers that match Energy Star

ratings is around USD 2 billion (Wilbanks, 2008). Green computing literature has assigned importance to meeting requirements of accepted energy standards such as EPEAT and Energy Star.

Inclusion of environmental concerns in IT development processes right from the conceptual stage is necessary, since a "holistic approach" towards greening the IT products and services supply chain will accelerate change and prove beneficial to all the players involved. In their work on the Challenges in Environmental Design of computing systems (Ravi & John Wullert, 2002), authors argue that pervasive computing design should explicitly consider and minimize environmental impacts as a separate parameter from cost. The report also argues that research should consider minimizing production and operation costs as also total lifecycle impacts, i.e., choosing techniques to reduce the costs of reuse, recycling, and disposal.

Further, Huang -recommends a formal Sustainable Systems Development Life Cycle, which emphasizes greening the entire lifecycle, starting from the planning stage, through analysis, design, implementation, maintenance and finally disposal (Huang, 2009). Revisiting the design of the entire value chain makes business sense (Harmon & Auseklis, 2009),since, making it efficient and sustainable will create innovation opportunities to improve manufacture, maintenance and disposal of IT products and services. This will ultimately lead to the development of a better business model. Novel ways of delivering and capturing value will ensure that the base of competition changes, thus offering opportunities to achieve organizational sustainability, argue Nidumolu et al., (Nidumolu et al., 2009).

Green IT efforts in Higher Education Institutions

Since college and University campuses are effectively small towns with the ability and facilities to produce their own power, they are ideal for exploring and implementing green IT solutions (St Arnaud, Smarr, Sheehan, & DeFanti, 2009). Thompson proposes three primary approaches to achieving green computing with energy thrift; power management of desktop systems, use of e-mail practices and policies to replace paper memos, and online learning options to cut down classroom usage of exhaustible resources. (Thompson, 2009). However, cut in classroom usage may have other effects on lack of one to one feedback in learning and also may widen the digital divide especially in developing countries fraught with poor infrastructure and asymmetric information.

In the case study of the Sustainable IT project started at Indiana University as a pilot, Cromwell et al., (Dennis Cromwell, 2009) state that "in environmental stewardship, the University is one body working toward solving a common problem, and given that IT is part of everything the University does, the field for IT-based sustainability initiatives is wide open". Thus, Universities have the power to be green-thought leaders and play a decisive role in achieving environmental sustainability, especially in the field of IT.

An increased awareness of ethical issues surrounding IT has placed emphasis on incorporation of this issue in IT education. IT has exponentially advanced in the last two decades, and while ethics and social responsibility are not new phenomena, they are yet to be into the education system. This study analyzes the efforts of educational institutions towards greening ICT.

Green IT efforts in technology companies

The goals of environmental sustainability and organizational sustainability need not be disparate, for environmental consciousness leads to competitive advantage. Technology companies which are proponents of this thesis have pioneered green IT efforts by not only targeting the environmentally conscious consumer, but also in the way of devising appropriate strategies to reduce consumption of energy and increase the efficiency of product and services development processes. (Sharma, Iyer, Mehrotra, & Krishnan)

Viet Dao et al., have argued that the distinct contributions of different types of IT resources (tangible technical resources, human resources, intangible IT-enabled knowledge) should collectively allow for the development of a sustainability strategy for practitioners to run sustainable businesses. (Dao, Langella, & Carbo)

An understanding of the holistic nature of sustainability facilitates businesses to perform environmental life cycle assessments, thus taking the negative environmental impact as a non-functional requirement in the process of developing IT systems. Inventory, impact and improvement analysis will allow for better planning of organization-wide environmental friendly goals. (He, Lin, & Tong)

In any preview of IT trends during this second decade of the 21st century, green IT and environmentally cognizant IT professionals have been given particular emphasis (Liu). As businesses have begun to experience a rather radical shift in availability of resources they are heavily dependent on, the imperative to revisit the traditional business model has become stronger. As millennial consumers have more disposable income, in the US, 30

percent plan to spend more money on green products in the year 2012. Thus, the value of companies having a green image will dramatically increase. (Swallow & Furniss)

A survey of 300 global business firms by Ernst & Young revealed that while 83% of them wanted to see a legally binding multilateral deal in the Durban UN Climate Summit putting a price on carbon emissions, only 18% believed that this would occur. Additionally, 44% of the firms indicated that despite the 2008 financial crisis, their expenditure on sustainability in fact increased. However, a lack of a clear climate policy does not allow for green initiatives to be discernible, yet, technology companies appear to have become seriously convinced about the benefits of being green ("Business: Why firms go green; Schumpeter,"). Sustainability initiatives are now designed for a resource-constrained future, as well as to create opportunities for money-making. Thus, technology companies are doing more than just being seen to be green.

This study highlighted contributions of the green ICT companies with innovative green initiatives.

Approach of IT users

The impact of the attitude of end users towards green IT has had a crucial influence on the green IT initiatives adopted by businesses and educational institutions. Chow and Chen (Chow & Chen, 2009), through their survey of 267 University students in Hong Kong confirmed that IT users' attitude towards green computing, influence of peers and perceived behavior influenced the practice of green computing. However, the actual practice of green computing was noticed in users who had a complete control over the

means to do so. Molla et al., (Molla et al., 2008) have argued that environmental attitudes and behavior are influenced by an emotional appeal rather than factual knowledge, and the attitudes vary depending on the organization and region. The steps taken by organizations towards greening their IT services and products is a function of the sentiments of both users and business leaders. Research suggests that sustainable consumers differ from apathetic consumers in that they exhibit pro-environmental behavior, thus manifesting different psychological characteristics in terms of recycling. That is, green product purchasers have more favorable cognitive and affective attitudes as well as stronger social pressure and personal obligations (Joohyung & Sejin).Businesses must use this approach of pro-environmental consumers to develop innovative marketing strategies, thus raising awareness about going green, among existing and potential customers. The correspondence between demographics and pro-environmental behavior, however, are ambivalent. Hence, further research is required to capture consumer sensitivity vis-`a-vis the environment (Cleveland, Kalamas, & Laroche). Thus, the dire need for creating environmental cognition by providing an environment conducive to practice green computing is crucial, not only at the IT vendors end, but also at the users end.

Human resource development

Although prior academic literature has adequately dealt with specific areas of green IT and the implications of not practicing green IT, the crucial and vital resources in the field of information technology, such as human resources, have not been discussed in great detail. An empirical investigation of French firms by Gilles Grolleau and others has

shown that environment-related voluntary standards have delivered benefits beyond environmental consideration, and in fact contribute to successful recruitment, thus improving business performance. A firm's environmental responsibility is important to potential employees. The corollary to this approach is that any business should have an interest in hiring environmentally sensitive job-seekers, thus strengthening its green computing (Grolleau, Mzoughi, & Pekovic). Engagement with employees at all levels is important for businesses to remain sustainable in the future. Thus, human resource managers, along with top level management within any firm must work on a people development strategy, visibly demonstrate commitments and communicate them to the entire organization, along with recruitment with sustainability as a goal. (Andrew)

The success of Green IT largely is a function of the 'green' steps taken to improve the efficiency of human resources. In most organizations, human resource exposure to IT has to be addressed through labor laws. This also requires an appropriate synergy of software and hardware sectors to manufacture the green computers, and the green habits to be recommended.

CHAPTER III: METHODOLOGY

The first part of the study is to identify technology companies and educational institutions with a strong commitment to greening their IT products and services. Due to the interdisciplinary nature of IT, in order to comply with the objectives of the study, businesses and Universities that offered solutions in the areas of ICT were sampled for the study. The sampled IT companies and Universities are pioneers of sustainable IT values, and were chosen after a careful review of academic and practitioner literature highlighting their efforts.

Sampling Universities

Schools and educational organizations should be the starting point for implementation of green IT solutions since IT has found roots in schools. Students need to be made aware of the economic, health and societal impacts of green IT. Hence, capacity building as well as researching green IT becomes the two sides of the coin of Sustainable IT solutions (SITS).

Case studies on sustainability efforts of Universities and Colleges were obtained online from three publications that are currently tracking the sustainability efforts made by educational institutions across the country and in other parts of the world. , These online publications are EDUCAUSE Review ("EDUCAUSE," 2010) , an electronic magazine by EDUCAUSE, a nonprofit association with the mission of advancing higher education through the promotion of intelligent use of information technology, the College Sustainability Report Card ("The College Sustainability Report Card," 2010), a free

interactive website aimed at providing in-depth sustainability profiles for Universities in the United States and Canada, as well as the sustainability resource center of Association for the Advancement of Sustainability in Higher Education AASHE ("AASHE," 2010). A large number of Universities across the United States were first chosen based on their overall sustainability ranking, and 20 Universities with a serious commitment to sustainability and specifically, to sustainable IT, were short listed and their websites examined to gather information about their current sustainability efforts (Table 1)

Table 1: List of institutions of higher learning sampled for the study

INSTITUTIONS OF HIGHER LEARNING (UNIVERSITIES)
1. Stanford University
2. Massachusetts Institute of Technology
3. Harvard University
4. Cornell University
5. Emory University
6. University of California, San Diego
7. Indiana University, Bloomington
8. Syracuse University
9. University of Michigan
10. University at Buffalo
11. Arizona State University
12. University of California, Berkeley
13. University of Minnesota
14. University of Pennsylvania
15. Carnegie Mellon University
16. University of Wisconsin, Green Bay
17. Georgia State University
18. Worcester Polytechnic University
19. Adelphi University
20. Iowa State University

Sampling business organizations

A comprehensive list of businesses whose primary industry is information and communications technology was made after a detailed review of reports of leading technology research and advisory companies Gartner Research ("Gartner," 2010), Forrester Research ("Forrester Research," 2010) and also Computerworld's top Green IT-organizations list ("Computerworld's Top Green-IT Organizations," 2010). Practitioner and academic research papers that reported on the most popular green IT embracing companies in the ICT industry were also reviewed, and 15 ICT pioneer companies were sampled for this study. The examined companies span the IT services, IT products, e-commerce and telecommunications and networking businesses. (Table 2)

Table 1: List of ICT Companies sampled for the study

ICT COMPANIES
1. Google Inc.
2. Microsoft Corporation
3. IBM
4. Amazon.com, Inc.
5. Wipro Technologies Limited
6. Oracle Corporation
7. Infosys
8. SAP Labs
9. Hewlett-Packard Company
10. Dell Inc.
11. Fujitsu America Inc.
12. Applied Materials Inc.
13. Cisco Systems Inc.
14. Qualcomm Inc.
15. Apple Inc.

Information search

The next part of the study involved extensive review of the websites of the sampled 20 educational institutions and 15 ICT companies, to gather relevant and appropriate information on their unique ICT sustainability efforts. The efforts towards relationship between information technology and environmental sustainability were obtained and reviewed. Published documents on the Corporate Social Responsibility section of the chosen ICT company websites, as well as specific sections of University websites dedicated for publishing sustainability efforts were analyzed. The resulting information classified under various categories of green IT initiatives. These elements formed the framework to establish and classify the effective green IT practices currently being pursued.

CHAPTER IV: FINDINGS

It was found that the of the 15 ICT companies and 20 Universities chosen for this study made significant contributions towards achieving sustainability, through the use of IT products and services. The most prominent sustainable IT efforts, in a taxonomical fashion, grouping individual efforts are in Table 3. This taxonomic classification of sustainable IT efforts aims to provide a comprehensive list of the most effective, best practiced green IT endeavors that have led to substantial reduction in energy consumption and increased efficiencies. The classification was made based on the level of adoption of the included sustainable IT efforts across all industries, and specifically by the sample Universities and ICT companies. Further, individual sustainable IT efforts were grouped under broad points of coverage, based on the information in websites of these organizations that were dedicated to showcasing sustainability efforts. The standardized "check-list" for organizations, to record measurable sustainable IT efforts is also provided in Table 3.

Table 3: Taxonomy of sustainable IT values

TAXONOMY OF SUSTAINABLE IT VALUES	

I.	**Green Computing and Infrastructure Management**
	• Greening data centers
	  ○ Efficient power conversion technology for server efficiency
	  ○ Usage of components that operate efficiently when idle
	  ○ Efficient Data center cooling methods
	  ○ Data center water management
	  ○ Consolidation of servers where appropriate
	  ○ Virtualization of servers where appropriate
	  ○ Use of thin clients
	  ○ Cloud Computing
	• Retrofitting
	  ○ High efficiency lighting
	  ○ Optimum use of natural light
	  ○ Use of better building control systems

II.	**Reducing carbon footprint**
	• Reducing emission of Green House Gases (GHG) measurably
	• Using renewable sources of energy for electricity
	  ○ Wind energy
	  ○ Solar energy

III.	**Employing a 'holistic approach'**
	• Greening the IT supply chain
	  ○ Logistics Optimization
	  ○ Product Redesign
	  ○ Optimum packaging
	  ○ Green Procurement
	  ○ Repurpose products
	• Creating a Sustainable Software Development Life Cycle

IV.	**Electronic waste disposal** • Reuse of retired server material or computers • Environmental friendly recycling techniques • Proper disposal of unusable e-wastes
V.	**Regulatory reforms and organization-wide policies** • Purchasing EPEAT and Energy Star compliant products • Defining reasonable green IT objectives • Advocating public policies to accelerate adoption of energy efficient technology • Budgetary allocation for green IT efforts • Encouraging tele-commuting practices
VI.	**Environmental sustainability for organizational sustainability** • Collaboration among organizations to achieve the same distant goal • Educate employees to develop a positive approach to green IT • Initiatives to engage the community in sustainability efforts • Leverage technology innovations for a sustainable future

The final objective of this report is to list noteworthy contributions made by Universities and ICT Companies sampled for this study, and analyze the benefits and constraints of adopting environmentally sustainable IT operations, and indicate the limitations of the study.

Noteworthy Sustainable IT initiatives at institutions of higher learning:

The "Adelphi goes Green" University-wide initiative at Adelphi University was part of a case study conducted by ECAR experts, to study the University's Business Process Reengineering or Streamlining Program which has proven to be a successful vehicle to enhance the involvement as well as the stature of Adelphi's IT department, within the student community. As an early adopter of green IT strategies, Adelphi IT has now successfully devised formalized Environmental Sustainability IT activities, which are evaluated against business processes throughout the University, thus reducing costs and energy consumption, while improving efficiencies. Adelphi's incorporation of methodological managerial practices not only projects central IT but also supported departments has thus allowed for a well-documented and publicized holistic strategy to practice green IT, across the breadth of the University (Albrecht, 2010). Adelphi University was recognized as a 2008 top honoree by IDG's Computerworld in its inaugural "Best Practices in Green IT" Awards Program and was selected from among a field of strong finalists that included Dell, Sprint Nextel, University of California Irvine, and Infosys Technologies ("Adelphi Goes Green," 2011).

As excessive use of paper and ink have come under the purview of Green IT, all of the sample Universities chosen for this study employed various methods to reduce their paper

and ink needs, by encouraging students and staff to employ simple yet effective processes such as printing on both sides of the page, using online electronic material versus hard copies, as well as recycling and reusing paper ("Printing - the Green IT Cinderella," 2010). A significant contribution in the regard, has been made by The University of Wisconsin, Green Bay, which has changed its default font for Outlook across campus to Century Gothic, thus using 30% less ink than the default font, resulting in a significant saving across the campus, reducing a large portion of the cost of printed page, of which ink accounts for 60% ("Sustainable IT, 30 tips for going green with IT operations and equipment," 2010).

Carnegie Mellon University (CMU) adopted its Green Practices since 1990, and has established its timeline of formal sustainability practices and accomplishments. As of 2011, the University is under contract for the purchase 120 mWh of Renewable Electricity Credits (RECs) for the period Jan-Dec 2011, which is equivalent to 100% of the University's electricity requirements. This contract is tied to the University's "Sleep is good" program, which aims at saving 2 million kWh of energy, through improved computer monitor management. Some of the earlier contributions of the University are especially noteworthy, and CMU is certainly one of the pioneer educational institutions in the area of producing and purchasing alternative renewable sources of energy ("Accomplishments of Carnegie Mellon Green Practices,")

As part of the system wide sustainability goals, the University of Minnesota campuses in 2009 proposed a new approach of creating a Sustainability Information System to help the sustainability committees across all sister campuses compile and analyze data. The

resulting information would then be used to determine the best approach to using resources and tailor goals appropriate for their campus' circumstances ("University of Minnesota System wide Sustainability," 2009). University of California, Berkeley ("Green Department Checklist," 2010) and Arizona State University("Green Office Program," 2010) both offer Certification Programs to departments that conform to a checklist, consisting of required and elective criteria that change over time. The checklist contains three levels of certification that individual departments may identify as being appropriate. Further, the checklist contains numerous pre-requisites around energy consumption, waste management, transportation and purchasing, thus encompassing the holistic strategy of achieving overall organizational sustainability.

Syracuse University's Sustainability initiative has harnessed the power of social media by announcing significant milestones and efforts taken to achieve sustainability to "followers" on Twitter.

The efforts made towards achieving sustainable IT by top-notch Universities such as Stanford University, Massachusetts Institute of Technology, Harvard University and Cornell University are an outstanding illustration of the "holistic" approach to confront the combined challenge of sustainable IT and negative impact of IT on the environment. From the inception or purchase of IT equipment and services to operation and finally to disposal, processes have been put in place to ensure that maximum energy efficiency is achieved. Furthermore, as an incentive, Stanford University has also received honors for its Sustainable IT efforts, such as an invitation to join the U.S. Department of Energy's Vision and Roadmap workshop on Routing Telecom and Data Centers towards

Efficiency Energy Use in 2008 and also an invitation to participate in the 2008 Educause IT Greening and Sustainability Summit (Wilbanks, 2008). Such honors may interest other academic institutions to conduct a study of their IT services and leverage efficient technology to achieve sustainability.

Indiana University took a unique approach to achieving sustainability through IT, as explained by Kristin Hanks, PhD candidate, in her internship report on achieving campus sustainability. Kristin Hanks (Hanks, 2008), explains that sustainable IT has complicated layers and associations across various levels, which can be laid out at – Policy / Planning Level, Operational / Structural Level and Personal Practice Levels. A high level planning/strategic development document and policies can change sustainability efforts at the operational level. The influence also moves towards changes in the operational level by changed personal practices. Thus, the sustainable IT efforts at Indiana University encourage enforcement of policies and individual practice in order to serve as a benchmark for future change.

These streamlined initiatives can bring about significant changes in IT services over a long term horizon, and only with time will their full benefit be realized.

Case Study: Sustainable IT efforts at Iowa State University

Iowa State University (ISU) was chosen for the examination of its environmental sustainability efforts. Specifically, the IT Services department at the University has explored and established green IT initiatives. . This case study involved interviews with the staff members in the Information Technology Services department at the University.

Part of the study was to review of documents including strategic plans and newsletters from the Office of the CIO.

The first part of the case study involved analyzing published documents from ISU that were believed to provide an insight into the sustainable IT efforts made by the University. Specifically, the website of Information Technology Services("Information Technology Services," 2010), a published newsletter from the Office of the CIO ("News from the Office of the CIO," 2010) and the strategic plans stating the University's goals , as well as the Information Technology Services department's goals were studied, to find indicators of green IT efforts.

In 2008, Iowa State University heralded "Live Green", a campus wide sustainability initiative, urging staff, faculty and students to be fully committed towards making ISU a leader in sustainability, among the land grant institutions. ("Live Green!," 2011) The IT Services department at ISU has contributed to the Live Green challenge by recognizing specific efforts IT can undertake in order to reduce energy consumption as well as handle electronic wastes. Significant efforts of ISU (listed in the Newsletter from the Office of the CIO as well as the Green IT section of the ITS website ("Green IT," 2011) as under :

1. ITS offers Server Virtualization, eliminating the need for hardware for physical servers, thus resulting in 80% reduction in energy consumption.
2. In the second quarter of 2010, ITS offered storage solutions scalable to over one petabyte. This new Network Attached Storage (NAS) infrastructure resulted in savings on energy, as well as, personnel and space.

3. Virtual desktop infrastructure (VDI), ensures central data storage, hence users can make use of minimal resources to access their data.
4. Certain laboratories practice hibernating computers through power management software when idle. ITS has implemented mandatory sleep settings on all supported machines across campus, resulting in an estimated $40,000 annual savings.
5. At an individual user's level, the network printing system PaperCut checks excessive printing and provides statistics on number of trees used, saved, CO_2 emission etc.
6. Administrative systems are in the process of converting to electronic reporting, which has allowed for a 25% reduction in paper use.
7. Coursework and instructor evaluations are increasingly being offered online, thus eliminating the need for printed material.
8. ISU allows for telecommuting, webinars, and multi-party conferences from campus, thus reducing travel costs, saving time and energy.
9. ISU is also a participant in the Energy Star Low Carbon IT Campaign, encouraging consumers of IT Services to purchase Energy Star 5.0 or higher rated equipment, as well as 80Plus rated power supplies on newer equipment.

These initiatives have been driven by the need to deploy latest, energy efficient technology, and may have been escalated due to the current economic meltdown. Iowa State University is thus creating significant technological changes at a campus-wide level, as well as at an individual level, in order to achieve cost and energy efficiency. ISU has been recognized country-wide as a "Green Campus" and the University is in the

process of developing and publishing a mission and vision statement exclusively addressing Green IT.

Noteworthy contributions by ICT Companies:

Over the last decade, Information Communication and Technology industry leaders have prioritized their green goals, saving costs and the environment in the process. Industry giants such as Microsoft Corporation, IBM and Google Inc., have built sustainable research labs, constantly improvising sustainability solutions that will drive efficiencies. These businesses have successfully achieved tangible results since on a regular basis, they use technology and event sponsorship to minimize the environmental impact, and thus help organizations around the world to develop green software solutions.

IBM commissioned a study conducted by the Info-Tech Research Group, through which 1,047 respondents from mid-sized companies participated in an online survey, highlighting the long term benefits of making a commitment towards going green. The report highlights the necessity and importance of investing in sustainable IT efforts such as virtualization, consolidation of servers, telecommuting etc, especially in small to mid-level companies, in order to attain organizational growth and success (Group, 2009).

Indian IT giants Wipro and Infosys, as well as SAP Labs and Hewlett-Packard, all of who run large operations in India, have pioneered and sustained green initiatives, adhering to industry standards, despite the change in regulations and laws in the country. A key factor to note is that local communities have been engaged heavily in supporting such green efforts, thus educating masses about the importance of greening Information Technology.

Among technology companies that offer products HP, Sprint-Nextel, Qualcomm, Cisco Systems, Dell Inc. and Apple Inc., have all emerged as leaders in greening their IT operations.

Some of the most interesting green IT efforts have been implemented by Google Inc. Google maintains a higher temperature within its data centers, which is tolerated by the equipment, thus allowing a relaxed heat friendly dress code for data center employees. The Google Earth engine has been used by the Surui tribe of the Brazilian Amazon, to monitor illegal logging on the reserve. This is a great example of how technology has been indirectly used to help slow down deforestation responsible for emission of large quantities of Carbon dioxide ("Google green," 2011).

The consolidated list of the most prominent and effective sustainable IT efforts undertaken by the studied Universities and ICT organizations is in Table 3. The discussion chapter analyzes the advantages of committing to practice environmentally sustainable IT operations, and presents the limitations of this study.

CHAPTER V: DISCUSSION

As media consumption of the average consumer has seen a radical increase in the last decade, computers, and other IT products and services are among the most commonly used among electronic devices. The over-dependence on IT enabled services has caused an increased dependence on available sources of energy. This realization has now paved the way for innovative ideas, technology and efforts towards achieving environmental sustainability. It is imperative for institutions of higher learning and business organizations across the world to operate in ways that will bring about transcendent changes, to solve vitally important environmental problems. This report attempts to dispassionately analyze the work of sample Universities as well as ICT companies in attempting to achieve tangible short-term and long-term environmental sustainability, towards long-term organizational sustainability. The organizations studied as part of this research have laid out a set of inspirational and achievable goals as well as measurable outcomes, thus proving their mettle and merit, and setting model example to newer, smaller organizations, which can take cues to implement recommendations. The purpose of this chapter is to discuss the present and the future of the current sustainability efforts in the IT industry, the advantages and limitations.

Limitation: Sustainable IT solutions cannot discount the overall health of ICT users

The reported energy consumption and CO_2 emissions relating to ICT are only the tip of the iceberg of sustainable IT solutions. In addition, organizations must need to include sustainable health for users of ICT and not mere a check on emissions. Sustainable ICT solutions accordingly need to cover damage to ill effects to consumers in the short,

medium and long term. Much like Energy-star rated equipment, a common international code must to be built in the manufacture/assembly of PCs/laptops/other ICT equipment to ensure zero damage to consumer health. A penalty clause must also be incorporated for violators.

This study however is limited to the non-health aspects of sustainable ICT solutions since that demands an exclusive clinical study. By incorporating the overall health of ICT users along with the effect on the environment, ICT companies in particular will improve credibility, thus attaining the two fold benefit of striving for environmental sustainability ultimately leading to organizational sustainability.

Engaging human resources and the community: necessity and challenges

The current economic crisis might make the challenge of forming an organized group to oversee sustainability efforts as well as setting aside a budget for green IT Nevertheless, the greenest companies and Universities have helped identify that in order to achieve environmental sustainability, does not entail significant additional monetary investment. That is, there is a dire need to expose the human resources of an organization to the benefits and significance of green IT. With this challenge comes the obscurity of understanding the tradeoff between enforcing labor laws to force an awareness of environmental concerns versus encouraging them, without stringent rules to adopt greener technology and practices.

"Green teams" within organizations can be grass-root level, voluntary groups of students, staff, faculty members or employees who come together to educate and

empower groups around sustainability. Organizations must then align internal teams with the overall corporate sustainability goals, thus ensuring communication of efforts and appreciation. Organizations may then leverage existing green team best practices to engage the community that the organization is part of. This is especially useful in the case of Universities, since smaller institutions of learning such as community Colleges, and schools are encouraged to set tangible sustainability goals modeled on the practices followed by Universities. In a global, inter-dependent society, corporate goals are always cross-functional and cross-territorial, linked to the outside community that the organizations are integral parts of.

Electronic waste management and retrofitting: Re-purposing debate

While in most instances, there does not seem to be a dire necessity to upgrade hardware at the same rate software is upgraded; an issue arises with discarding old hardware due to the depreciation over time as well as obsolescence owing not being able to support the latest software. A challenge that ICT companies and Universities face, then, is how best they can achieve synergy between computer hardware and software, in order to reduce the overall ill-effects of discarded hardware as well as the increased consumption of energy by old hardware, and create a balanced e-waste management system. Not all of the organizations analyzed had an apparent manner of quantifying the energy consumption or effectiveness of green IT and e-waste disposal so as to quantify their efforts. As many organizations rest their old unusable server material and computers, they are passed off to smaller organizations within the community, such as schools, where there is a growing need for affordable computing equipment. While on a short term basis,

this re-use of retrofitted hardware delays the process of e-waste disposal for that set of equipment, in the long run, the re-purposing of depreciating or obsolete equipment will pose problems during recycling and disposal. The small organizations, schools then should not be treated by big organizations as dumping yards of their electronic waste. In fact transfer of old hardware to schools should consider the impact on child health, since children do not understand or are not educated to appreciate the green IT.

Thus, it is necessary to develop green electronic waste management technologies which are cost effective and widely adaptable and verify whether re-purposing is less energy consuming and more efficient than recycling of retired computer equipment, also factoring in concerns such as the harmful effects of material used on the environment both in the short run and in the long run. Mere transfer of obsolete equipment results in transfer and procrastination of the hazards of waste disposal. The EPA (Environmental Protection Agency) needs to gear up towards Sustainable IT Solutions (SITS) for different classes of firms, educational organizations developing proper governance mechanism with sound institutional structure.

Early adoption of groundbreaking innovations: Recommendations

A truly sustainable organization will factor in the environmental effect its IT department may have, and takes collective action as an organization by putting in place sustainability efforts at the least cost. Firms and Universities must then identify the best practices, to provide direction to smaller organizations to follow suit. In this study, it has been identified that more and more small, mid-level businesses as well as small to mid-sized Universities attempt to set sustainability goals modeled on such innovative efforts. In the

near future, a majority of ground breaking sustainability ideas should no longer remain as options, but should be the models of choice for all IT implementations, across all organizations across all industries. As of 2011, ENERGY STAR qualified products qualify for a tax credit, thus providing an impetus to organizations to ensure that energy efficient equipment is purchased and maintained ("2011 Federal Tax Credits for Consumer Energy Efficiency," 2011). Listed below are the key sustainability initiatives organizations can make progress on:

- Power management of computers
- Energy-efficient equipment
- Reduction of Paper Use
- Conversion to energy-efficient Servers
- Transition to Virtualization Software
- Consolidation of Storage
- Installation of energy-saving equipment
- Energy-efficient Transportation
- Effective and green disposal of IT equipment
- Developing innovative institutions towards Sustainable IT solutions (SITS)
- Green computing certifications
- Health indicators

Adopting a holistic approach

There is a need to cut costs and improve efficiencies, and while it is not apparent that organizations are jumping the bandwagon, the need of the hour is to work towards building a cost-efficient system towards green IT. Businesses and educational organizations have finally realized the urgency of this need, and have made new investments towards sustainable IT. However, business decision makers must make a robust effort into adopting a "holistic approach" towards greening IT. This necessitates greening every aspect of the IT supply chain, as well as developing an environmentally sustainable Software Development Life Cycle.

IT is a pervasive field seamlessly binding all departments of an organization, and all organizations within an industry, across all industries. Thus, Green IT within an organization does not entail a singular action, and green IT initiatives must be viewed as an overall, paradigm change. A supportive institutional culture is more likely to translate into successful actions sustainably.

There is also a word of caution in the process. As the development of IT is a dynamic process, to what extent the health care providers, such as specialists (ophthalmologists and orthopedics) are involved by IT hard ware researchers is a major question. The excessive use of IT hardware is resulting in problems related to diminished sight, bone related disorders etc. Green IT literature has not focused on the health aspect as much as it should reflect. Ultimately IT has to address human health as humans are the only users. Thus, Sustainability of green IT should equally emphasize the health aspects and

sustainability of health is crucial. On this token, the appropriate use of marketing principles to understand the appropriate business-to-business marketing strategies in the supply chain for achieving environmental sustainability objectives is important. Such marketing initiatives should likely focus on educating the pro-environmental end user regarding the health benefits and monetary benefits of going green with their consumption of IT services and products.

CHAPTER VI: CONCLUSION

In conclusion, there is a dire need for developing and preparing institutions for Sustainable IT – which in and of itself, is a journey of several miles. This calls for heralding innovative institutions which are mandatory for organizations to move towards sustainable IT with proper and effective governance:

1. Investment of at least 10% of annual firm's profits towards Sustainable IT solutions (SITS) which have low and affordable transaction costs
2. Educational programs and capacity building of employees towards SITS
3. Establishing incentives to identify outstanding employees and their contributions towards SITS which will also form the core part of firm's promotion policy
4. Defining and redefining SITS by way of organizing exhibitions to create competitive atmosphere for educational institutions so as to generate innovative SITS
5. Organizing Friday after class meetings, e-group meetings, blogs, among employees regarding SITS including lectures with rewards and incentive schemes
6. Encouraging female employees towards their contribution to SITS as a part of gender inclusive growth
7. Developing governance including E Governance structures to effectively incorporate SITS with periodic review giving due consideration to the growth of the firm as well as maintaining health of employees and clients.
8. Efforts to educate students and employees towards health awareness pertaining to health problems from use of IT.

APPENDIX A

ICT Company	Dedicated Sustainability Information on Website
Google Inc.	http://www.google.com/green/
Microsoft Corporation	http://www.microsoft.com/environment/products_solutions/green_it.aspx
IBM	http://www.ibm.com/ibm/green/
Amazon.com, Inc.	www.amazon.com/green
Wipro Technologies Limited	http://www.wipro.com/greenit/index.htm
Oracle Corporation	http://www.oracle.com/us/products/applications/green/it-infrastructure-304614.html
Infosys	http://www.infosys.com/sustainability/green-innovation/Pages/index.aspx
SAP Labs	http://www.sap.com/about/csr/environment/index.epx
Hewlett-Packard Company	http://www.hp.com/hpinfo/globalcitizenship/environment/commitment/goals.html
Dell Inc.	http://content.dell.com/us/en/corp/dell-earth.aspx
Fujitsu America Inc.	http://www.fujitsu.com/global/about/environment/green-it/
Applied Materials Inc.	http://www.appliedmaterials.com/news/articles/applied-materials-receives-epa-green-power-leadership-award
Cisco Systems Inc.	http://www.cisco.com/en/US/solutions/ns726/netsol_generic_enabling_green_practices.html
Qualcomm Inc.	http://www.qualcomm.com/about/citizenship/environment
Apple Inc.	http://www.apple.com/environment/

APPENDIX B

Institution of Higher Learning (Universities)	Dedicated Sustainability Information on Website
Stanford University	http://sustainablestanford.stanford.edu/
Massachusetts Institute of Technology	http://sustainability.mit.edu/
Harvard University	http://www.green.harvard.edu/
Cornell University	http://www.cornell.edu/sustainability/
Emory University	http://sustainability.emory.edu/
University of California, San Diego	http://www.calstate.edu/impact/sustainability/infrastructure.html
Indiana University, Bloomington	http://www.indiana.edu/~sustain/home.html
Syracuse University	http://greenuniversecity.syr.edu/
University of Michigan	http://sustainability.umich.edu/
University at Buffalo	http://www.buffalo.edu/uls/sustain/
Arizona State University	http://sustainability.asu.edu/index.php
University of California, Berkeley	http://sustainability.berkeley.edu/
University of Minnesota	http://www.uservices.umn.edu/sustainableU/
University of Pennsylvania	http://www.upenn.edu/sustainability/
Carnegie Mellon University	http://www.cmu.edu/environment/
University of Wisconsin, Green Bay	http://www.uwgb.edu/sustainablegb/renew/index.html
Georgia State University	http://www.gsu.edu/staffcouncil/33176.html
Worcester Polytechnic University	http://www.wpi.edu/about/sustainability.html
Adelphi University	http://www.adelphi.edu/greenau/greenconst.php
Iowa State University	http://www.livegreen.iastate.edu/

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