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Factors driving the implementation of green IT initiatives : an empirical investigation

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Factors Driving the Implementation of Green IT Initiatives: An Empirical Investigation

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ABSTRACT

Green IT practices focus on designing, manufacturing, and using IT infrastructure efficiently and effectively in order both to reduce IT's carbon footprint and cost. While green IT is gaining increasing attention in the industry, there has been a paucity of research that examines the reasons for and challenges faced in pursuing green IT initiatives. "What factors motivate and/or impede the adoption of green IT initiatives in organizations?" This is a complex question to explore due to the existing gaps in practice and research about green IT. This paper draws from institutional theory and literature on adoption of innovation to develop an initial understanding of factors affecting green IT implementations. This was complemented by a qualitative multi-site case study in organizations that have implemented or considered green IT initiatives. A research framework that details how and why organizations adopt or abandon green IT initiatives was developed based on the results of the case study analysis. Our study contributes to three areas of literature – institutional theory, innovation, and green IT by providing rich insights into how and why various factors affect green IT adoption.

I. INTRODUCTION

Over the years, the use of information and communications technologies (ICT) has exploded, improving our lives, work, business processes, education systems, and societies by making our lives much easier, convenient and efficient (Murugesan 2008). Although appropriate use of ICT could positively impact business through automation and innovation of business processes, ICT practices also contribute to environmental issues such as the emission of greenhouse gases. The ICT industry plays an important role in causing as well as resolving environmental sustainability issues. Although the ICT industry accounts for 2% of the global carbon dioxide emissions (Gartner 2007; O'Neill 2010), ICT is in a unique position to help other industries to reduce the remaining 98% of the global carbon dioxide emissions through the ability to empower new and more efficient ways of doing business (Molla 2009). Our study includes both of these components in that it examines both practices that focus on making ICT infrastructure more sustainable and those that focus on helping organizations improve business operations by adopting sustainable practices enabled by ICT.

The increasing uses of ICT resources entail significant increase in hardware production and equipment disposal. In addition, computers and IT infrastructure consume significant electricity, which places a heavy burden on electric grids and contributes to greenhouse gas emissions (Murugesan 2008). In order to minimize or possibly eliminate IT impact on the environment and improve the sustainability of IT, research and practice in the area of green IT have gained wider attention. Even though sustainability initiatives are attracting businesses' attention, organizations may also feel burdened with green initiatives due to overheads, costs and changes in processes

involved as well as new regulations. Nonetheless, organizations recognize sustainability as a strategy to reduce cost (Murugesan et al. 2011).

Green IT is the study and practice of designing, manufacturing, and using computers, servers, monitors, printers, storage devices, and networking and communications systems efficiently and effectively with minimal impact on the environment (Murugesan et al. 2011). Green IT initiatives tend to directly influence and reduce an organization's environmental footprint while making business operations more efficient. Green IT offers strategies on how to reduce environmental problems by improving the sustainability of IT systems, which includes the use of less harmful materials in hardware production and other strategies that involve sustainable manufacturing practices for IT products.

In addition to reducing ICT's carbon footprint, green IT practices enable business to save money. Green IT's main goal is to make business operations more eco-friendly by helping businesses to reduce the consumption of resources while often resulting in cost savings. Although green IT offers solutions to resolve environmental sustainability problems, not every organization considers practicing it. While green computing sounds favorable to organizations, widespread adoption of green IT practices faces considerable challenges (Webber et al. 2009). This study will identify those challenges and contribute to the IT community in finding ways to solve issues such as the existing knowing-doing gap between IT professionals and green IT.

IT plays a key role in bringing innovation to businesses. However, there is a disparity in green IT understanding across companies, IT professionals, students, and IT users (Murugesan et al. 2011) that needs to be addressed by professionals who fully understand the need for environmental sustainability and how green IT can enable innovation. Prior literature has identified the following questions as critical to address the understanding gap on green IT (Brooks et al. 2010):

What are the motivational drivers for a company to choose to begin green IT adoption? How should the firm manage the process of green IT and what are the impacts (net benefits and risks) of the adoption of green IT? After researching green IT initiatives and observing the gap identified by previous research about the lack of understanding of the green/sustainable IT concept among IT professionals, we have decided to analyze the external and internal pressures that influence organizations to adopt, reject, or abandon green IT initiatives. We focus on the following question: *What factors motivate and/or impede the adoption of green IT initiatives in organizations?* In this study, we identify the knowing-doing gaps that pertain to green IT and identify the factors that drive the lack of consensus on the notion of green IT among organizations.

II. THEORETICAL BACKGROUND

A. Green vs. Sustainable

The World Commission on Environmental and Development has defined environmental sustainability as the "development that meets the needs and aspirations of the present without compromising the ability of future generations to meet their own needs" (Bruntland 1987 as cited in; Iacobelli et al. 2010). According to Halley & Fridian (2009), research and practice in the area of sustainability already show a wide variety of different interpretations of sustainability. The standard definition of sustainable development provided by the Brundtland Commission is a starting point.

Environmental sustainability has been defined by several concepts such as "green," eco-sustainable, and environmentally friendly. For instance, Hart (1997) discusses the concept from an ecological perspective while Baumann et al. (2002) use "green" to describe firms, products,

and production processes that use less energy, that recycle materials, that reduce waste and pollution, and that preserve natural resources. Furthermore, many authors have used the triple bottom line (TBL) concept which focuses on profits, people, and planet to describe sustainability. The idea behind this is that equal weight should be placed on economic, environmental and social considerations when it comes to the decision-making process. Therefore, sustainability is mostly linked to ongoing economic growth, development, and environmental issues. The exact meaning of sustainability is unclear and a main reason for this ambiguity is the different perceptions and views each organization and individual has about environmental impact (Jenkin et al. 2011b).

The discrepancy in meanings leads individuals to perceive sustainability as environmental impact that focuses only on natural issues, rather than financial and social issues. Sustainability is more than reducing carbon dioxide emissions and saving trees. The Encyclopedia Britannica defines “sustainable development as the approach to economic planning that attempts to foster economic growth while preserving the quality of the environment for future generations. Sustainability aims at developing new technologies and business processes to reduce the consumption of resources and environmental impact.” This will reduce the degree to which an organization's business processes, activities, and operations positively or negatively affect the natural environment (Jenkin et al. 2011b).

“Green” is generally understood to mean “friendly to the environment and energy efficient” (Pollack 2008) while sustainable means “planning and investing in a technology infrastructure that serves the needs of today as well as the needs of tomorrow while conserving resources and saving money” (Brooks et al. 2010). According to Webber et al. (2009), “green” has a positive earth-friendly connotation which is perfect for marketing purposes. Consumers are also getting jaded with green washing (Baguley 2009). Green washing is not a recent phenomenon; it has

been around since the mid-1980s. Dahl (2010) defines green washing as the practice of making unwarranted or overblown claims of sustainability or environmental friendliness in an attempt to gain market share. According to O'Neill (2010), green washing is the practice of misrepresenting products or services as eco-friendly for personal or organizational gain, when they are not. A common example given by O'Neill is that a manufacturer of an electronic product claims its product is green because it consumes less power than its competitor's product. Nevertheless, it may be the case that this product has been manufactured using hazardous material. However, if manufacturers do not share this type of information, customers will be led to think that these manufacturers are eco-friendly while they are just green washing. This is why IT professionals should be cautious about any sustainable innovations they want to implement. IT professionals should make sure their green IT initiatives are sustainable. This means that practices can be measured and managed. We are sustainable when our use of resources does not permanently deplete or damage our supply, including natural resources, energy, and capital.

Companies that do not comply with environmental regulations and lack concern for the environment are likely at a disadvantage in comparison to other companies that seize green initiatives (Sullivan 1992). IT managers are expected to provide IT solutions that enable businesses to measure, monitor, report, and improve their environmental footprint within their core enterprise and supply chain processes (Molla et al. 2011). Therefore, it is important for organizations to green and sustain their systems and business practices with initiatives that completely comply with regulations and procedures. In order for a sustainable development to be implemented within an organization, organization's stakeholders should start viewing green initiatives as strategies that will optimize business profit, resources and operations.

B. Green IT: A Business Strategy

The production, use, and disposal of IT directly impact the natural environment and eco-sustainability. Each stage of the IT lifecycle from manufacturing to usage and disposal causes environmental issues such as footprints and landfill pollution. Consequently, both IT hardware producers and organizations using IT need to apply principles of environmental sustainability, which include pollution prevention, product stewardship, and sustainable development in managing IT (Molla 2009). "IT organizations are embracing the notion of incorporating sustainable business practices into the design and operation of their products and systems" (Harmon et al. 2011, p. 19).

Green IT enables organizations to become more sustainable by designing IT practices to reduce ICT's negative impact on the environment. Green IT embraces solutions to reduce power consumption, green manufacturing practices, data center design and operations, recycling and end-of-life concerns for computer equipment, total cost of ownership issues, both micro and macro-economic issues, systems performance and efficient systems use and environmental, social, and ethical practices relating to IT acquisition, use, and disposal (Brooks et al. 2010).

There is a difference between green IT and sustainable IT. Green IT focuses on manufacturing sustainable products with minimal impact on the environment, regulatory compliance, energy consumption in the data center as well as enhancing sustainable practice for equipment disposition while sustainable IT mainly focuses on services that will address broader "societal problems such as government regulations, changes in customer perceptions of corporate responsibility and new requirements for implementing sustainable solutions" (Harmon et al. 2011, p. 19). Green IT is not just an IT practice but a business strategy (Watson et al. 2010). Green IT has a narrower

focus on carbon footprint of IT infrastructure and on the role of IT in reducing carbon footprint in other domains while sustainable IT has a wider focus on societal impact as well.

A strategy is defined as "the determination of the basic long-run goals and objectives of an enterprise and the adoption of course of action and the allocation of resources necessary for carrying out these goals" (Aldrich 1979). Sustainable IT serves organizations as the solution to shape and define their corporate social responsibility efforts. For instance, companies such as IBM, Hewlett Packard (HP), and Wipro in India have started making a difference by giving back to communities, implementing green IT initiatives, and increasing awareness about green IT.

Sustainable IT does not just refer to going paperless or reducing servers. Organizations that adopt IT sustainability are willing to influence others by being the opinion leader and working with communities and different stakeholders to achieve their goals. An example is Wipro, an IT company that has pioneered many an innovation in the IT services, headquartered at Bangalore, India. Wipro's philosophy is "Applying Thought," which refers to helping their clients to do business better and more efficiently. Wipro is bringing awareness about IT sustainability through sponsoring educational programs to help employees and outside communities to understand Wipro's green initiatives (Wipro 2011).

In addition, HP, a hardware and software company, headquartered in California, United States has addressed data center efficiency, energy efficiency, cooling, server virtualization, and cloud computing among other initiatives. However, HP is not just focusing on developing technologies and services that will reduce greenhouse gasses emissions. HP is also supporting social responsibility programs to educate employees and business people so HP stakeholders commit with sustainability as well (Harmon et al. 2011). Another example is IBM, a multinational technology and consulting corporation headquartered in New York, United States. IBM' sustainable

IT practices address problems such as energy conservation, increasing use of renewable energy, and increasing supply chain efficiency. One of the important success factors with IBM is that they use all of their innovations they develop internally before they commercialize it. “IBM’s goal is to increase stakeholders’ awareness of company efforts and reinforce its social responsibility” (Harmon et al. 2011). IBM does not just produce technology that contributes to more sustainable IT practices but also focuses on educating stakeholders.

In addition, non-IT companies such as KPMG, an accounting firm that provides tax, auditing and advisory services to businesses, has started implementing green IT practices. KPMG developed an IT sustainable procurement standard as a joint effort between the IT and procurement department to ensure that all the new IT equipment they acquire meet the Energy Star standards. Furthermore, KPMG reduced the amount of servers in their data center which enabled the company to reduce energy consumption by 50% (Violino 2011). Kaiser Permanente, a health care company, addresses green IT by virtualizing servers and using cloud computing which involves sharing of computing resources to maximize its utilization. This company has understood the significant role played by top management in adoption of innovation and decided to have its data center facilities team to oversee green IT initiatives (Violino 2011). Similarly, Wipro established Eco Eye, a committee which was responsible for regulating and coordinating sustainability initiatives in the company (Bose 2009).

In order for companies to use IT to become more sustainable, green IT policies must be established (Webber et al. 2009). Such policies should then be communicated to employees, suppliers, customers, and users to help them understand the companies’ environmental efforts. According to O'Neill (2010), in order for green IT to be credible, the organization’s senior management must be committed to such initiatives and adopt them (Bose 2009). The majority of the

examples described above involve organizations that have demonstrated strong senior management involvement in its green IT initiatives. One challenge facing green IT policies is in encouraging widespread compliance across all organizational units (Velte et al. 2008). Green IT is often misconstrued as sole responsibility of the IT department. Green IT should be considered as a company-wide strategy that involves all departments. Green IT adoption by a various stakeholders across different units in an organization will often face considerable challenges and might ensue gradually. Stakeholders need to be educated and conscious about any new process. Changes are often challenging for organizations entrenched in their practices. Therefore, managers should explain and promote the benefits of the new IT practices (Velte et al. 2008).

C. Green IT Best Practices

Green IT applies the 3Rs strategy: Reduce, Reuse and Recycle in order to help organizations to become sustainable and reduce their footprint. For example, organizations can reduce e-waste and energy consumption. Also, organizations can reuse cables, hard disks, and peripherals, and extend the life span of its assets by using equipment longer. By extending their assets' lifecycle, organizations are able to maximize equipment use and reduce e-waste. Besides reducing and reusing, organizations will also have to recycle. Disposal of unwanted equipment requires appropriate procedures. For products whose manufacturers do not have "take back programs," organizations should contract with companies that collect e-waste, wipe data from storage devices securely, and disassemble electronics to recover recyclable materials and parts that can be reused.

A data center is a facility used to house computer systems such as telecommunications and storage systems. It also contains air conditioning units, fire suppression and security devices (Stryer 2010). The data center is considered to be the unit that consumes the most electricity in a facility. Continuously powered servers, disk drives, and tape backup systems also consume ener-

gy for cooling (Webber et al. 2009). It could be a large room in the basement of a building or a room full of servers on the other side of the world that can be accessed via the Internet (Elsenpeter et al. 2010). The main problem with the data center is simply that there is an ever-increasing need for energy (Webber et al. 2009). With rapid increase in computing capacity, the amount of energy consumed in datacenters and other infrastructure in the United States also increases (Velte et al. 2008). As our need for computing power increases for everything from running our businesses to streaming video over the internet, so has our need for energy to power and cool the servers (Velte et al. 2008). However, "part of this problem is caused by the fact that in a typical data center, 60% to 70% of the energy used is not for the computers, but to power the facility and cool the data center" (Webber et al. 2009). Figure 1 identifies examples that map to the three types of sustainable practices.

Reduce	• Server Virtualization • Cooling Efficiency • Energy Consumption • Telecommuting • Paper Reduction
Reuse	• Equipment and Parts
Recycle	• Equipment Disposal

Figure 1: ***Green IT Practices***

Server Virtualization

A growing trend in green IT are solution to reduce energy is virtualizing servers (Elsenpeter et al. 2010). Server virtualization is a technology that allows organizations to consolidate equipment such as servers. This solution allows organizations to run one or more "virtual" servers on a single physical host system. A virtual server behaves like physical servers in terms of accessing,

addressing, and installation but it does not have dedicated hardware infrastructure. The virtual server shares computer resources with other virtual servers in that the entire computer is not dedicated to running only one sever software but many (Golden 2008).

Virtualization is one of the most commonly implemented green IT initiatives. Virtualization enables companies to manage and maintain its servers more efficiently. Server virtualization benefits organizations by lowering data center operation costs, by reducing electricity consumption, improving disaster recovery and backup capabilities as well as enabling more effective software development and testing environments (Pollack 2008). According to Elsenpeter et al. (2010), the number of virtual servers on one physical server depends on the size and speed of the physical server and on the nature of applications that will be housed on the virtual server.

According to Golden (2008) virtualization is driven by four trends: hardware underutilization, space constraints in the data centers, need for energy efficiencies, and system administration cost reduction. By virtualizing servers, organizations are able to reduce the amount of physical equipment in their facility. Increase in virtualization would reduce future equipment disposal. Also, by hosting a higher number of physical servers, the data center operations would have a lower efficiency rate.

Virtualization enables organizations to run their data center more efficiently by reducing the amount of hardware; congestion of equipment will be avoided in the data center. Virtualization reduces the amount of system administration work necessary for hardware, but it doesn't reduce the amount of system administration required for guest operating systems. Hence, virtualization improves system administration, but does not wipe it out (Golden 2008). The only difference is that systems administrators will manage less hardware but they still have to maintain the software piece. Top green IT organizations identified server virtualization as their top green IT prac-

tice to save energy. For example, Citigroup, a financial firm, reduced its data centers from 68 to 28 (Violino 2011). Northrop Grumman, a defense firm, emphasizes sustainability and IT plays a significant role in achieving its sustainability efforts. This firm has started a consolidation program in its data center which comprises moving 100 server rooms to 3 data centers. Consequently, Northrop Grumman was able to eliminate more than 26 million pounds of carbon emissions annually (Pratt 2011).

Cooling Efficiency

Another green IT initiative to reduce energy consumption is to redesign the data center to have more efficient cooling. 60% to 70% of the electricity used in a data center is used for cooling. As computing power generates more heat, more cooling is needed to balance temperature in the data center (Webber et al. 2009). “Servers require a proper balance of temperature and humidity to perform properly. Therefore, energy cost increases if the temperature and humidity are not controlled efficiently” (Webber et al. 2009).

A layout that organizes data center equipment into a hot aisle and cold aisle facilitates better cooling (O'Neill 2010; Pollack 2008; Velte et al. 2008; Webber et al. 2009). The hot aisle/cold design “produces a constant flow of cool air through the racks, assuming there is no interruption in the airflow. In a hot/cold aisle configuration, the hot aisles are always at a much higher temperature than the cold aisles. For this to provide the most efficient cooling, internal fans that bring air into it out of individual units should be disabled or configured to act with, not against, the overall pattern of air flow in the aisles” (Webber et al. 2009). Data centers’ layout affects the efficiency of the air condition system. If the airflow is blocked, efficiency is adversely affected (O'Neill 2010). Therefore, a hot /cold aisle is needed to improve energy efficiency. It is very important to add vent tiles on the floor so cold air can efficiently flow through the devices. Also,

cabling is considered as an important factor in data center layout. Although cables do not generate heat, they can block air if they are not placed correctly (O'Neill 2010; Pollack 2008; Webber et al. 2009).

Energy Consumption

Another way to save energy is by implementing power management tools that help organizations shut down machines when they are not in use or to put the machine in sleep mode during periods of inactivity to save energy. Having users turn off PCs and monitors is often difficult; therefore, using power management systems, companies will be able to reduce their electricity costs about 40% (O'Neill 2010; Pollack 2008; Webber et al. 2009). When computers are in sleep mode, they consume less power (Webber et al. 2009). Numerous case studies have documented the implementation of desktop power management tools to reduce energy consumption. According to Pike Research, a market research and consulting team, power management tools offer a fast return on investment for companies looking to save costs and reduce emissions. For instance, Northrop Grumman Corporation has successfully reduced its greenhouse gas emissions by implementing desktop power management tools which automatically puts PCs, Laptops and monitors into lower power states when not in use (Pratt 2011).

Energy Star is one of the well-known government backed programs that focuses on energy efficiency. It addresses power usage and efficient use of equipment, putting equipment to “sleep” when they are idle (Webber et al. 2009). Energy Star provides solutions that allow companies to reduce energy consumption. For instance, Partners Health Care, a not-for-profit health care system that is committed to patient care, research, teaching, and service to the community in Boston was able to save $2.2 million per year by implementing a software tool for power management. Also, General Electric was able to cut energy costs by $25 to $75 per PC annually (Dubie 2007).

Telecommuting

Another green IT practice is telecommuting or working from outside the company's real estate. Virtual workers or telecommuters can also contribute to reduce greenhouse gasses emissions. "Virtual workers are employees who are in the office virtually. They connect to the company's IT systems and complete their work as before, except that they are not physically present. Rather than people coming to the work, the work (electronically) goes to them"(Webber et al. 2009). Velte et al. (2008) identify telecommuting as a major way to reduce the amount of electricity used and the need for new computers. Workers still need to complete work, but they do not necessarily need to fill up office space.

A virtualized workforce can reduce footprints while reducing operational costs. For example, it generates a paperless office, employees just have to sign it and get the job done. Also, companies will spend less in its real state, building management, parking lots and more facilities (Webber et al. 2009& Velte et al., 2008). Moreover, a virtualized workforce will reduce carbon dioxide emissions by not commuting to work and driving their vehicles. This means that fewer vehicles will be emitting greenhouse gasses. However, telecommuting is often wrongly perceived as a vacation and workers not having to do their share of the work but that is not the case (Velte et al. 2008).

A study conducted by Global Workplace Analytics and Telework Research Network (2011) shows that telecommuting rate in United States has increased by 73% between 2005 and 2011 compared to only 4.3% growth of the overall workforce (not including the self-employed). In order to break the negative perception about virtualized work force, rules and computing systems have been created. However, the success of telecommuting depends on the company's culture. For example, if the company values workers and holds them accountable for completion of work

to a commonly accepted level of service, then virtual teams can succeed. On the other hand, if employees are not trustworthy, virtualized work will not apply to them (Webber et al. 2009).

Information Communications Technologies (ICT) can create a secure environment for telecommuting. For instance, Sun Microsystems, a manufacturer of hardware and software and information technology services which was acquired by Oracle in January 2010, operates a telecommuting program called iWork (Oracle 2010). Employees can work from home; they can drive to a flexible work center when they need an office. "Sun Microsystems employees have identification cards with Java encoding. When they insert their card into a workstation, it instantly sets up the user's personal preferences" (Velte et al. 2008). A telecommuting program is not difficult to set up, but some work needs to be done upfront. For example, work rules need to be setup to let telecommuters know that they are still part of the company. Also, videoconferencing technology can help to reduce travel cost. KPMG was able to save $2 million in travel costs after the created a program called Green Travel Advisor in 2010 (Violino 2011).

Paper Reduction

Going paperless and reducing paper is another practice to save trees. Green IT can facilitate and create the necessary tools to reduce the amount of paper an organization uses (Webber et al. 2009). "Each year the U.S. alone consumes around 200 million tons of wood products, and this number increases 4 percent each year. The biggest source of wood consumption is paper production. U.S. paper producers consume one billion trees per year. That's the same as 12,430 square miles of forests each year, resulting in 735 pounds of paper for each American. Although the U.S. has less than 5 percent of the world's population, it consumes 30 percent of the world's paper" (Velte et al. 2008). Going paperless depends on the behavior of people. Newspapers and

magazines, despite having a web presence, are still printed and sold due to preferences of customers (Velte et al. 2008).

Some of the advantages of working with electronic files other than printed files in paper are the following: less paper will be consumed; therefore, fewer trees will be destroyed; it leads to easier document handling; backups are easier to create and recover when needed; this results in cost savings through reduced paper costs and less storage space; files can be found using computerized search tools; organizations are left with less waste to be recycled, burned or sent to a landfill (Velte et al. 2008). By printing less, organizations will save money on toners, printers and copiers' maintenance, paper, electricity, and shredding services. A perfect example of going paperless is what Nixon Peabody, a law firm, started doing 2 years ago. This law firm reduced its paper usage by 15% saving an average of 120 cartons or 600 sheets every month by setting all printers to double-sided printing and by encouraging employees to keep documents in an electronic form instead printing them (Pratt 2011).

Paper use can be reduced by 50% by setting printers to duplex printing as a default, by not printing emails, and of course by just printing what is needed. Additionally, scanning documents help to reduce paper; existing paper work can be scanned to reduce space in your file cabinets as well as in your company. Also, fillable PDF forms could be useful as they allow customers to fill and submit forms digitally through emails or other applications. Another practice that includes reducing paper is online billing and using computer software to send fax electronically instead of using the physical fax and paper to print faxes.

Equipment and Parts

Reusing equipment components such as hard drives, cables and among other peripherals is a green IT practice that reduces disposal of hazardous material. By reusing components of IT

equipment, organizations reduce costs on purchasing equipment while reducing the amount of equipment to be disposed. Unwanted but not obsolete equipment can be donated to organizations that can still use it. Equipment at its end of life should be transferred to a recycling firm where they can be dismantled and some of its components can be reused (Webber & Wallace, 2009). For instance, equipment that is no longer in use but in working condition can be diverted from landfill and be donated to nonprofit organizations. Fortunately, the amount of regulations in the United States has reduced e-waste reaching landfills. However, Americans' e-waste has been disposed overseas to Asia or Africa where computers are dismantled for usable materials in conditions that are hazardous to the environment and to the health of people (Webber et al. 2009). All this recycling process must be done carefully with a minimal impact on the environment and human health (Webber et al. 2009).

Equipment Disposal

Another way green IT can contribute to environmental sustainability is by managing equipment disposal properly. Many companies have started implementing initiatives that reduce the amount of equipment they use; however, what needs to be done more carefully is the disposal of equipment (Webber et al. 2009). Electronic equipment cannot be disposed off in the regular waste stream. Electronics should be recycled properly and not just sent overseas. Electronics, especially computers that contain hazardous materials such as lead, mercury, polybrominated flame retardants, and cadmium are toxic and can result in adverse health impact. For example, cadmium can damage kidneys, lead damages nervous, urinary and reproductive systems, and polybrominated flame retardants can be an endocrine disruptor and developmental neurotoxicant. Also, mercury which is more commonly found in batteries and switches is considered toxic.

All of these initiatives discussed above tend to make business more eco-friendly and profitable. However, a variety of factors including lack of awareness, budget constraints, and employees' negative behavior towards change may hinder such initiatives. In the following sections, we examine the literature on factors that impact the adoption of green IT initiatives.

D. Factors that Delay Green IT Adoption

Green IT has many potential benefits but there are several issues that need to be managed (Brooks et al. 2010). Green IT initiatives benefit organizations if they are properly implemented; however, there are still some organizations that are not seizing the opportunity to go green (Iacobelli et al. 2010). Those organizations view green IT initiatives as overheads rather than opportunities (Murugesan et al. 2011& Molla, 2009). In order to reduce the uncertainty surrounding green IT, ICT community needs to be better educated about green IT practices. According to (Jenkin et al. 2011a), there are four gaps among IT professionals: knowledge gap– IT professionals do not know how green IT can contribute to environmental sustainability, practice gap – IT professionals are not aware of best practices and therefore, they do not implement green IT initiatives, opportunity gap– IT professionals have not realized how green IT can enable organizations to reduce costs, improve business operations and contribute to environmental sustainability, and knowing-doing gap– IT professionals need to be specialized and be educated about green IT practices so they can successfully practice green IT initiatives within their organizations.

In order to fill these gaps more educational resources and training should be available to IT professionals. One approach to reducing uncertainty and increasing awareness of green IT among professionals and the business environment is by incorporating sustainability related programs in the curriculum in higher education institutions. This entails introduction of green IT courses and offering minors and degrees on IT sustainability practices. Consequently, green IT

will gain more attention and acceptance. Sendall et al. (2010)'s study results show that just a few higher education institutions have incorporated green IT in to their curriculum.

According to DiMaggio et al. (1991), university and professional training institutions are important centers for the development of organizational norms among professionals managers and staff. This highlights the role of universities in increasing awareness of green IT in organizations, thereby enabling better compliance and triggering innovations. The lack of education among IT professionals about IT sustainability might play a role in lack of green IT adoption. ICT community should join and support educational programs in the computer field by providing resources such as training and literature. Some of the issues that need to be taken care of to accelerate green IT adoption are uncertainty, lack of awareness, and cost. IT professionals need to understand the whole idea of greening business through IT practices. Employees are less likely to practice sustainable initiatives if they do not have a positive perception about IT-related sustainability practices. Top managers and the ICT community in general have to focus in increasing awareness about green IT initiatives.

E. Motivational Drivers for Green IT Adoption

Greening efforts will be given high priority in the next years to come as it is both an economic and environmental imperative that helps reduce costs as well as footprint and improve the public image of organizations (Smart 1992). By reviewing the extant literature, we have found that most of the businesses implement green IT initiatives because they have to comply with government regulations, improve their public image, reduce expenses, and deliver services more efficiently.

Regulatory Pressures: Regulatory requirements and legislative action splay a significant role in the adoption of green technologies. Government regulations can force companies to green

their business operations and adopt new technologies even if they do not want to do it (Molla 2009). For instance, government regulations influence how we handle "the waste generated from the computers and other IT-related equipment that we depend upon to run our businesses" (Webber et al. 2009). Noncompliance may lead to fines, legal issues, and consequently will hurt organizations' public image. Policies and regulations can facilitate technological adoption by providing incentives and subsidies (Dedrick et al. 2011). Incentive and rewards from governments accelerate green practice acceptance. For instance, in Denmark companies are required by the law to have a "green budget" in their annual reports (Hedman et al. 2011). Even though companies just buy energy efficient technologies to justify their corporate social responsibility, they are complying with regulations.

*Public Image***:** Environmental crisis in 1990's presented the business community an incredible opportunity to make companies profitable as well as to create an outstanding corporate citizenship (Sullivan 1992). Adoption of green technologies could result in cost savings while making it a better neighbor (Webber et al. 2009). Sustainability practices improve companies' public image. Developing a good corporate social responsibility image might be related to profitability as well (Molla 2009). Some companies not only want to increase the efficiency of their organizational processes, but they also want customers and the general public to acknowledge their efforts (Orsato 2006). Green initiatives present opportunities for companies to develop a good image of social responsibility and stewardship (Velte et al. 2008). Public pressure can play a large role in moving organizations towards more sustainable business practices, including green IT practices(Jenkin et al. 2011b).Companies whose efforts go beyond compliance as Wipro (Bose 2009), and 3M (Smart 1992), tend to create a strong public image that will affect the shopping behavior of consumers (Orsato 2006).

Competitive Advantage: Green IT initiatives can also be a source of competitive advantage. Making the right choices such as money spent on eco-investments can transform a company performance (Orsato, 2006 as cited in Brooks et al. 2010). Competitive pressures are also found to drive technology adoption as firms look for ways to gain competitive advantage (Dedrick et al. 2011). Green IT is a business strategy and enables organizations to save money while aligning with corporate social responsibility which helps companies differentiate themselves from their competitors (Velte et al. 2008). Companies that implement green initiatives will efficiently deliver the same or better service while expending fewer resources. For example, 3M was able to save $530 million dollars by preventing pollution at the source, disposing treatment residues through appropriate methods, and by recycling manufacturing by-products for internal reuse or external sale (Smart 1992). For instance, Wal-Mart's computerized warehouse inventory system allows the company to identify items sold, find prices and to reorder inventory efficiently. This system allows automatic reordering from its suppliers and better coordination. By using this system, Wal-Mart spends less on inventory than many of their competitors and reduces floor space for goods as goods arrive and leave its warehouses without sitting on a shelf. Wal-Mart uses only 10% of floor space for inventory storage while the average in the industry is 25% (Alter 1999). Wal-Mart initially had to invest in technology that can help achieve such efficiencies, but in the long run Wal-Mart was able to significantly reduce cost as well as footprints as they started greening their supply chain.

Cost Reduction: Green IT enables businesses to become sustainable while reducing costs. The adoption of innovation is a decision made through a cost-benefit analysis (Rogers 1995). Organizations analyze the ROI (Return on Investment) when they invest money on any initiatives. The adoption of green IT contributes not only to improve business' environmental cre-

dential but also to reduce of the total cost of technology ownership while increasing the total environmental value of ownership (Molla 2009). Green technologies implementation allows companies to reduce energy consumption and other operational costs such as going paperless and telecommuting.

Green IT initiatives are often considered as different types of innovations. In other words adopting green IT as a business practice is similar to bringing innovation to a company (Nidumolu et al. 2009). “Sustainability is a major and growing driver of business change” (Seebode et al. 2012). Whenever there is a change in business process or a new technology is integrated in business activities, this entails bringing innovation to the organization. Studies on managing sustainability for innovation argue that sustainability initiatives represent a long wave of innovation since it has to go through an adoption process (Seebode et al. 2012). Implementing sustainable and new technology to do things better and differently involves increasing awareness and acceptance from users (Seebode et al. 2012). Hence it is important to understand prior research on adoption of innovation.

F. Adoption of Innovation

Innovation is a product or practice that is new to the organizations adopting it. Significant innovations are those which are new to all organizations of a similar form (Aldrich 1979). Some theorists would reserve the concept of innovations for the first appearance of a new practice or product (Aldrich 1979). Innovation is the process of developing new ideas and putting them into practice. Innovation can be defined as an effort to create purposeful, focused change in organization’s economic as well as converting new ideas into usable applications with positive economics or and social consequences (Schermerhorn 2009). Innovation in and by the organizations mostly occurs in two forms: process and product innovations. Process innovation is basically a better

and more efficient way of doing things while product innovation is a new product or improved goods and services (Schermerhorn 2009).

Presently, the word innovation has a variety of meanings. Every new product in the market may claim to be innovative (Lehmann 2004). Additionally, politicians and society as a whole see innovation as technology development, progress and efficiency. From a technological perspective, innovation refers to the idea of information expressed by an innovation (Rogers 1995), which includes hardware or a software component. When innovations are expressed in a technological design, uncertainty will decrease in the organizational environment (Rogers 1995). This means that new information expressed in a certain technology will reduce the level of uncertainty when it comes to adopting innovations.

Innovative organizations may present variations into an organization population by intentionally fluctuating routine modes of behavior (Aldrich 1979). Innovation and new business practice will produce a type of uncertainty. The initial customer base might be limited in the early days of an innovation. Individuals or organizations will embrace changes or innovations when they have a perception of the meaning of innovation and they understand the benefits and the need for change. People will adopt an innovation if they believe that it will enhance their utility (Rogers 1995). Hence they must believe that the innovation will yield some relative advantage to the idea it supersedes.

Kimberly (1978) identified three questions regarding the adoption of innovations: “(1) Why do some organizations adopt an innovation that others ignore? (2) Why do some organizations adopt an innovation more rapidly than others? (3) Why are organizations selective in adopting some but not all innovations possible in their industry or niche?” According to Kimberly (1978), there are three factors affecting the adoption of new innovations: (1) the personal characteristics

of administrators, managers and other members (2) structural characteristics of organizations such as the size or degree of centralization of authority and (3) the relations between the organization and other in its environment (as cited in Aldrich 1979).

Highly innovative organizations tend to be change leaders rather than followers of status quo. Organizations where top management (decision makers, administrators, executives and managers) follows the status quo wherein managers accept things as they are and resist to change them, it is unlikely that favorable conditions to accept new ideas would be generated (Kimberly 1978; Schermerhorn, 2009 & Dedrick & Zheng, 2011). Status quo followers are bothered by uncertainty and are predictable in that they wait for things to happen while change leaders actively look for new processes and more efficient ways of doing things. Professional training and education in an open leadership style will likely help bring awareness about the new ideas and accelerate innovation acceptance by top management (Kimberly 1978). Senior management support and training play a key role in the process of green IT adoption. In organizations where top managers are open to innovation and employees are willing to be educated about new practices, the implementation of green IT will likely be more successful. Green IT practices may be innovative and it is necessary that top management is involved and willing to contribute.

Secondly, Kimberly (1978) identified structural characteristics as one of the factors that affect the adoption of new processes in organizations. Organizations that follow a centralized structure often face more challenges when adopting new ideas (Kimberly 1978). Centralization or formalization occurs when in an organization all decisions and actions at the lower level are subjected to the approval of the top management. On the other hand, decentralization is a systematic delegation of authority across different levels of management. While the top management may make major decisions, the rest of the authority may be delegated to the middle and

lower level of management. Such differences in decision making structure may play a role in shaping green IT implementations within an organization. For instance, in order for a green IT initiative to be executed, a budget and certain allocation of resources have to be approved by top executives and then the lower level managers will delegate functions and assign work with specific IT staff.

Since organizational success does not always occur linearly (Schermerhorn 2009), centralization does not easily contribute to new processes and ideas adoption. On the other hand, Kimberly (1978) argued that depending on the environment, centralization can positively influence innovations. For instance, when an environment is predictable and stable, centralization and formalization can generate conditions to accept changes and new processes. However, when the environment is full of instability and turbulence, decentralization and lesser formalization increase the probability of adoption. Instability and turbulence often place heavy demands on an organization's control and communication activities (Aldrich 1979). Greater delegation of authority and untying rules are required to allow members to respond to rapidly changing conditions. In contrast, stability and predictability allow top management to follow their own plan for innovations and a high degree of centralization will accelerate the implementation of such plans.

The third factor Kimberly (1978) recognized is the relation of an organization with other organizations in its environment. For instance, in environments where the market for an organization's product is expanding and the level of competing organizations is low, the possibility for adopting innovations increases (Enos 1962). Another factor that promotes the adoption of new practice in an organization is imitation. Organizations with links to others that serve as opinion leaders may adopt an innovation in imitation of the opinion leader. Table 1 summarizes the three factors presented above.

Factors Affecting Innovations Adoption	***Overview***
1. *Personal Characteristics of Administrators, Managers, and others members*	Organizations where top management is open to new ideas and willing to learn through professional trainings and employees insights tend to implement innovations faster than those organizations where top management is conservative.
2. *Structural Characteristics of Organizations*	Formal or centralized organizations where all decisions have to be approved by top management (top to bottom organizations) are less likely to adopt new initiatives than those decentralized organizations where the lower level participates in decision making process.
3. *Organizations' relations with other organizations in its environment*	An organization whose market is expanding and competition is low, joint ventures or organizations that imitate opinion leader's organizations adopt new initiatives rapidly.

Table 1: ***Factors Affecting Innovation Adoption (Kimberly 1978)***

Adoption by imitation is exemplified by the impact of 3M's environmental sustainability program, Pollution, Prevention, Pays (3P) initiated in 1975. This program was established at 3M to motivate employees worldwide to look for innovative ways to eliminate pollution at the source (Smart 1992). After 16 years of implanting the 3P program, 3M announced that the company's savings were $530 million from pollution control facilities that did not have to be purchased and installed. In the mid-1980s, others companies started emulating 3M's concept of 3P. For example, *Dow Company* initiated its "Waste Reduction Always Pays" program, and *Chevron* began its efforts to "Save Money and Reduce Toxics." Both of these organizations reports substantial reductions in their operating cost and waste discharges using techniques similar to 3M's 3P program (Smart 1992). Imitation of the opinion leaders is another factor why organizations adopt new products and techniques.

Kimberly (1978) disagrees with the idea that larger firms should be more innovative than small firms. Margaret Sharp (1973), in the book *The State, The Enterprise, The Individual* presents how smaller organizations in the steel and pharmaceutical industry spend more on innovative activity than larger companies. Other studies have found that larger firms invest as much as the smaller firms in some industries, while in other industries larger firms invest less than smaller firms in innovation (Aldrich 1979). A study conducted by the U.S. Small Business Administration (SBA) found that smaller firms are more innovative than larger firms and that small firms are more likely than larger firms to have green technology as a core part of their business (Breitzman et al. 2011).

This study, referred as SBA4, retrieved data from the U.S. innovative firm database which consisted of data from 1279 small and large technology-based innovative companies. The SBA identifies these firms as a special group of companies that have had a least 15 patents granted in the past 5 years (Dizon 2011). This study focused on patents dealing with "green" technology that involved batteries, clean coal, smart grid, fuel cells, hybrid electric, and generic green technology. This study reported that smaller organizations apply for green technology patents more than expected. According to the study findings, 8 percent of patents in the U.S. innovative firm database are from small firms. Small firms account for about 32 percent of patents dealing with smart grids and solar energy.

The rate of smart grid and solar related patenting by small firms has exceeded their expected rate by about four times. The report also shares data on large firms in order to highlight the difference between large and smaller firms. Based on the patenting data from 2005-2009, the study identified that a small firm by the name of Current Group, LLC which had approximately 60 employees held a large share of patents in the smart grid/smart metering/grid infrastructure cate-

gory. This firm had 62 relevant patents while General Electric had 14 patents (Breitzman et al. 2011; Dizon 2011)

This indicates that organizational slack might be related to organizational size and lead to reduced innovation. Organizational slack refers to "the resources available to be allocated on new projects without affecting an organization financial stability" (Kimberly 1978, p. 104). Adopting new initiatives depends on the extent of resources the organization is willing to allocate to the new project. There could be large organizations, which do not have the resources and funds to support an innovation while there could be smaller organizations, which envision and are able to support innovations. Therefore, size is still an ambiguous factor related to adoption of innovations. In addition to the factors that presented above, we draw from the literature on isomorphic forces from the institutional theory to examine motivational drivers that make companies adopt new practices.

G. Institutional Theory (Isomorphism)

Drawing from institutional theory and isomorphism, we developed a theoretical foundation for this study. Institutional theory argues that organizations in competitive marketplaces will inevitably face social pressures that lead them to adopt eco-friendly initiatives. "Institutional theory investigates how external forces influence organizations" (Clemens et al. 2006; DiMaggio et al. 1991). This theory explains that there are three forces that influence organizations: coercive, normative, and mimetic and describe this process as Institutional Isomorphic Change (see Table 2 for a summary). Isomorphism is defined by Hawley (1968) as a constraining process that forces one unit in a population to resemble the other units that face the same set of environmental conditions. Institutional isomorphism deals with forces pressing organizations to accommodate to the outside world (Kanter, 1972 as Cited in DiMaggio et al. 1991).

"Organizations compete not just for resources and customers, but for political power and institutional legitimacy for social as well as economic fitness" (Smart, 1992; Hart, 1997; & Jenkin et al. 2011b). Nowadays, organizations do not just think about profit but about how stakeholders view them. Organizations strategically plan their organizational changes so they do not affect their financial and social performance. Isomorphism occurs when organizations respond to uncertainty, ambiguity or when unpredictability is present (Kerno Jr 2010). Business leaders tend to imitate other organizations practices when they perceive those organizations to be superior in term of legitimacy or success (Kerno Jr 2010; Kimberly 1978).

Isomorphic Forces	***Overview***
Coercive Pressures	They require actors to comply with certain collective practice to prevent formal sanctions or severe consequences. For example, Government regulation or industrial legal actions could shape certain organizational changes.
Normative Pressures	Normative isomorphism refers to an organization seeking legitimacy from alignment with professional values originated from licensing and educational credentialing. For example, group of employees initiate change in their organization after get some training and specialization.
Mimetic Pressures	Organizations are driven by environmental and technological uncertainty. As emerging technology rapidly advances, risks associated with technology uncertainty would be inevitable. While facing such uncertainty, actors in a social group would often fear to be different and tend adopt innovation after the opinion leader in the industry does it.

Table 2: ***Isomorphic Forces - Institutional Theory (DiMaggio & Powell, 1991, pp. 67-74)***

Coercive isomorphism originates from political influence and organizations seeking legitimacy from government mandates derived from contract law. Coercive forces "may be felt as a force, a persuasion, or as an invitation to join in collusion" (DiMaggio et al. 1991). For example, one organization may influence another or encourage another to adopt its initiatives. Furthermore, governmental mandates are considered coercive forces. For instance, a manufacturer may

adopt eco-friendly technologies to comply with an environmental regulation. The existence of a common legal environmental framework affects many aspects of an organization's behavior and structure (DiMaggio and Powell, 1991; Smart, 1992; Webber and Wallace, 2009 & Sullivan 1992). Coercive pressures are outside social forces that affect organizations' behavior towards change or adopting new initiatives. According to Kerno Jr (2010), governmental regulatory agencies have the complete authority to impose sanctions upon non-compliant organizations. Therefore, organizations make the necessary efforts so their business operations comply with government regulations.

Normative isomorphism refers to organization's seeking legitimacy from alignment with professional values originated from licensing and educational credentialing. Normative pressure originates from professionalization (DiMaggio et al. 1991). Professionalization is interpreted as the collective struggle of members of an occupation to define the conditions and methods of their work to control the production of producers and to establish a cognitive base and legitimation of their occupational autonomy (Larson 1977 as cited in DiMaggio and Powell). Filtering of personnel is a mechanism suggested to encourage normative pressure (DiMaggio et al. 1991). This occurs when an organization hires individuals from firms within the same industry; through the recruitment process, organizations hire professionals who have been working at companies where training and innovation are higher priorities. Those professionals can initiate change and innovations in hiring organizations.

Mimetic isomorphism is in response to uncertainty and seeking legitimacy, for example, from models diffused through consulting firms. Not all elements of institutional isomorphism are based on external forces; uncertainty and imitation drive organizational changes as well. Uncertainty refers to a lack of sureness, conviction or knowledge which leads organizations to imitate

what other competitors are doing. Innovations or changes to organizations need not be part of a conscious strategy and may be a result of an imperfect attempt to imitate other organizations perceived to be successful (Alchian 1950 as cited in Aldrich, 1979). Mimetic behavior can help organizations that are unclear about how to solve a specific problem finds solutions with little expense by analyzing competitors and imitating successful industry practices (DiMaggio et al. 1991). Mimetic pressure leads organizations to "benchmarking that allows organizations to measure themselves against those who have successfully adopted certain technology or implemented new policies" (Chen 2011).

In summary, while prior research identifies several factors that may play a role in helping organizations adopt innovations, there is a lack of clarity in understanding motivational drivers that shape green IT adoption. Green IT as a business strategy will gain more attention in the business sector and we would like to examine its motivational drivers to contribute to green IT literature and practice. In the following sections, we present a multi-site case study, connect our findings from the case study that explain the various reasons that encourage or hamper organizations' shift towards green IT with elements of the theory of institutional isomorphism, and. present novel insights into the conception and execution of green IT initiatives.

III. RESEARCH METHODOLOGY

Because our research is exploratory rather than confirmatory, we[1]use a case study design (Yin 2009). A case study is the most common qualitative research method used in information systems (Orlikowski et al. 1991). Yin (2009) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the bound-

[1] I used "we" as it is customary in information systems research. Most research papers in Information Systems use "we" rather than "I". The data collection and analysis were completely performed by me while my mentor advised me and directed me towards resources and tools that I could use for my research.

aries between phenomenon and context are not clearly evident." Case study research method is well-suited to several areas in Information Systems (IS) research (Benbasat et al. 1987). The primary focus of IS discipline is the study of information systems impact in organizations. This interest includes a lot of different inquiries such as understanding how and why new systems affect organizations' operations process, why some companies adopt some technologies and innovations while other companies reject them, and among others. According to Yin (2009), a case study encourages to develop knowledge and create awareness about an individual, organizational, social, group, political related phenomena.

Therefore, the lack of knowledge and practice of green IT initiatives among organizations motivates us to use a case a study approach to develop a model that explains the motivation and adoption process of green IT initiatives in the context of the isomorphic pressures. Case study research is useful when "a phenomenon is broad and complex, where the existing body of knowledge is insufficient to permit the posing of causal questions, when a holistic, in-depth investigation is needed, and when a phenomenon cannot be studied outside the context in which it occurs" (Paré 2004) which fits the focus of our study on examining green IT initiatives. Such initiatives have not gained enough widespread awareness among organizations.

The main focus of this study is to identify how and why organizations adopt green IT practices by analyzing adoption of innovation process and using institutional theory as a theoretical lens. Our study uses constructs from the institutional theory which emphasizes that there are three social pressures or forces which influence organizations to adopt new practices (DiMaggio et al. 1991). Those constructs are the coercive, normative and mimetic pressures. These isomorphic pressures will provide the necessary framing for developing an understanding on how and what drivers motivate organizations to adopt green IT initiatives.

Also, we will use three factors as constructs from the adoption of innovation process which are personal characteristics of administrators, managers and other staff, structural characteristics of organizations, and organizations' relations with other organizations in its environment. These factors will help explain how business model, organizational structure, and an organization relation to its environment can affect green IT adoption. Our study identifies new factors that affect green IT execution while developing a framework that integrates concepts from the institutional theory and adoption of innovation process.

A. Site Selection

We selected five organizations in four domains such as academic, nonprofit, governmental, and e-business. We selected this set of organizations because of their involvement with green IT initiatives. Each site has accomplished different levels of maturity in implementing green IT initiatives. The five sites view green IT practices from different perspectives since each site is driven by different factors and interests to adopt green IT. These sites differ in their decision making process as well in their employees adoption of innovation process. The amount of resources available to complete a project is different among these sites. For instance, academic institutions and governmental agencies entities have the opportunity to request a budget to be allocated in projects and innovations while nonprofit and e-business entities have to generate funds to invest in innovation.

Furthermore, each site makes their business case for implementing green IT differently. For instance, green IT efforts at academic institutions are mostly driven by the need to comply with institutional and state regulations while green efforts at e-business entities are cost driven. They mainly want to reduce their expenses and improve business operation while maximizing profits. Sustainability efforts at nonprofit organizations are driven by cost savings and improved ethical

standards. Even though these sites have adopted green IT practices, our findings indicate that there is still a lack of understanding and uncertainty in green IT practices among them. Each one of these sites has a different organization structure and business model on how they achieve daily operations. All these firms face pressures from regulations to be more sustainable. However, a few of them take regulatory compliance and tackling adverse environmental impact seriously. By analyzing data collected from the sites selected we were able to identify how much these sites know about green IT opportunities and benefits for the environment and the organizations' profitability goals in addition to why and how they adopted or delayed certain green IT initiatives.

B. Data Collection

Qualitative data were collected from the five sites progressively via on-site and phone interviews. All the interviews were conducted by me between June and August of 2012. Documentation provided by some of our informants were collected and analyzed. Data collection and analysis were conducted over a period of 2 months. Table 3 provides details on the participants and company characteristics. Snowball sampling was used in that we initially discussed our research goals with key contact persons who were IT senior managers in the five organizations. They then helped identify participants who were most likely involved in green IT initiatives. In turn, these participants helped identify additional participants. We conducted semi structured interviews with each participant to collect data, seek clarifications, and obtain additional insights.

According to Yin (2009), one of the most important and essential sources of data for case studies is the interview. Interviews will be guided conversations rather than structured queries. Even though we pursued a consistent line of questions, our actual stream of questions in a case study interview is more likely to be fluid rather than rigid (Yin 2009). Instead of just following

the protocol that we developed upfront, our semi-structured interviews[2] included follow-up questions based on the responses provided by the informants. Also some actual conversational questions were asked in an unbiased manner to help contribute to a better understanding of our line of inquiry (Yin 2009).

Interviews focused on identifying green IT practices within organizations and describing the adoption process of new initiatives. The average duration for interviews was 45 minutes. All the interviews were audio recorded and transcribed. Furthermore, additional data in the form of documentation were used. Specifically, notes taken during interviews and other documentation shared with us by our informants were reviewed. Data collection was tightly interlinked with data analysis. Subsequent interviews were conducted to follow up on insights that emerged from data analysis. Data collection and coding were done until saturation point was reached, when additional data did not add to the concepts and subcategories. In other words, we ended the process of interviews when new data collected did not add any additional insights. Table 3: Subjects in the Study and Company Characteristics identifies the different roles of our informants and the number of interviews.

		EDU	**COL**	**NON**	**GOV**	**BUS**	
		Academic	***Academic***	***Non-Profit Organization***	***Governmental Agency***	***E-Business***	***Total***
Roles	*Senior Management*	3	1	0	1	1	6
	Technical IT Staff	2	1	1	1	0	5
	Administrative Staff	1	0	0	0	1	2
	Total No. of Participants	6	2	1	2	2	13

Table 3: ***Subjects in the Study and Company Characteristics***

[2] Initial Questionnaire is under the a Appendix A

C. Data Analysis

Transcripts of interviews represent the primary data in this study. First, interview data were coded to reflect constructs that were identified from our review of literature and conversation with stakeholders. Codes in the interviews transcripts range from quotation, short and long sentences. All codes were linked in a network view to identify some relationships and develop our framework. Also, we examined all the codes and relationships to find out major themes that support the constructs found in green IT adoption literature as well as those new constructs that emerged during our analysis.

Atlas-ti7® a software tool was used to organize and code the data[3]. Throughout our analysis we identified key concepts, categories, and relationships from each of the cases. The discovered theoretical concepts and relationships are included in the framework described in the next section. The data analysis process helped us establish plausibility and consistency of the concepts, subcategories, and relationships to ensure that our framework satisfies commonly used criteria for credibility and validity of qualitative research (Pawlowski et al. 2004). Relevance of concepts in our framework is established by examining their presence or absence when comparing incidents or explanations of green IT initiatives from our data (Strauss et al. 1990). While the software helped me to organize the data, locate quotes relatively easily, and to connect quotes to codes and the network, the actual data analysis process was conducted by me. Unlike quantitative analysis, we cannot use the software outputs as outputs of our analysis (Yin 2009). Once I loaded the transcripts intoAtlas-ti7®, it allowed me to create networks and relationships among codes to complete data analysis. Figures 2 and 3 under Appendix B present screenshots from Atlas-ti7®. Figure 3 shows an example of a network that I developed by establishing relationships

[3]**Coding** is a technique that both organizes the data and provides a means to introduce the interpretations of it into certain qualitative methods. Each segment is labeled with a "**code**" – usually a word or short phrase that suggests how the associated data segments inform the research objectives (Yin, 2009).

among codes and categories. Figure 3 shows a screenshot of a transcript and the codes used for labeling text fragments from the transcript.

The findings from such analyses may be detailed and specific to the cases and contexts studied. However, they can be used to develop a general explanation of the result through analytic generalization (Yin 2009). We present evidence through quotes from qualitative data in accordance with recommended practice in qualitative research (Mason 2002). The organization and the role of the informant are also identified with a letter code representing the organization and the role of the informant (identified in Table 3). In the findings section, we use pseudonymous names as we cannot reveal the identity of our subjects due to confidentiality agreements. For example, GOV represents a quote from the government organization EDU and COL for academic institutions, NON for non-profit organizations, and BUS for e-business entities.

IV. FINDINGS

A. Case Study Sites

Site 1 - EDU: EDU is an academic institution which has a diverse IT work force. Although the IT department is implementing green IT initiatives, some systems administrators did not initially consider those initiatives as sustainability-related, but started changing direction and classified those initiatives as green IT initiatives. Top management is open minded in that IT managers and directors often meet with their staff and obtain input and recommendations about new IT initiatives that align with EDU's strategic plan and benefit the academic community as a whole. EDU has implemented green IT practices for nearly 3 years. They started virtualizing servers and currently they are working on the redesign of the data center infrastructure. The majority of their

green IT initiatives have been successfully implemented and adopted because of top management support who allocates funds for training and purchase of resources.

Site 2 - COL: COL is an academic institution which is putting as much effort as possible in green IT practices. Top Management in its IT department agrees with green IT's potential benefits to its operations. Some of the major green IT practices that COL has implemented are driven by the need to reduce power consumption. Examples include sever consolidation in the data center and equipment upgrade pertaining to telecommunications infrastructure. They aim to reduce the amount of physical servers and wherever new equipment is needed they procure those that consume less energy. Top managers meet with their staff and identify possible projects and initiatives that align with the institution's strategic goal. Top managers support the idea of how green IT reduces costs and runs operations more efficiently. COL started its green IT efforts around 3 to 4 years ago when they started virtualization. COL and EDU are two units of a larger system that governs multiple academic units.

Site 3 - NON: NON is a nonprofit organization which is funded by different organizations and partners with several educational organizations to develop self-learning applications to help students at school. NON's operations are driven by technology. All major innovative initiatives including green IT at NON are initiated by top management. NON is very focused on reducing power consumption, reducing printing, and recycling. For instance, NON shifted towards cloud computing[4] instead of having a data center; they are using Microsoft cloud computing services to host their applications. Also, there are no desktops at the company; all employees use a laptop which can be carried easily carried to their meetings. According to a database administrator, employees accepted the idea of the laptops without resistance. NON is saving costs in energy and

[4] Cloud Computing is a technology which uses internet and remote servers to maintain data and various applications (Stryer 2010).

has less cable and equipment to be managed at their site. IT Top management at NON decided to reduce printing by replacing local printers with a network printer on each floor.

Site 4 – GOV: GOV is a governmental agency which has formalized green IT initiatives in the organization's operations. For instance, this organization has formalized a green IT committee that is responsible for making operations more sustainable. GOV IT department decision making process is open and decentralized. This means that staff from all levels in the organization can contribute their ideas and recommend initiatives. GOV green IT committee works to integrate sustainability as part of their operations and organizational goals as well as to better comply with regulations.

Site 5 - BUS: BUS is a small size e-commerce company that sells products online. BUS follows a top-down hierarchical approach in that all the major decisions are initiated by top managers. The CEO of the company approached the IT director and planned all the IT initiatives. BUS' green efforts include virtualization and outsourcing of hosting their email accounts. BUS started virtualizing servers 2 years ago and reducing the number of equipment to save money by reducing energy consumption. However, there is not much clarity on how disposal of equipment should be handled correctly. While BUS does not consider green IT a priority, they try to virtualize servers and implement tools that allow servers to go sleep when they are not in use, without affecting performance.

B. Research Framework

We developed a research framework (Figure 2) based on the analysis of data collected from the sites described above. This framework uses seed concepts drawn from two different streams of literature. These seed concepts include (presented in §II): (1.) Coercive, normative and mimet-

ic pressures (from institutional theory) and (2.) Top management, organizational and Inter organizational characteristics (from the literature on adoption of innovation).

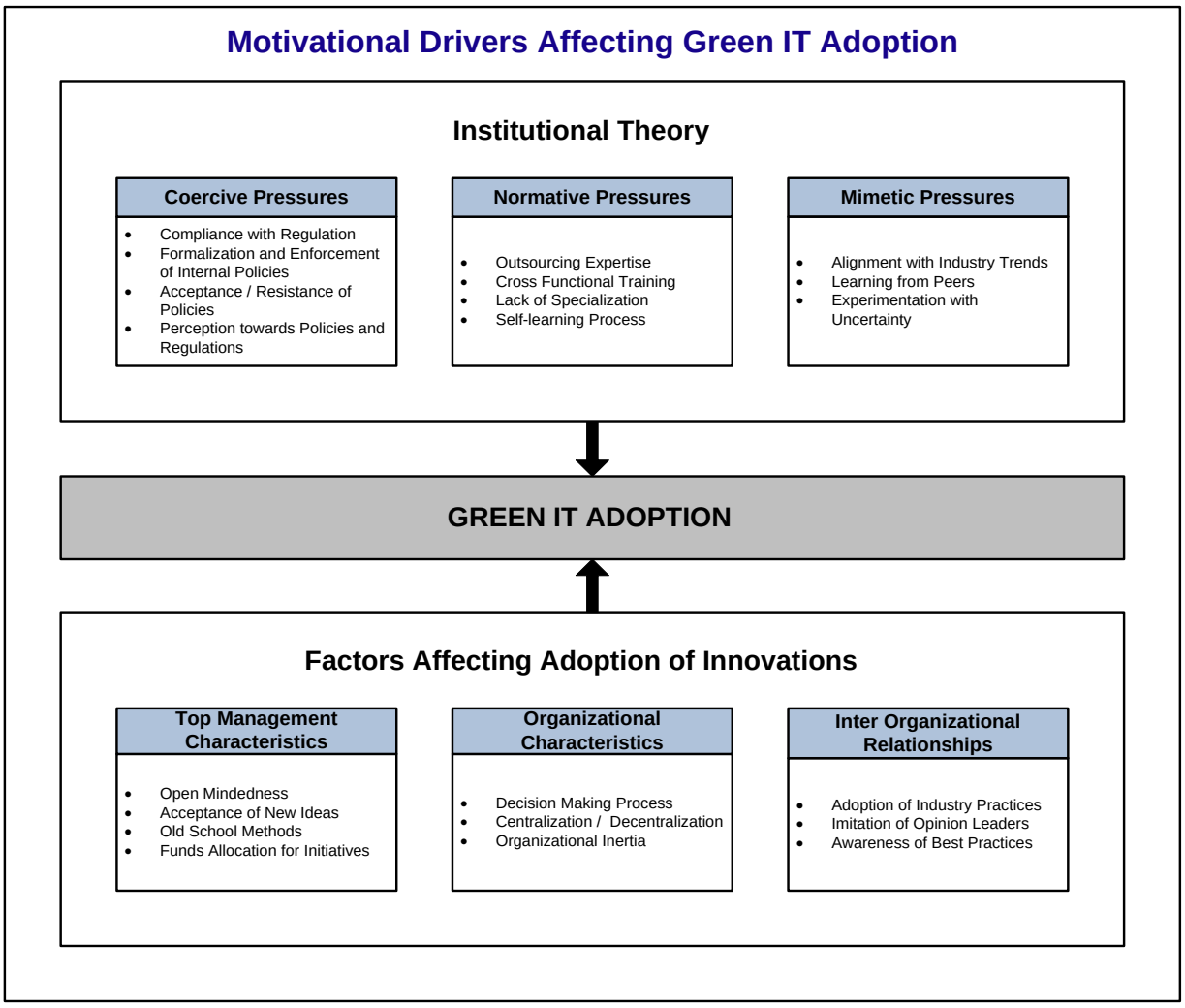

Figure 2: ***Research Framework***

Subcategories of these two concepts emerged from our data (this includes the 21 subcategories identified in our research framework - Compliance with regulations, formalization and enforcement of internal policies, acceptance and resistance of new policies, perceptions towards policies and regulations, outsourcing expertise, cross functional training, lack of specialization, self-learning process, alignment with industry trends, learning from peers, experimentation with uncertainty, open mindedness, acceptance of new ideas, old school methods, funds allocation for initiatives, decision making process, centralization and decentralization, organizational inertia,

adoption of industry practices, imitation of opinion leaders, and awareness of best practices). Our framework is described in detail in this section.

1. Institutional Theory

1.1 Coercive Pressures

- ***Compliance with Regulations:*** Organizations adopt green IT practices because they have to comply with state mandates and regulations. For instance, EDU makes sure that equipment that obsolete and is no longer in use is properly disposed. EDU has contracted a certified state recycling company to manage their equipment disposal procedures. However, we observed variations in the extent to which interviewees understand the implications of disposal procedures and the differences in various approaches to disposal. One of the staff responsible for the disposal of equipment stated that *"the vendor issues a recycling certificate and it tells us how many pounds we have recycled and they give us all the information of what they shred, and many times we can actually get a video of the shredding. We get a recycling certification from the vendor and then we give a copy to public safety for OSHA, Occupational Safety & Health Administration. We are not just concern to be green but also to comply with OSHA rules & regulations."* EDU's major motivator for disposing equipment correctly is in compliance with university and state regulations. This academic institution is aware of regulations and the consequences of noncompliance. The disposal of equipment at EDU and COL is driven by university mandates. There are certain procedures that these institutions have to follow in order to dispose equipment. However, these institutional mandates do not always align well with regulations from government bodies. For example, EDU and GOV had to im-

plement internal policies and procedures to promote and formalize sustainability efforts within their organizations.

- ***Formalization and Enforcement of Internal Policies:*** Top managers and green IT's committee members understand that complying with government regulations is not sufficient to successfully implement green IT within their organizations. Organizations such as EDU and GOV had to implement internal policies and procedures to formalize green IT and sustainability efforts. GOV's IT project manager said *"we try to follow New York initiatives and policies, so essentially in the formal level that the direction we take but we try internally to give this a lot of thought and decide how we will proceed."* Even though GOV is a governmental agency, it also establishes its own internal policies and procedures to promote and implement green IT initiatives. For example, GOV created internal policies for reducing printing activities. These internal policies and procedures were primarily implemented by informing staff that the IT department will no longer support local printers and that all employees will have to print in network printers which were set up to print double-sided by default. Such practices were formalized by EDU's top managers and program executives. In addition, EDU has a committee comprised of IT top management to create IT policies and procedures. One of the IT directors at EDU said *"we implemented a green IT policy to run a job that will automatically turn the PCs in the public areas off after midnight. We have an imaging system called Altiris and though Altiris we are able create scripts that turn off the computers we turn the computer off during midnight and we turn them on in the morning at 6AM and at that time we run all of the updates like the McAfee updates and anything related to windows."* Internal policies have helped these organizations implement their green IT initiatives with minimal resistance from stakeholders.

- ***Acceptance / Resistance of Policies:*** Stakeholders play an important role in terms of adoption of innovations or new practices within organizations. Acceptance or resistance of new initiatives can influence the success of green IT initiatives in an organization. An example of resistance to green IT initiative is how one department resisted using duplex printing settings at GOV *"the department says they have some procedures and rules and that they cannot always use double-sided printing. There are certain requirements for them that do not apply for the rest."* Moreover, it was not possible to switch off faculty and staff computers at EDU and COL during the night because of some special jobs running overnight. Therefore, IT directors and staff did not have more options other than implementing a screen saver on faculty and administration computers which will not conserve energy but will lock the computer to protect data. *"For faculty and staff we implemented a new screen saver and if they don't use the PC for a while, we cannot log them off, a lot of them are working in important documents during the day so we just lock their PCs to make sure not one sees private data."* This is an example of how IT lack of alignment with institution's goals will deviate green IT initiatives towards others directions. Initially, IT upper management at EDU planned to shut down faculty and administration computers overnight; however, this goal was not achieved because faculty and administration leave special jobs running overnight and their computers cannot be turned off.
- ***Perceptions towards Policies and Regulations:*** All of our case study sites have different perspectives toward policies and regulations. There is not a clear understanding on how to comply with regulations. For example, the IT director of BUS stated *"we do also take into consideration the environment perhaps not so much government regulations because as a small company we don't reduce that much footprint I think."* Green IT efforts at BUS are not fully

driven by regulation compliance since they believe that regulations do not apply to small companies such as them. BUS does not have a comprehensive understanding about regulations pertaining to sustainability and how to treat equipment disposal regardless of company size. Additionally, EDU has a misperception on the education authority mandates and therefore, created their own internal policies. According to an IT manager at EDU *"The education authority has a lot of policies, a lot of policies are kind of a dead letters [that] they [are] just on paper but they don't have that much of impact in reality."* An IT manager, who is responsible for the data center operations, believes that some of these regulations established by the higher authority are simply static policies which do not have any impact on how EDU implements its green IT initiatives. Therefore, EDU's IT top management had to implement some IT internal policies to communicate better to stakeholders the organizations' IT sustainability efforts.

1.2 Normative Pressures

- ***Outsourcing Expertise:*** Organizations like NON outsourced parts or most of their IT operations to providers such as Microsoft that offer cloud computing services. NON does not have a data center in site; all their servers and applications are hosted in Microsoft data centers. *"We used to have a server room where we stored physical equipment, routers and switches and stuff like that but right now everything moved to Microsoft data centers and basically we just need a laptop to connect to it and get our data from there."* COL also has outsourced some IT consultant services to get advice on how to redesign their data centers infrastructure. A systems administrator said *"a couple years ago we ended up hiring some consultants to come and look at our data center and let us know what can be done."* IT managers at COL are aware that there are green IT practices to run data center more efficiently by consuming

less energy and resources. While such initiatives were implemented due to their increasing prevalence across various industries, they provided a byproduct pertaining to sustainability for these organizations to recognize these as relatively more sustainable when compared to running their own operations.

- ***Cross Functional Training:*** Cross training has been a powerful tool that allows green IT practices to be promoted and understood within organizations. For instance, the data center infrastructure redesign at EDU would have never been implemented if their staff had not attend a training to learn better green IT practices about data center redesign for cooling efficiency. IT managers at EDU pay serious attention to training: *"we have given our team serious attention and training to this kind of issues."* A systems administrator at EDU states *"we do cross training, we cross reference throughout our colleagues. This project has been integrated as part of our maintenance of our every day's task."* EDU was not able to send all the systems administrator to training because of budget constraints; however, they sent one IT staff who then was responsible to transfer knowledge to colleagues to successfully complete the data center design using hot and cold aisles. Since green IT was new for EDU, they preferred to educate and specialized a system administrator before they started working on that project. Cross training reduces costs as well as promotes green IT among IT staff. Cross training also worked at BUS where an IT staff constantly educates on IT innovation and then shared knowledge with other IT staff. BUS' IT director said "*I generally have someone in my department who is kind of the right hand man. Generally, he is in charge of educating users and IT staff about new practices, procedures or any changes that we employees should know."* Such cross functional training initiatives present an interesting variation on normative pressures that shape green IT initiatives.

- ***Lack of Specialization:*** The complexity of various IT projects translates to green IT project initiatives. These initiatives are often new for some of the IT professionals who identify their lack of specialization as a challenge. Seldom are IT professionals exclusively dedicated to implementing green IT projects. At EDU, the data center was redesigned for cooling and management efficiency through training that enabled the development of specialized expertise for some staff members. At EDU green IT initiatives moved forward faster due to the importance given to training by the IT top management. An IT director said *"our data center redesign happened because staff member from the systems unit attend trainings on cabling and being green in the data center and virtualizing servers. Because of the knowledge they gain now they are able to come back and make all of these changes."* On the other hand, organizations like COL and BUS have faced some delays on their green IT initiatives implementations because of a lack of specialization and budget constraints.
- ***Self-learning Process:*** Besides training, IT staffs who are involved in new initiatives such as green IT needs to acquire specialized knowledge to complete certain tasks on their own. For instance, at BUS, IT staff learned and implemented virtualization on their own through their self-interest to learn. The IT director at BUS said that *"there is no formal training, we may train ourselves."* BUS IT staff had not attended any formal training; they learn online and share knowledge with others in the unit. BUS has not fully formalized its green IT efforts. Therefore, training employees on green IT practices is not a priority for them. Green IT is an investment and part of its successful implementation is staff specialization. However, not all organizations are willing to allocate funds for those trainings. Although, self-learning facilitates IT staff to learn at their own pace, it tends to be experimental. IT staff explore green IT practices and obtain new knowledge but hardly with a clear focus on what to implement.

1.3 Mimetic Pressures

- ***Alignment with Industry Trends:*** Organizations tends to adopt changes and new practices because of alignment with industry trends. For instance, EDU was also motivated to implement IT sustainability practices by following industry trends. IT top management at EDU reads and informs their staff about what other academic institutions are doing so they can improve their own operations. An IT director at EDU said **"***we are a community that is very open minded and we like to read a lot and see what is going on in all the universities, we subscribed ourselves to a lot of a listserv, Educause which is very big for universities and we constantly see what is out there, what the trends are coming on."* Another IT director at EDU said that *"we are following the general trends in the industry towards more and more virtualization in our server environment."* By attempting to mimic other organizations' practices, they were able to replace more than 75% of their physical servers with virtual servers.
- ***Learning from Peers:*** Collected data show how academic institutions learn from each other's green IT efforts. EDU made efforts to keep up on technology and try to comply with university mandates as well as learning from others academic institutions green IT practices. Furthermore, outsourcing expertise allowed COL to learn what others academic institutions have accomplished and how they will be able to improve their data center operations. Even though COL and EDU are part of the same system and both are academic institutions, they differ in how they approached green IT initiatives. For instance, EDU had already finished redesigning their data center while COL had not started its plans to work on the infrastructure because of budget and resources constrains. IT upper management at COL said *"we have been working with vendors, contactors and manufacturing saying this is our physical space this is what we want to do."* Although, COL has not fully started its data center redesign,

they are still learning from the industry's new practices and becoming aware of what options they have to redesign the data center's physical space.

- ***Experimentation with Uncertainty:*** Organizations such as BUS do not fully understand green IT initiatives and the impact of regulations. Some organizations imitate other organizations' best practices because they are not clear on what to do and observe the leaders in their industry and imitate some of their practices. Green IT is relatively new to the majority of these sites. Therefore, green IT is mostly viewed as an experiment by some of these sites. For instance, COL started virtualizing servers with a prototype first; systems administrators at COL did not fully replace a huge number of physical servers with virtual ones in one shot. When they first started virtualization they moved slowly until they got to virtualize most of their servers. *"We were using a free version of VMware server; we bought one host and put maybe 3 or 4 in there. It was a free version, nothing fancy but we used it initially for just development."* A system administrator at COL said *"It was an experiment, we said this is nice whenever someone uses a development box we just put it here and it was pretty good so we started looking at how we are going to actually make a full production system."* At that time COL did not have a clear understanding and did not want to invest significant amount of money on something new that they were just trying and experimenting without exactly knowing what the results would be. Systems administrators at COL were following what others in their domain were using in their data centers and found that virtualization has potential benefits to bring more efficiency to their data center. IT Top management agreed with the idea of using a free version in the beginning to project benefits will be and then they decided to invest on more equipment and virtualized around 157 servers.

2. Factors Affecting Adoption of Innovations

2.1 Top Management Characteristics

- ***Open Mindedness:*** Open minded IT top management plays a considerable role in supporting green IT initiatives. For instance, at GOV, EDU, and NON, top management support and openness to innovation contributed to successful green IT implementation. For example, at GOV, top management not only approved green IT initiatives, they also initiated and promoted organizations' green efforts. A member of GOV's green IT committee said *"we were given an initiative by a high level stakeholder; this initiative was to reduce the number of output devices throughout the organization."* Also, at NON the idea of moving to the cloud computing came from top management, *"the idea basically came from the managers that are responsible for utility bills and management,"* a database administrator said. Furthermore, at EDU, the institution's executives along with the IT top management support the idea of eliminating local printers and making stakeholders to send faxes through their computers instead of using the fax machines. These machines were replaced with a computer application that allows for sending faxes. *"The good thing here is that we have back up from upper management. The VP of IT supports almost all the decisions that we take because they are based on data, they are based on metrics, so we removed every local printer there is no paper being wasted and toner throwing in the garbage. We found out also that people were just throwing away toners,"* an IT director said.
- ***Acceptance of New Ideas:*** Green IT initiatives often represent innovations to the majority of our case sites. For instance, at COL, IT top managers accepted the idea of buying new equipment that consumes less energy and consolidates servers. They understood that they will be investing in the present but saving in the future. A systems administrator said *"our*

CIO and Deputy CIO are open-minded so they kind of buy it." IT top management at COL views green IT practices as a cost saving opportunity while reducing footprints. Top management support is crucial toward green IT implementations; however, staff acceptance towards change is also important. For instance, at NON green IT practices had buy-in among the employees. A database administrator said that *"the idea came from the manager and everybody kind of picks up and likes the idea."*

- ***Old School Methods:*** Top managers who are entrenched in old school methods presented a challenge to green IT implementations. Those managers delayed the progress of certain projects. For instance, at COL the facilities department that is responsible for maintaining the cooling units are still operating the old way, affirmed one of the IT top managers at COL who said *"It is their equipment but the knowledge and the expertise on this new way of cooling is in IT skills, facilities still operates in old school method which is kind of problematic for us."* According to COL's IT director, *"the facilities department is participating in the process but still their contribution is minimal at this time which is understandable."* Besides facilities, stakeholders such as faculty and administration staff need to be educated about green efforts so they can contribute to their implementations as well as break old habits and adopt new initiatives smoothly.
- ***Funds Allocation for New Initiatives:*** As we mentioned before, green IT represents an investment and a lot of resources are needed in order to implement it. For example, at EDU IT top managers work hard to allocate funds and resources to support these initiatives. A system administrator stated *"we did not know about the hot and cold aisle and airflow efficiency before training. They support it and try to get the funds to implement it."* EDU's IT top managers understand the importance of having resources needed on time and in order to

successfully implement green IT initiatives. Therefore, staff from the system area was sent to training to obtain the expertise. An IT manager said *"one of the reasons why we are able to implement initiatives such as the redesign of the data center is because when we make sure that when the budget is put together we put enough funds dedicated to training. Our data center was redesigned because a staff member from the systems unit attend trainings on cabling and being green in the data center and virtualizing servers. Because of the knowledge they gain now they are able to come back and make all of these changes."* IT top managers at EDU make sure their staff has the tools they need to do their job, *"we don't just ask to ask, we provide them the tools they need to do a great job."* Funds allocation for new initiatives is significantly important to achieve green IT goals. For instance, at COL there are some delays on redesigning the data center because of budget constraints; however, at EDU, an organization that invests in their staff by providing tools and resources, green IT initiatives are completed faster.

2.2 Organizational Characteristics

- ***Decision Making Process:*** The decision making process followed at each of the focal organizations shaped how successfully innovations can be adopted and practiced within organizations. Organizations such as EDU, COL and GOV, where managers are open to new ideas and employees can freely recommend new practices, tended to adopt green IT faster than organizations like BUS where top management has more control on every decision. The situation at NON is different because in this organization all the changes were generated by top managers as the database administrator said *"the idea basically came from the managers, they are responsible for utility bills and management,"* and employees just accepted the new practices and adopted with no complaints at all. At organizations, like EDU

and COL all decisions have to go through a process and gain approval by different authorities. The vice-president for IT at EDU explained *"a technician may say I have a good idea about how we should change or upgrade some procedures, technology, etc. We have a process in the spring where all the managers come together within all IT divisions and each of those divisions has it organizational structures with managers assigned to it. All the managers come together to identify its initiatives. At this point each manager and director has already met with their staff and got inputs and deliberations from their staff. Managers put their ideas together and they prioritize them. They all meet couple of times until they finalized their list. We identify high priority and medium priority with cost and then we request the operating budget to the school."*

- ***Centralization vs. Decentralization:*** The business model and structure of the organizations affect how these organizations make decisions. For instance, at BUS the decision making process follows a top down approach which affects how green IT initiatives are implemented. At BUS the CEO will approach the IT director who then decides what needs to be done and then the IT director will develop a work plan to achieve the goal. At EDU, IT top management accepts recommendations from staff; however, those recommendations and projects will then be approved depending on how much they align with the university's strategic plan as well as how much priority they have. It is a decentralized model and goes through a voting process in which IT directors, managers and the vice president for IT will decide on either how to implement it or not. One of the IT directors at EDU said *"All projects have to be approved by the VP and also align with the [EDU] goals not only IT goals. We make sure that what we do will benefit all the faculty and students."* At EDU, organizational structure is more centralized even though IT upper management is open to

receive new ideas from the staff. A system administrator said *"we have the freedom to make suggestions but rather those suggestions are going to be adopted or not that is beyond our atmosphere, it is not like we vote on things like that. We talk with our management team and their managers will go in higher scales and propose those ideas."* Although, green IT efforts at GOV have been formalized, initiatives can start at any level, as one of the green IT member said *"anyone can initiate an IT green proposal if it has merits."* A successful example of centralization is the model NON followed; all the green efforts were initiated at the upper management level. As a database administrator expressed *"the idea came from the managers."* In the case of NON, staff did not participate in the decision making process; all decisions were made by managers and in this case staff did not have more options than accept it.

- ***Organizational Inertia:*** Another factor that affects how quickly organizations adopt changes is the organizational inertia. Organizations cannot just make decisions overnight. Green IT decisions at these sites are approved depending on how these organizations operate. For example, at COL, IT top managers agree with the idea that the data center needs to be redesigned; however, the process has been slowed down because of budget constraints. In regards to COL's data center reorganization, a systems administrator said *"this costs money and it is in process but now with all the freeze and budget cuts, we internally do what we can and try to buy supplies from manufacturers who are implementing green initiatives whenever is possible."* At organizations like EDU and COL, project completion depends on many resources and not just one. IT top management support is important as well as resource availability such as funds and workforce. Furthermore, lack of green IT formalization plays a significant role on how those projects move along. For example, at organizations such as GOV, there is

an IT committee that makes sure everybody at the organization is on the same page. This means that they are informed of what green IT initiatives are taking place and what resources they will need. This committee minimizes delays on projects through strong communication with stakeholders in IT and non IT top management.

2.3 Inter Organizational Relationships

- ***Imitation of Opinion Leaders:*** Organizations' relationships with other organizations also influence organizations' adoption of green IT. Organizations such as EDU and COL make efforts to follow industry trends, learn from peers, and then analyze benefits and implement new practices. At these academic institutions IT initiatives have to align with the institution's and higher education authority strategic goals; therefore, they analyze new practices and prioritize them before implementation. However, at small companies such as BUS where although all decisions are more centralized and rigid because of profit optimization, they do some research through their staff and implement new things as they can little by little. It is understandable that organizations won't implement green IT initiatives overnight. Organizations such as BUS and COL are still in the process of becoming more aware about green IT practices and analyzing what fits best for their particular organizations. For instance, at COL, IT top management is working to redesign their data center's physical space. *"The room has to be redesigned in a way to make it more efficient for heating, cooling and electrical usage and just in general best practices. We had consultants coming in and they did it like an evaluation, they gave us a recommendation and after, it is up to upper management to make decisions since this takes some money,"* a systems administrator said. Although, green IT initiatives have potential to organizations, these academic institutions will not implement them until they ensure that such initiatives fit into their strategic plan.

- ***Awareness of Best Practices:*** Organizations' relationships are crucial in terms of bringing green IT awareness to organizations. For example, IT top managers at COL acknowledge the fact that there are better practices being implemented in the industry that they have not yet tried. IT upper manager at COL said *"we are learning about the new best practices so we can make our data center more efficient."* IT staff at COL and EDU are learning from the best practices in the industry. Although these two academic institutions belong to the same system and are regulated by the same authority, they have a chance to acquire the same practices due to existent relationships among campuses; they have not practiced the same green IT initiatives due to the fact that both of these academic institutions obtained green IT insights from different industry sources. For example, at COL, they depended on consultants to get to know what needed to be done in their data center while, at EDU, data center redesign initiatives came from their IT staff that had the capabilities to improve their data center operations. This staff went to training and was able to bring innovation to its organization. Bringing awareness of new IT practices to an organization can be originated internally by the staff as well as externally by outsourcing manufacturers and consultants.

V. DISCUSSION

Our study addresses the research question presented in §1 "What factors motivate and/or impede the adoption of green IT initiatives in organizations?" by analyzing the motivational drivers and factors that influence organizations to adopt green IT practices through the study of the isomorphic pressures from institutional theory and the adoption of innovation literature. Both of these streams of literature help provide an initial framing of challenges that impede or enable green IT adoption within organizations.

Our findings show that while coercive, normative, and mimetic pressures play an important role in shaping green IT initiatives, there are interesting variations that pertain to how these pressures shape the nature of green IT initiatives. For instance, at academic institutions, the disposal of equipment procedure is mostly driven by the university and state regulations. According to DiMaggio et al. (1991), the existence of legal mandates and regulations motivates organizations to adopt changes. However, our findings show that legal mandates were not sufficiently motivational for these organizations to adopt green IT initiatives. Academic institutions and government agencies had the need to enforce internal policies due to the fact that the government mandates did not impact their green IT efforts effectively. Both academic institutions and government agencies recognized that appropriate internal policies and procedures were more effective in enabling them to achieve formalization and acceptance of green IT practices within their organizations. According to our findings, government regulations do not motivate organizations to adopt green IT efforts in a straightforward way as it is typically explained by institutional forces.

DiMaggio and Powell (1991) suggest that normative pressures,focused on how individuals at organizations seek for specialization and professionalization, also influence organizations to adopt changes. Our study shows that normative pressures play a role in how effectively green IT practices are implemented. There were some of our sites where green IT initiatives were not that well established because of lack of specialization. However, at some of these sites green IT initiatives were well implemented and completed because of cross training and specialization. In addition, self-training enable green IT practices adoption, IT staff who have a curiosity and self-interest to learn and find ways online or other resources to learn about IT innovations. Thus, our findings present a nuanced view of the role of normative pressures in shaping green IT initiatives.

Our findings highlight that mimetic pressures play an underwhelming role when compared to other pressures, particularly when organizations get to the point of making decisions. Not all of our case study sites follows industry trends and learn from peers in order to make changes. The majorities of these sites tend to first identify what their colleagues are doing and then analyze potential benefits and decided whether or not those practices would apply to their organizations. These sites do not make those decisions immediately; they have some procedures to follow in order to implement new practices. They then craft a decision that best aligns with these organizational strategic goals. Even though decisions were not made immediately, these organizations took the opportunity to learn from peers and become aware of better green IT practices.

Our findings also present a richer account of how the three factors that were identified as critical in determining adoption of innovation (top management characteristics, organizational characteristics and inter organizational relationships) affected green IT. Our results suggest open mindedness of top management played an important role. At organizations where top managers were very rigid and authoritarian, green IT projects' execution presented challenges. Such projects were likely delayed or never adopted. Furthermore, past literature suggests that, in organizations which follow a top down approach and have a centralized structure, changes and innovation tend to be minimal. However, our findings show that at organizations where decisions are made at the top management level, green IT initiatives were successfully implemented. IT top management took the initiatives and helped to promote green IT efforts within the organizations. Also, in organizations which follow a decentralization model where decisions can be made or recommended irrespective of the organizational hierarchy in place, green IT practices are successfully implemented. Moreover, our findings show how organizations' relationships with other organizations influence how they adopt green IT initiatives. According to Kimberly (1978),

organizations that tend to adopt new practices are also organizations that interact with other organizations and learn new practices from them.

In addition to the factors that motivate green IT adoption, our findings show that there are also some challenges affecting green IT adoption such as budget contrains and a lack of fomalization within organizations. According to O'Neill (2010), green IT policies must be established within organizations in order for green IT efforts to be official. Our results suggest that organizations which were able to successfully implement green IT were those organizations that formalized its efforts by creating green IT committees and implemented policies that enforce green IT initiatives. Our findings also identify how green IT projects were delayed and abandoned due to lack of financial resources and knowledge expertise resources. IT top managers confirmed that expertise in green IT is needed in order to run green IT initiatives; however, due to the lack of financial resources, organizations are not able to fund training to all IT staff and instead send a few staff to training and then those staff who attended training will do cross training within their IT departments.

Additionally, more awareness is needed on green IT in order to be implemented. Our findings show that there is still a lack of on consensus on green IT practices and therefore, organizations are not able to fully implement green IT. Although our case study sites implement green IT practices, some organizations more than others, there is still a lack of awareness among IT professional about the notion of green IT. This represents a challenge for its effective implementation. More efforts need to be made to promote these IT sustainability initiatives to reduce the knowledge – doing gaps on green IT and to enhance formalization to green IT projects and policies.

VI. CONTRIBUTIONS

A. Contributions to Theory

Our findings contribute to a better understanding of the factors affecting green IT initiatives implementation. Our research contributes to two theoretical areas: the institutional theory and the factors affecting adoption of innovation theory. Both of these theories significantly contributed to explain green IT adoption process and the factors impeding and motivating green IT initiatives within organizations.

1) Institutional Theory (Isomorphism)

We examine the three forces (coercive, normative and mimetic) from the institutional theory to explain the green IT adoption issue. Past research on green IT adoption primarily relies on coercive forces (Clemens et al. 2006) and also stops short of examining why and how certain forces may or may not play a role in shaping innovation and sustainable behavior in organizations. Our study addresses this gap by examining how and why certain aspects of the three isomorphic forces shape the implementation of green IT practices. While our research shows that mimetic force components do not seem to be a strong motivational driver for green IT adoption and the normative and coercive do drive green IT implementation, it also provides a nuanced view of the role of specific elements of these forces. The institutional theory suggests that government regulations are outside pressures organizations face that motivate them to adopt sustainability practices(Kerno Jr 2010). However, findings show that legal mandates do not entirely make organizations adopt green IT practices. The majority of our case study sites had to implement internal policies to achieve successfully their IT sustainability goals. Here we develop a framework where both outside and internal pressures, merged from our data, show the forces driving green IT acceptance within organizations.

2) Innovation Adoption

From this stream of literature, we identify critical factors that play a role in how organizations adopt new practices. Our case study results present a rich account of how factors such as top management characteristics and organizational structure play a role in shaping green IT adoption. The most successful implementation of green IT initiatives from our case study sites were organizations where upper management was able to promote, formalize green IT practices by establishing green IT committees and allocating funds and resources for training specialization. Our findings highlight how centralization and decentralization shape green IT practices. Kimberly (1978) states that organizations which follow a decentralized organizational structure tend to adopt innovation faster than those organizations in which the decision making process is very rigid and centralized. However, our findings present a mixed view highlighting the complexity of the role organizational structure plays in that organizations where all decisions were made by top managers green IT efforts were effectively implemented.

In summary, our research constitutes one of the first studies that examine green IT adoption by examining in detail how isomorphic forces and other factors from innovation adoption literature play a role in green IT adoption. Our framework expands on the seed concepts drawn from the two streams of literature to provide a richer account of how and why certain organizations succeed in implementing green IT initiatives.

B. Contributions to Practice

The practices identified in this research, directed towards various stakeholders including top management and IT staff, highlight the role of formalization and specialization, and funding resources. These constitute concrete prescriptions that can help organizations develop an appropriate environment to foster green IT adoption.

1) Top Management

We suggest that top management provide an open environment to empower staff such that bottom-up recommendations for green IT initiatives might be considered in the decision making process. Instead of enforcing top-down approach, top management should obtain inputs and recommendations from staff by working in teams. Also, top management should provide incentive to stakeholders to influence them to practice green IT. In addition, top management should ensure that green IT practices are being completed and aligned with the organization's strategic plan. Top management support plays a significant role in terms of making green IT implementation more effective.

2) Formalization and Specialization

Our research shows that there is still a lack of awareness and formalization in green IT practices. Green IT efforts need to become more official and formal within organizations. Formalization can be achieved through the implementation of policies that enforce green IT practices and a formal committee comprised of top management and staff to monitor and run green IT projects. In order to make green IT practices official, specialization is needed. IT staff has to attend trainings and get knowledge on the use and implementation on green technologies to bring awareness to organizations. Our findings show that the lack of specialization in green IT impedes its implementation. In cases where green IT expertise is minimal, those organizations have to outsource or rely on consultants to meet these needs.

3) Funding Resources

Budget constraints are one of the challenges that adversely impact green IT initiatives. Even when IT and non IT top management support green IT innovations and organizations structure enable its implementation, funding is crucial for green IT. Our findings show how organizations

were not able to complete green IT project due to a lack of resources and budget constraints, despite their interest in such initiatives. Lack of training, technologies and expertise are some of the factors that emerged from our findings. IT top management should endure that a budget for green IT project is allocated to fund such initiatives.

C. Limitations and Futures Research

Due to our study limitations, generalizations should be made with caution. Our study involved data collection from four domains and 13 subjects. While our findings may be specific to these sites that we studied, the factors that we identified and described in our framework are independent of specific contextual characteristics from these sites. Further empirical studies that examine the validity of these results at organizations in different domains would help generalize our findings further. Although we develop a relationship between the factors affecting the adoption of innovation and green IT adoption, further research is needed to establish this link in a wide variety among organizations at different environments. Finally, our study provides a rich ground for a quantitative study operationalizing the various components in our framework and examining the relationships among them.

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VIII. APPENDIX A: Excerpt from our Interview Protocol

Data collection is done through semi-structured interviews. The following questionnaire is an excerpt from our interview protocol and additional questions were asked based on responses by participants.

1. How does your organization view Green IT?
2. How long has your company been implementing Green IT initiatives?
3. What are the employee's reactions towards Green IT initiatives?
4. Please describe some examples of Green IT initiatives implemented in your company and describe the stakeholder's adoption process.
5. How Green IT initiatives are budgeted and planned?
6. Who typically initiates Green IT initiatives? Please provide examples of initiatives that were initiated by different stakeholders in the organization.
7. Explain how your organization views sustainability regulations and their role in shaping your organization's green IT policies.
8. How does your organization link green IT and education/training?
9. What processes or infrastructure has your company redesigned completely to achieve sustainability standards?
10. How were green IT initiatives justified in your organization?
11. How does your organization view the advantages and disadvantages of Green IT?

IX. APPENDIX B: Screenshots from Atlas-ti7®.

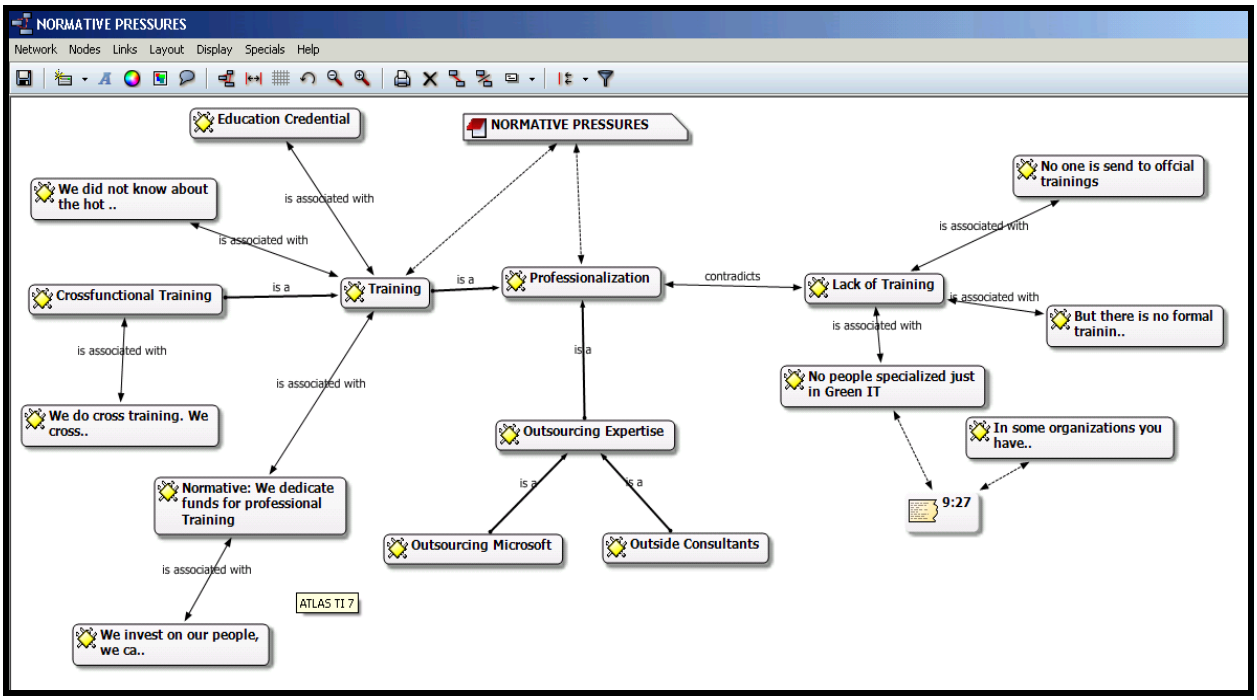

Figure 3: ***AtlasTi: Networks and Relationships***

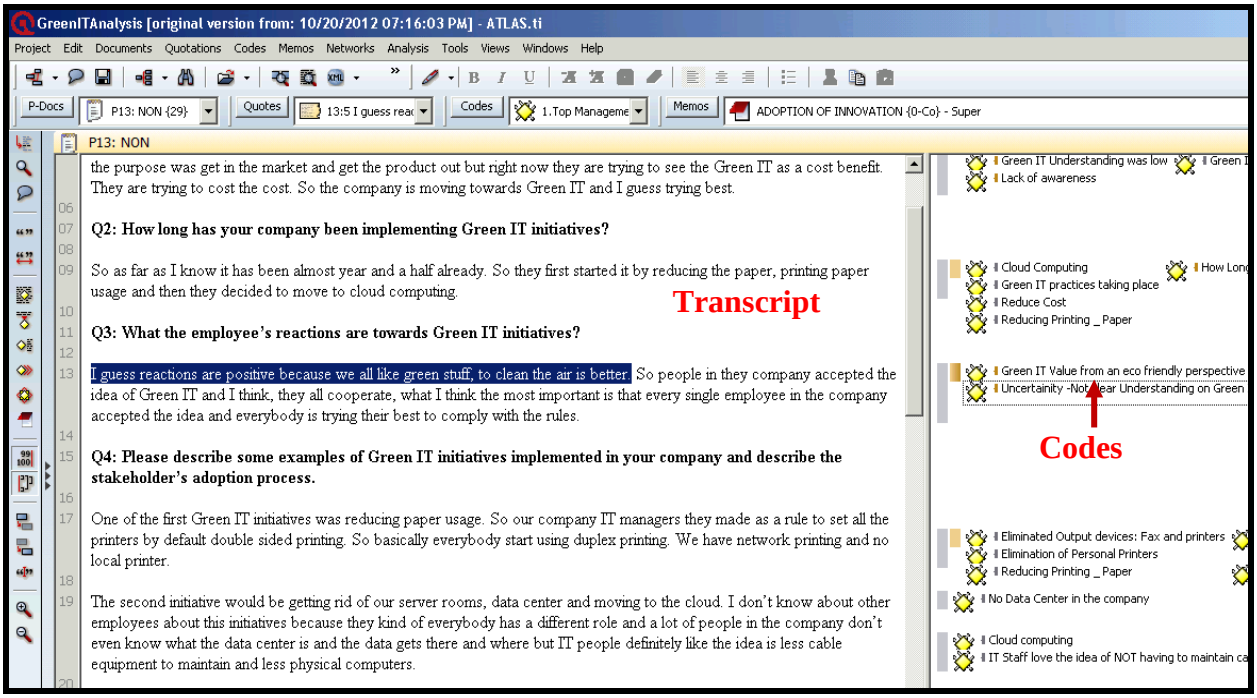

Figure 4: ***AtlasTi: Transcript and Codes***

X. APPENDIX C: Glossary

Coding: an interpretive technique that both organizes the data and provides a means to introduce the interpretations of it into certain qualitative methods. Each segment is labeled with a "**code**" – usually a word or short phrase that suggests how the associated data segments inform the research objectives (Yin 2009).

Cloud Computing is a technology which uses internet and remote servers to maintain data and various applications (Stryer 2010).

Data Center: a facility used to house computer systems such as telecommunications and storage systems. It also contains air conditioning units, fire suppression and security devices (Stryer 2010).

Energy Star: a government backed programs that focuses on energy efficiency and provide solutions to reduce energy consumption. It addresses power usage and efficient use of equipment, putting equipment to "sleep" when they are idle (Webber et al. 2009).

Hot /Cold Aisle: a layout that enables constant flow of cool air through the racks in a data center, assuming there is no interruption in the airflow. In a hot/cold aisle configuration, the hot aisles are always at a much higher temperature than the cold aisles (O'Neill 2010).

Isomorphism: a constraining process that forces one unit in a population to resemble the other units that face the same set of environmental conditions (Hawley 1968).

Institutional Theory: a theory that argues that organizations in competitive marketplaces will inevitably face social pressures that lead them to adopt new initiatives (DiMaggio et al. 1991).

Power Management Tools: tools that shut down computers and servers when they are not in use or to put the equipment in sleep mode during periods of inactivity to save energy (Webber et al. 2009).

Virtualization: a technology that allows organizations to consolidate equipment such as servers. This solution allows organizations to run one or more "virtual" servers on a single physical host system (Golden 2008).

Virtual Servers: a server that behaves like physical servers in terms of accessing, addressing, and installation but it does not have dedicated hardware infrastructure. Virtual servers share computer resources with other virtual servers in that the entire computer is not dedicated to running only one sever software but many than one (Golden 2008).

Virtual Workers (Telecommuters): employees who are in the office virtually. They connect to the company's IT systems and complete their work as before, except that they are not physically present (Webber et al. 2009).