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The Relationship Between Organizational Resources and Green IT/S Adoption: A RBV Approach

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ABSTRACT

The objective of the present study was to empirically explore the impact of the implementation of Green IT/S measures on organizational resources in the US and European firms. The study examined the influence of reconfiguration of resources within a firm while adopting various Green IT/S practices and technologies. Green IT/S implementation requires resource commitment from organizations (Bose and Luo, 2011). What are these resources and how do they affect the extent of Green IT/S measures adopted by businesses? Resource Based View (RBV) of the firm was used as the theoretical framework of the study. The relationship between the adoption of Green IT/S measures and the relevant resources were examined using empirical methods. Fifty three US and EU executives who were knowledgeable about Green IT/S implementation in thirty three organizations provided the data through structured interviews. The findings suggest statistically significant relationship between the Green IT/S adoption practices and reconfiguration of several IT and non-IT resources. Findings indicate the effectiveness of RBV as a theoretical framework to investigate the factors that influence Green IT/S measures and technologies. Environmental impacts of IT is an issue of practical relevance to enterprises facing energy constraints and addressing environmental concerns as a social responsibility. The current study integrates two streams of research, namely, the adoption of Green IT and, the Resource Based View (RBV) of a firm as the theoretical framework of this research.

KEYWORDS: Green IT/S; Sustainability, Resource Based View

INTRODUCTION

The goal of the present study is to empirically investigate the relationship between environmentally sustainable information technology or systems (Green IT/S)

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implementation and resulting changes in the resources of an organization. Specifically, the study examined the influence of reconfiguration of resources within a firm while adopting various Green IT/S practices and technologies. Green IT/S implementation requires resource commitment from organizations (Bose and Luo, 2011). What are these resources and how do they affect the extent of Green IT/S measures adopted by businesses? In order to explore this relationship, the current study integrates two streams of research, namely, the adoption of Green IT and, the Resource Based View (RBV) of the firm as the theoretical framework of this research. Although Green IT/S is a relatively new area of academic research, several researchers in Information Systems (IS) field have addressed this significant issue (Campbell et al., 2013; Erek et al., 2012; Esfahani et al., 2015; Wang et al., 2015).

Environmental impacts of IT is an issue of practical relevance to enterprises facing energy constraints and addressing environmental concerns as a social responsibility. The area of RBV of the firm in the context of IS is a natural fit for the current research because the objective of the study is to examine the impact of Green IT/S implementation on firm resources (Chae et al., 2014; Jarvenpaa and Leidner, 1998; Liu et al., 2013; Mithas et al., 2011; Mithas et al., 2012; Wade and Hulland, 2004). Therefore, the present study makes significant theoretical as well as managerial contributions. Specifically, the present study will investigate if the implementation of Green IT/S measures are influenced by IT and non IT resources in the firm.

The current study is a response to Gholami et al,'s (2016) call for more IS researchers to engage in impactful investigation in issues such as climate change. Furthermore, the significance of the present study is based on the observations of Wang et al., (2015), who, after a comprehensive review of Green IT/S, asserted, "The literature has examined environmental, economic, and social outcomes of green IS initiatives, but the results have been mixed, indicating that further theoretical development is needed to explain results" (page 402). In order to infuse more theoretical development in the area of Green IS/T research, the current study adopted the RBV framework- a well- established management construct to strengthen the conceptual foundation of investigation in this area. The objectives of the study is to examine the impact of Green IT/S on tangible as well as intangible resources of the firm. Specifically, the current study aim to identify the resources that need to be changed as a result of Green IT/S adoption.

The present paper is structured as follows. A review of published research in recent years based on Green IT/S initiatives in organizations and relevant literature on RBV of the firm will be presented first followed by the argument to investigate

Green IT/S within the RBV framework. Please note that the terms 'resource,' 'asset,' and 'capability' are interchangeable according to the convention used in the existing literature on the subject. A hypothesized research question on the relationship between Green IT adoption and strategic actions will be developed based on this review. Additional objectives of the study will be formulated. The methodology section will describe the design of an empirical study to collect and analyze data to test the hypothesis. The final two sections of discussion of results and conclusions will provide the analysis of the collected data and directions for future research.

GREEN IT/S

Practitioners and researchers have proposed several similar definitions of Green IT/S. We will adopt the definition provided by Brooks, Wang and Sarkar (2012) that is based on a comprehensive review of research in the area- "the initiatives to utilize IT infrastructure to change organizational processes and/or practices to improve energy efficiency and reduce the environmental impacts and to introduce environmentally healthier products and/or services." Ruth (2009) identified the "Energy Star" program started by the EPA in 1992 as the beginning of the "green computing" era. Later in this section, we will briefly discuss some of the research efforts in this area.

IS practitioners have led their academic counterparts in this regard. Past investigations indicate that businesses are very much aware of this issue (Brill, 2007). Moreover, the US government also has paid attention to the environmental impacts of IT use. A US Environmental Protection Agency report (2007) has investigated the environmental consequences of IT use in organizations.

For the purposes of gauging environmental impacts, organizational activities that use IT can be very broadly categorized as: (1) data processing tasks performed by corporate data centers, and (2) all other information processing tasks that require IT for support and execution in addition to corporate data center activities.

A report published in August 2007 by the EPA in response to a request from Congress noted that the U.S. data centers are experiencing major growth through increasing demand for data processing and storage capacities.

In addition to the data centers, IT supports day to day operations of present day enterprises ranging from end user information processing tasks to supply chain activities. Thus far, the EPA has not assessed the environmental impact of the

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activities in addition to that of data centers. However, IT as a whole leaves a carbon footprint that is a combination of centralized and non-centralized data centers and non-data center activities. "In 2007, ICT's global CO_2 footprint accounted for 2% of all emissions, or about 830 metric tons of CO_2, comparable to the aviation industry, which is widely cited for its emissions. ICT's share of global emissions is projected to double to 4% by 2020, a mere four years away" (IEEE IoT Brain Trust series, 2016).

As mentioned above, a considerable body of IS research now addresses the relationship between Green IT implementation activities, business operations, and strategy. Wang et al. (2015) provided a comprehensive review of academic research as well as practitioner analyses related to Green IT/S. The academic literature review categorized existing literature into four groups- initiation, enterprise strategies, the adoption framework, and outcome of Green IT/S implementation. Wang et al. (2015) generated a framework capturing different facets of Green IT/S adoption. These facets are divided into organization level and individual level factors. At the organizational level, the facets include environmental and technological factors interacting with strategies and practices to different outcomes for Green IT/S adoption. At the individual level, individual initiatives lead to different outcomes for Green IT/S adoption. The authors noted the need for further theoretical development and empirical investigation in this research area. They note the need for further investigation on the effects of Green IT/S adoption. Based on their literature review, Wang et al. (2015) identified several organizational factors that influence Green IT/S initiatives. These include: 1) top management support (Nedbal, Wetzlinger, Auinger, & Wagner, 2011), 2) leadership, (Mann, Grant, & Singh Mann, 2009), 3) commitment of resources (Bose and Luo, 2011), 4) operational inefficiencies (Simmonds and Bhattacherjee, 2012), 5) internal resistance (Mann et al., 2009), 6) financial considerations (Kuo and Dick, 2010), 7) Green IT/S policy (Alaraifi et al., 2011), 8) IT department, 9) industry type and 10) business size (Mann et al., 2009). Several of these factors- top management support, commitment of resources, commitment of resources and internal resistance- have been used by researchers who used the RBV research framework as determinants of overall sustainability practices. We will discuss these three variables further in the next section when we propose RBV as a framework for Green IT/S research.

Bose and Luo (2011) note the existence of a gap in IS research to provide a theoretical framework that can be used by business organizations in assessing potential gains and risks while undertaking initiatives to implement Green IT/S. Jenkin, Webster and McShane (2011) generated eleven propositions to be addressed in future Green IT/S research. The eleven propositions were derived from four conceptual components- motivating forces for Green IT/IS initiatives, Green

IT/S strategies, environmental orientation of organizations, and environmental impacts of Green IT/S initiatives. The researchers hoped that future studies will utilize the eleven propositions to extend research in this area.

Molla and his colleagues have investigated Green IT/S implementation using multiple approaches. Molla (2008) proposes a Green IT adoption model consisting of five constructs- Green IT/S context, Green IT/S readiness, Green IT/S drivers, the intention to adopt Green IT/S, and Green IT/S adoption. The first two constructs represent the primary set of causal variables in the adoption of Green IT/S. Based on empirical research, Molla, Cooper and Pittayachawan (2011) constructed a framework for Green IT/S adoption readiness. In another empirically based study, Molla (2009) identified four clusters of Green IT/S adopter organizations and four sets of motivations. The organization clusters were Green IT/S Leaders, Green IT/S Niche Seekers, Green IT/S Starters, and Green IT/S Experimenters. The four motivations were eco-efficiency, eco-effectiveness, eco-responsive, and eco-legitimacy.

In addition to the above work, several other IS researchers have paid attention to the impact of Green IT on business operations and strategy. Melville (2010) has argued that IS can play three significant roles in the interaction between the environment and organizations. The roles are: influencing beliefs about the environment, enabling and transforming sustainable practices, and improving environmental performance. In addition, Melville proposes a Belief-Action-Outcome (BAO) framework for IS research on sustainability. The BAO framework integrates the interactions between micro and macro variables to identify a set of research issues relevant for investigating the relationship between IS and the environment. The micro issues were individual behavior, actions, and beliefs while macro issues included organizational and societal factors such as organizational structure and the strategy of the organization. Watson et al. (2010) argue that IS researchers "need to demonstrate the transformative power of IS" to achieve an environmentally sustainable world.

RESOURCE BASED VIEW (RBV), GREEN IT/S AND SUSTAINABILITY RESEARCH

The goal of this paper is to examine if and how firms reconfigure and mobilize their resources as a result of integrating green technologies in their IT/S operations. RBV presents firms as a collection of resources that are heterogeneously distributed among competitors (Amit and Schoemaker, 1993; Mahoney and Pandian, 1992; Penrose, 1959; Wernerfelt, 1984). The heterogeneity in resource distribution

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accounts for the difference in financial and other organizational performance measures. RBV emphasizes the significance of internal organizational resources, as opposed to external forces in the industry, in attaining strategic goals. In order to attain continued competitive performance, firms must accumulate resources that generate financial value. In addition, these resources must be relatively scarce and cannot be copied, acquired or substituted by the firm's competitor. Therefore, the strategic importance of resources is embedded in four qualities- valuable, rare, inimitable and non-substitutable; also known as the VRIN attributes (Barney, 1991; Conner and Prahalad, 1996).

However, critics of RBV have suggested that the paradigm is inadequate in explaining competitive advantage captured by certain firms in times of rapid technological and unpredictable change (Eisenhardt and Martin, 2000). Grant (1996) and Kogut and Zander (1996) suggest that knowledge resources rather than tangible resources are key determinants of strategic advantage in rapidly changing environments. Teece et al. (1997) argue that dynamic capabilities of firms to "integrate, build, and reconfigure internal and external competencies" are key to creating competitive advantage in environments characterized by rapid technological changes (pp.516). Other scholars corroborate Teece et al.'s assertion (Eisenhardt and Martin, 2000; Jarvenpaa and Leidner 1998).

RBV framework has been adopted in IS research. Tippin and Sohi (2003) suggested that IT as a resource can be infused in a firm's business objectives (for example, sustainability initiatives) through "complimentarity" and "co-specialization". Complimentarity exists when two resources lead to synergistic results for the firm (Powell and Dent-Micallef (1997). In case of Green IT/S, a firm's sustainability practices (a resource or capability) is enhanced by appropriate IT resources and practices. On the other hand, co-specialization is the situation when it is necessary for two resources to exist simultaneously to be of value to the firm (Clemons and Row, 1991). Green IT/S measures that include abilities to implement technology to enhance ecofriendly data center operations could be such a competency/resource.

Wade and Hulland (2004) provide an account of RBV in the context of IS research. They propose a typology of IS resources consisting of three categories of resources: outside-in, spanning, and inside-out. Outside-in resources include external relationship management and market responsiveness of the IS department; spanning resources include IS-business partnership and IS planning/change management. Finally, inside-out resources include IS infrastructure, technical skills, IS development, and cost effectiveness of IS operations. They argue that RBV provides a way for researchers to better understand the role of IS within a firm. Further, RBV describes information technology as an asset based resource

while information systems as a mixture of assets and capabilities that result from the use of IT.

The current study extends the body of research that has developed based on the investigation of the relationship between environmental sustainability and corporate strategy (e.g., Anderson and Bateman, 2000; Bansal and Roth, 2000; Florida, 1996; Marshall and Brown, 2003; Rugman and Verbeke, 1998; Russo and Fouts, 1997). Of these studies, Russo and Fouts (19997) adopted RBV as a basis of their investigation of firms' sustainability efforts. Therefore, it is logical to explore the relationship between Green IT/S adoption- an environmentally responsible initiative and organizational strategy, based on the RBV framework.

It could be argued that environmentally responsible IT products and initiatives in firms, or Green IT/S, represent a disruptive technological change (Christensen and Overdorf, 2000). The disruptive nature of Green IT/S measures may not be apparent to an organization until the adoption is undertaken. For example, in order to implement virtualization technology, the data center staff needs to get a buy in from departments whose applications will be virtualized. Some departments may not want to relinquish control of dedicated servers through virtualized servers for political or strategic reasons. Other Green IT measures such as reorganizing the workforce based on the length of physical presence at work may face organizational resistance. Russo and Fouts (1997) identified cooperation of other departments as a resource in their study of sustainability efforts in organizations. Specifically, Russo and Fouts (1997) identified three resources in their study of organizational sustainability initiatives based on the RBV perspective. In addition to financial and human resources, the reputation of the firm was also considered as a resource (Russo and Fouts, 1997).

In addition to those cited in Russo and Fouts (1997), we identify two additional factors- barriers to implementation and the upper management support as resources relevant to this study. This addition was based on scholarly work on Green IT/S implementation discussed earlier. We also considered cooperation from other departments while implementing Green IT/S measures as a resource because cooperation is (inversely) related to setting up of barriers to implementation. In sum, we considered the following resources or capabilities in our study that could influence Green IT/S adoption: restructuring of operating and capital expenditures, redesign of data center, specific metrics and targets for Green IT/S initiatives, human resources reconfiguration resulting from Green IT/S implementation, impact on the firm's reputation, barriers to implementing Green IT /S measures, upper management support, and cooperation from other departments.

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HYPOTHESIS

The objective of the current study is to investigate the relationship between Green IT adoption and organizational changes or adjustments in resources resulting from the adoption.

Based on the above discussion, we formulate the following hypothesis in non-null form:

H1: The changes or reconfiguration of a firm's resources will influence the extent of the adoption of Green IT/S measures.

By testing this hypothesis, the current research aims to identify organizational resources that influence implementation of Green IT/S measures and technologies. The statistically significant independent variables are the resources that influence Green IT/S implementation.

METHODS

In order to begin our data gathering process, we sought to identify the most informed individuals within organizations who could provide the details of Green IT/S adoption. As a first step, we endeavored to contact information providers who could be considered knowledgeable about Green IT/S in general. Using Internet searches and IT practitioner publications, we identified several individuals who were actively promoting the adoption of environmentally responsible IT practices. We use the term "Green IT/S evangelists" to identify these individuals. These individuals were promoting the spread of Green IT/S practices.

We sought input from Green IT/S evangelists to: 1) identify other evangelists, 2) construct a set of interview questions that would be useful for eliciting information from organizations that are implementing Green IT/S technologies and initiatives, and 3) identify appropriate managers/executives in organizations who would provide us with reliable information regarding environmental impacts of IT use and their organizational initiatives. We initially intensively interviewed three Green IT/S evangelists whom we identified through internet-based searches and practitioner publications.

Our interviews with the first three Green IT/S evangelists helped us identify five more evangelists from private and public sectors. In addition, we prepared the first

draft of twenty six potential interview questions for the Chief Information Officer (CIO) in practitioner organizations which we refined during our interviews with subsequent Green IT evangelists. All eight Green IT/S evangelists opined that, in addition to the CIO, the executive in charge of facilities and physical plants would be the person we would need to interview in practitioner organizations to collect appropriate information regarding the management of environmental impacts of IT use. As a result, we drafted and finalized a set of interview questions for the second executive in the practitioner organizations based on the evangelists' input. The questions for the CIOs interviewed in this study are listed in the Appendix. We modified the questions while interviewing other executives in the organizations.

For data collection purposes, we concluded that interview was the most appropriate method because we had to contact specific executives who were domain specialists in the area of Green IT/S. It would be difficult to reach such executives through a survey. Although Gholami et al. (2013) constructed a survey instrument aimed at eliciting senior managers' perceptions on Green IT/S adoption and environmental performance, we did not consider the questionnaire to be a suitable fit for the purposes of the current study. This is because the absence of data center initiatives in the Green IT/S measures in the Gholami et al, (2013) instrument. Our interactions with the evangelists indicated that data center management issues are an essential concern of Green IT/S initiatives in organizations.

Following our interviews with the Green IT evangelists, we employed purposive sampling to reach our subjects (Maxwell 1997, p. 87). We contacted twenty organizations in the US and fourteen in the EU to interview the top IT executive and the executive in charge of physical plants or facilities. Two US organizations did not respond to our proposal to interview. We were able to interview eighteen top IT executives in the US organizations who were involved with Green IT decisions in their organizations. The most commonly reported job titles of the respondents were CIO and Vice President of IT. We were also able to interview eleven executives in the US organizations who were in charge of physical plants and facilities. The most commonly reported position of this group of executives were Vice President of Physical Plants.

In the EU countries, we were able to interview fourteen top IT executives and eleven executives from the physical plants area. Altogether we gathered fifty three interviews from the US and EU organizations. All interviews were audio taped and transcribed. Moreover, researchers in the US as well as in Europe took meticulous notes during the interviews. In general, each interview lasted from forty five to ninety minutes. We also consulted web sites of all the practitioner and evangelist organizations. In addition, we reviewed relevant documents and memos shared by

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the respondents. Of the fifty three executives, forty were men. The average job experience of the interviewees was more than fifteen years.

The appendix provides the set of interview questions and illustrates thirty three of the US and EU organizations providing data for the current study. Of the eighteen US organizations, five were public companies, with revenues ranging from $80 million to $3.3 billion, engaged in the production of semiconductors, customer relationship management software, accounting software, storage and data management systems while four were private companies, with revenues ranging from $75 million to $1 billion, engaged in the production of imaging and audio technologies, manufacturing, financial services, education and pharmaceutical products.

We analyzed the interview data iteratively following Bansal and Roth's (2000) approach to inductive analysis. Inductive content analysis is used in social sciences to analyze verbal and written data. We used a set of codes to reduce the volume of written data to manageable size. Through this analysis, we aimed to gain insights and patterns in responses collected through the interviews. Bansal and Roth (2000) had also used interviews to collect data in their study on sustainability. Using the inductive analysis, we were able to identify key themes in the area of Green IT/S by reducing the material to a set of themes or categories. At least two researchers individually read the transcripts of the fifty three interviews in addition to their own notes taken during the interviews. We individually recorded the data collected from the practitioner organizations based on their Green IT/S initiatives and then compared our recording to represent a uniform data interpretation. The data were initially coded by both researchers. Then the recordings were reconciled in cases of disagreements that were very few. Using this method, the inter rater agreement was 100%.

To initiate our analysis, we started with a list of environmentally responsible IT measures. Table 1 shows a list of environmentally responsible IT initiatives that could be potentially adopted by the organizations (Sayeed and Gill, 2010). Fifteen of these are aimed at improving the environmental impact of data centers while seven are organization wide initiatives.

Based on table 1, we constructed two dependent variables. The first dependent variable aimed to capture the extent of Green IT initiatives in data center while the second dependent variable aimed to gauge the extent of organization wide Green IT/S initiatives. The dependent variables were percentages of the above initiatives that were implemented in the respondent's organization. In case of the first dependent variable, the value of 100% would be achieved if the respondent's organization adopted all fifteen data center Green IT/S initiatives. Similarly, the second dependent variable would attain a value of 100% if the respondent's

organization implemented all seven organization wide initiatives. Therefore, the two dependent variables ranged from 0 to 100% and were continuous in nature.

The independent variables were:

1. Restructure of Capital and Operational Expenditures (Question 5 in the interview- please see appendix)- Resource 1
2. Change in Procurement Practices (Question 8)- Resource 2
3. Use of Metrics to Measure Energy Consumption (Question 9)- Resource 3
4. Specific Targets for Data Centers (Question 10)- Resource 4
5. Redesign of Physical Facilities (Question 17)- Resource 5
6. Cooperation from Other Departments (Question 18)- Resource 6
7. Change in HR (Question 19)- Resource 7
8. Reputation of the Firm (Question 20)- Resource 8
9. Organizational Barriers (Question 22)- Resource 9
10. Commitment of Upper Management (Question 23)- Resource 10

Independent variables 1 through 10 were all categorical or dummy variables. Additional questions in the interview were included to look for further insights into the relationship between Green IT/S initiatives and organizational resources. Sayeed and Gill (2010) proposed these variables based on a literature review of research on sustainability measures that used the resource-based perspective.

Table 1: Environmentally responsible IT initiatives

Data Center Initiatives	**Organization Wide Initiatives**
Implementing Virtualization servers	Implementing Virtualization server
Server consolidation in data centers	Recycling of hardware
Efficiency improvement in electrical distribution	Managing E-waste
Improvement in cooling distribution	Implementing a green procurement policy
Advanced Configurations and Power Interface (ACPI)	Implementing thin client end user environment
Networked storage	Implementing flexible telecommuting
Brocade Communications switches	Reorganizing the workforce based on the length of physical presence at work
Airflow optimization	
Sealing of cable cutouts	

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Inserting blanking plates and clearing under floor obstructions	
Rewiring under floor	
Redesigning the return air plenum	
Placing perforated tiles in the cold aisles	
Installing variable fan speeds	
Retrofitting fans	
Replacing battery backed UPSs with rotary	

RESULTS

The two dependent variables were continuous (percentages- ranging from 0 to 100) and the independent variables were categorical in nature leading to the application of the multivariate analysis of variance (MANOVA). The data were analyzed using the General Linear Model (GLM). The two dependent variables represented the extent of Green IT/S adoption measures while the predictors represented organizational resources. Table 2 shows the results of the GLM and Table 3 displays the MANOVA model.

Dependent Variable: **Data Center Green IT/S Initiatives**

Table 2: Results of Full Model GLM

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	12	14001.66118	1166.80510	1.90	0.0640
Error	40	24545.92792	613.64820		
Corrected Total	52	38547.58910			

R-Square	**Coeff Var**	**Root MSE**	**Mean**
0.363231	47.11407	24.77192	52.57862

Source	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Resource 1	3	1075.976987	358.658996	0.58	0.6287

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Resource 2	1	120.040432	120.040432	0.20	0.6607
Resource 3	1	348.670274	348.670274	0.57	0.4554
Resource 4	1	5534.424940	5534.424940	9.02	*0.0046*
Resource 5	1	219.212689	219.212689	0.36	0.5534
Resource 6	1	109.278854	109.278854	0.18	0.6753
Resource 7	1	2824.075971	2824.075971	4.60	*0.0381*
Resource 8	1	137.084676	137.084676	0.22	0.6390
Resource 9	1	176.361978	176.361978	0.29	0.5949
Resource 10	1	243.169613	243.169613	0.40	0.5326

Dependent Variable: **Organization Wide Green IT Initiatives**

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	14988.48643	1249.04054	4.89	*<.0001*
Error	40	10210.67499	255.26687		
Corrected Total	52	25199.16143			

R-Square	Coeff Var	Root MSE	Mean
0.594801	29.88653	15.97707	53.45912

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Resource 1	3	1004.007296	334.669099	1.31	0.2842
Resource 2	1	4111.237998	4111.237998	16.11	*0.0003*
Resource 3	1	103.865524	103.865524	0.41	0.5272
Resource 4	1	1534.229695	1534.229695	6.01	*0.0187*
Resource 5	1	93.628028	93.628028	0.37	0.5482
Resource 6	1	374.429037	374.429037	1.47	0.2330
Resource 7	1	467.190103	467.190103	1.83	0.1837
Resource 8	1	18.365997	18.365997	0.07	0.7899

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Source	DF	Type III SS	Mean Square	F Value	Pr > F
Resource 9	1	9.248707	9.248707	0.04	0.8500
Resource 10	1	425.837875	425.837875	1.67	0.2039

The GLM analysis (i.e., ANOVA) indicates that the first dependent variable- Data Center Green IT/S initiatives, does not hold a statistically significant relationship with the ten resources (Model F = 1.9, p> 0.064). However, the second dependent variable- Organization Wide Green IT/S initiatives holds a statistically significant relationship with the independent variables (F= 4.89, p< 0.0001). Two independent variables Resource 2- change in procurement practices and Resource 4- specific targets for data centers are statistically significant.

Table 3: Results of Full Model MANOVA

MANOVA Test Criteria and F Approximations for the Hypothesis of No Overall Q5 Effect

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.89576470	0.74	6	78	0.6225
Pillai's Trace	0.10551017	0.74	6	80	0.6170
Hotelling-Lawley Trace	0.11494139	0.74	6	50.261	0.6213
Roy's Greatest Root	0.10082580	1.34	3	40	0.2736

The results indicate that overall MANOVA is not statistically significant. However, two of the independent variables were statistically significant with the dependent variables. These were Resource 8 (reputation of the firm) and Resource 10 (Commitment of Upper Management) were significant at p-value levels of 0.0007 and 0.0102 respectively. In order to achieve a better fit for the statistical analysis, the GLM and MANOVA were conducted with exclusively these two independent variables. Tables 4 and 5 show the results of the parsimonious model.

Dependent Variable: **Data Center Green IT/S Initiatives**

Table 4: Results of Parsimonious GLM Analysis

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	8852.79466	4426.39733	7.45	*0.0015*
Error	50	29694.79444	593.89589		
Corrected Total	52	38547.58910			

R-Square	Coeff Var	Root MSE	Depvardcpercent Mean
0.229659	46.34960	24.36998	52.57862

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Resource 8	1	788.168525	788.168525	1.33	0.2548
Resource 10	1	6949.099611	6949.099611	11.70	*0.0013*

Dependent Variable: **Organization Wide Green IT Initiatives**

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	12449.62877	6224.81438	24.41	*<.0001*
Error	50	12749.53266	254.99065		
Corrected Total	52	25199.16143			

R-Square	Coeff Var	Root MSE	Mean
0.494049	29.87035	15.96843	53.45912

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Resource 8	1	9260.129176	9260.129176	36.32	<.0001
Resource 10	1	1476.043536	1476.043536	5.79	0.0199

Results indicate that both dependent variables are significantly related to the two independent variables although the first dependent variable (data center Green IT/S initiatives) is significantly related only with Resource 10 (reputation of the firm) at p-value <0.0013. On the other hand, both resources are statistically (p-value < .0001

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and 0.0199 respectively) related with the second dependent variable (organization wide Green IT/S initiatives).

Table 5 displays the results of the MANOVA analysis with the two dependent and two independent variables. The results indicate that the dependent variables are significantly related to the two independent variables.

Table 5: Results of Parsimonious MANOVA

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall Resource 8 Effect
H = Type III SSCP Matrix for Resource 8

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.54496009	20.46	2	49	<.0001
Pillai's Trace	0.45503991	20.46	2	49	<.0001
Hotelling-Lawley Trace	0.83499677	20.46	2	49	<.0001
Roy's Greatest Root	0.83499677	20.46	2	49	<.0001

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall Resource 10 Effect
H = Type III SSCP Matrix for Resource 10

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.80342546	5.99	2	49	0.0047
Pillai's Trace	0.19657454	5.99	2	49	0.0047
Hotelling-Lawley Trace	0.24467054	5.99	2	49	0.0047
Roy's Greatest Root	0.24467054	5.99	2	49	0.0047

DISCUSSION AND CONCLUSIONS

The objective of the research was to study the relationship between the extent of Green IT/S initiatives and organizational resources. Based on the statistical analysis, H1 can be affirmed. The MANOVA results indicate a relationship between the dependent variables- Green IT implementation measures and independent variables, namely, organizational resources. The relationship that was examined in this paper was the effect of the resources on Green IT/S measures in organizations. Our goal was to determine the impact of resources on Green IT/S, if any.

The data analysis indicated several statistically significant relationships between resources and Green IT/S measures. These resources influenced the implementation of Green IT/S in the study. Specifically, statistically significant (p-value <.05) relationships existed between the Green IT/S initiatives and five of the ten resources used in the analysis. These resources are: change in procurement practices (resource 2), specific targets for data center operations (resource 4), changes in human resource capabilities (resource 7), reputation of the firm (resource 8), and commitment of upper management (resources 10).

Statistical significance of the five resources corroborate Bose and Luo's (2011) assertion. Change in procurement practice (resource 2) is an attempt by organizations to eliminate inefficiencies in a business process. This is consistent with Simmonds and Bhattacherjee (2012). Specifics targets for data center operations (resource 4) is supported by Alaraifi et al. (2011). Changes in HR capabilities (resource 7) requires training current employees and hiring of employees with skills in Green IT/S technologies. This is an illustration of the financial consideration required to implement Green IT/S measures (Kuo and Dick, 2010). Reputation of the firm is a reflection of the company leadership (Mann et al., 2009). Finally, the commitment of upper management is a corroboration of Nedbal et al. (2011).

The statistical significance of five independent variables can be useful to organizations that are undertaking sustainable practices. They must be aware that the upper management must be on board. Similarly, elimination of slacks in supply chain can be achieved through Green IT/S measures. Data center targets help the organization move toward sustainability goals. Changes in human resources is a corollary of Green IT/S implementation. Finally, an organization may be able to enhance its reputation through implementation of Green IT/S measures.

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The results of the current study provide a basis for further analyzing and refining the results. This analysis will add to the growing body of research on Green IT. The current study is limited by its sampling methodology and sample size. The assertions were based on interview data collected from fifty three executives and managers who were the most informed individuals in thirty three organizations. The findings and conclusions of the current study must be considered in the context of the sample. The collection of the data for the study consumed significant resources because of the efforts needed to identify the managers knowledgeable about organizational Green IT/S efforts. This limitation may be addressed in future studies. In addition, the current study did not include company size, change in performance and other relevant measures. These variables may be included in future studies as moderating variables.

Future research should address the limitations of the current study by conducting data collection from a larger sample. In addition, a systematic study to identify all organizational resources relevant to Green IT/S implementation will enhance theoretical as well as managerial understanding in this area. The current study collected a large amount of interview data. Qualitative analysis of this data will yield greater insights and patterns of Green IT/S implementation efforts in organizations.

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APPENDIX

Interview Questions:

1. Tell us about your company: revenue, number of employees, size of IT (number of servers and employees), IT centralized/decentralized, CIO reporting to CEO/CFO, type of company? Your experience in number of years in this industry?

2. Is there an environmental /sustainability action plan in your company? If yes, does this action plan include Green IT (GIT)?

3. Is there a sustainability manager or an equivalent in your company?

4. Is GIT a corporate issue or just an IT issue?

5. Is there a restructuring of capital costs and operating costs as a result of GIT? If yes, does the restructuring involve the CFO or only the IT department and facilities/operations department?

6. Do you have any policy to encourage GIT to your users? If yes, what are the policies?

7. What is the size of your data centers? ___ sq ft, How many? ____Mid Tier; ____ Enterprise

8. Does GIT influence your purchasing/procurement decisions (e.g., buy Energy Star)?
9. What metrics are being used to measure power consumption in data centers? Do you plan to use these metrics for benchmarking purpose?
10. Have you set specific targets for data centers to be achieved by your GIT initiatives?
11. Which of the following GIT measures have you adopted? See Table 1 above for a list of these measures.
12. Do you consider GIT in your evaluation of outsourcing/collocation facilities?
13. When and under what circumstances did you adopt the GIT measures above?
14. Has the EPA played any role in your GIT adoption?
15. Do you think GIT measures impact your company's profitability/bottom line?
16. What are the broader organizational advantages of GIT beyond financial reasons?
17. Has GIT led to the redesign of your data centers or other physical facilities?
18. Did the implementation of GIT measures require or engender cooperation from other departments?
19. Has GIT influenced your human resource capabilities?
20. Does GIT have any impact on your firm's reputation?
21. Do you seek a leadership position on GIT within your industry?
22. What are the organizational barriers or resistance to GIT?
23. How committed are your upper management to GIT?
24. What role do you see standards or regulations having on adoption of GIT (innovation)?
25. Are you aware of any incentives from Federal/State governments or public utilities encouraging GIT?
26. Can you tell us how your organization's IT governance structure helps or hinders GIT? Any conflict with Sarbanes and Oxley Act?

Eighteen US organizations in the study

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Practitioner Organization	Business and Ownership	Size: Revenue and Number of Employees	Number of Data Centers (DC) and Servers	CIO Reporting to
Organization 1:	Manufacturing and media service; Public	$482 million; >1,000 employees	DC: 2; 300 servers	COO
Organization 2:	Manufacturing; private	Revenue undisclosed; 250 employees	DC: 1; 50-70 servers	CFO
Organization 3:	Software; private	$115 million; 320 employees	DC: 2; 120-140 servers	CFO
Organization 4:	Manufacturing and service; public	$1.2 billion; 3,400 employees	DC: 25 600+ servers	CFO
Organization 5:	State university	$350 million budget; 4,000+ employees	DC: 5; 350-400 servers	VP of Finance
Organization 6:	Manufacturing; public	$1.33 billion; 2,700 employees	DC: multiple but exact number not disclosed; 800+ servers	CEO and VP of Business Development
Organization 7:	Electronic manufacturing; private	Revenue undisclosed; 120 employees	DC: 1; 65 servers	CEO and CFO

Organization 8:	Software; public	$3 billion; 8,400 employees	DC: 9; number of servers not disclosed	CEO
Organization 9:	Software and storage devices; public	$2.8 billion; 7,000 employees	DC: 6; 1700+ servers	CFO
Organization 10:	Media; private	$500 million; 1,200 employees	DC: 19; 1000+ servers	CEO
Organization 11:	Software company; private	$150 million; 2,000 employees	DC: 6; 1,500 servers	CFO
Organization 12:	Pharmaceutical company; private	$ 200-600 million; 800 employees	DC: 0 580 desktops (distributed servers)	CFO
Organization 13:	Manufacturing; private	$1 billion; 5,000 employees	DC: 7; 10,000 servers	CFO
Organization 14:	Manufacturing; private	Revenue undisclosed; Employees undisclosed	DC: number of data centers not disclosed; Number of servers not disclosed	Not disclosed
Organization 15:	Software company; private	$2 billion; 500 employees	DC: 2; 270 servers	CFO

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Organization 16:	Financial services	$40 million; 71 employees	DC: 2; 40 servers	President
Organization 17:	Education; private	$10 million; 100+ employees	DC: 2; 10 servers	CEO
Organization 18:	Manufacturing company; private	$150 million; 200 employees	DC: 1; 45 servers	CFO

Fifteen EU organizations in the study

Practitioner Organization	**Business and Ownership**	**Size: Revenue and Number of Employees**	**Number of Data Centers (DC) and Servers**	**CIO Reporting to**
Organization 1:	Manufacturing; private	€320 million; 1,200 employees (up to 2,400 in Q4)	DC: 1;30 servers	CEO
Organization 2:	Manufacturing; public	€1.1 billion; 3,200 employees (worldwide €3,9 billion; 12,000)	DC: 1; 30 servers plus one for each production plant (10)	Corporate CFO
Organization 3:	Energy; Public	€108 billion; 35,000 employees (worldwide 70,000)	DC: 4; 3000 servers	COO

Organization 4:	Pharmaceutical company; public	€500 million; 1,000 employees (worldwide €18 billion; 40,000 employees)	DC: 1; 605 servers	CEO and Managing Director
Organization 5:	Manufacturing; Private	€22 million; 60 employees	DC: 1; 2 servers	Managing Director
Organization 6:	Manufacturing; Private	€10.5 million; 54 employees	DC: 1;	Group Leader CEO
Organization 7:	Energy; Public	€11.6 million; 1,580 employees	DC: 2;350 servers	CEO
Organization 8:	Software; private	€3 million; 50 employees (worldwide $6 million, 90 employees)	DC: 2;	CEO
Organization 9:	State university	€82.6 million; 688 employees	DC: 2 25 servers	Company Secretary and Rector
Organization 10	Manufacturing company; private	€120 million; 627 employees (worldwide €380 million, 1,200 employees),	DC: 1; 20 servers	CEO
Organization 11:	Express shipping company; Private	€650-700 million; 3,100 employees	DC: 3; 450servers	CEO

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Organization 12:	Telco; Private	€30 billion; 50,000 employees	DC: 8; 6,000 servers	CTO
Organization 13:	Manufacturing company; Private	€8 million; 30 employees	DC: 0; 4 servers	There is no CIO
Organization 14:	Corporate Reseller and System Integrator; Private	€120 million; 500 employees	DC: 3; Number of servers not disclosed	CEO
Organization 15:	Cosmetics; Private	€880 million; 1,100 employees	DC: 2; 110 servers	CEO