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Organizational Green IT: It seems the bottom line rules

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ABSTRACT

As the perceived importance of environmental sustainability has grown, there has been increasing discussion on both reducing the environmental impact of IT and on increasing the role IS plays as a potential source of environmental solutions. An understanding of the factors that influence organizations towards green IT and IS may assist in both predicting future behavior and creating mechanisms to encourage more sustainable organizations.

Using an online survey, this paper refines a model exploring the factors which influence the extent of green IT in organizations. Regression analysis revealed that the extent of green IT in organizations is influenced by a combination of the influence of management, bottom line considerations and normative legitimation pressures. The regression indicated a good fit for the developed model, providing a basis for further research.

Keywords

Green IT, environmental sustainability

INTRODUCTION

Information and communication technology (ICT) has transformed modern life, driving innovation, productivity and growth in organizations and playing key roles in how people live, work, learn and interact. The ICT sector continues to grow and is predicted to comprise 8.7% of global GDP by 2020 (The Climate Group, 2008). However, the increasing energy and resource demands from the production and use of IT are being met by fossil fuel based power plants which contribute to the generation of greenhouse gases that cause global warming and climate change (Katzer, Deutch, Moniz, Ansolabehere, Beer, Ellerman, Friedmann, Herzog, Jacoby, Joskow and McRae, 2007; The Climate Group, 2008). Additionally, the rapid obsolescence of electronic products results in waste that causes environmental contamination (Herat and Bahadir, 2007). Despite these environmental impacts, the role of technology in organizations as drivers and enablers of business innovation also makes it a potential source of solutions to environmental sustainability (Ghose, Hasan and Spedding, 2008).

As corporate awareness of environmental sustainability has increased within organizational IT departments, there has been an emergence of an area now generally termed 'green IT' where IS and IT are used to improve environmental performance. Gartner (2007, 2008, 2009) has identified green IT as one of the top strategic technologies for the third consecutive year demonstrating that environmental sustainability has shifted from being solely the concern of scientists and environmentalists to being recognized as the most important and universal public issue today (Banerjee, 2002; Bonini, Hintz and Mendonca, 2008; United Nations Environment Programme, 2008).

An organization's IT can both contribute to and reduce its environmental impact. Identifying and understanding the factors influencing green IT initiatives is critical as it may assist in predicting future organizational behavior. Additionally, this understanding can also be used to encourage more sustainable organizations by creating more effective mechanisms to undertake green IT initiatives. This can allow organizations to reduce the environmental impact of their IT operations as well as allowing them to utilize IS to improve environment performance in other areas throughout the organization. This study aims to answer the following question: what are the factors and to what extent do these factors influence the use of IT to improve environmental performance in organizations?

BACKGROUND

The existing literature on the use of IS and IT as it relates to environmental sustainability is dominated by industry practitioners, industry consortiums, industry research groups, environmental groups, governmental bodies and international organizations. By contrast, academics have only recently begun to address green IT with a number of conference papers (Elliot, 2007; Elliot and Binney, 2008; Molla, 2008; Molla, 2009b; Sayeed and Gill, 2008; Hasan, Ghose and Spedding, 2009), journal articles (Chen, Boudreau & Watson, 2008; Murugesan 2008; Molla 2009a) and academic initiatives (Ghose et al., 2008; RMIT University, 2009). This paper draws on organizational environmental strategy literature and preliminary academic green IT studies in order to understand the factors that influence the extent to which IT is used to improve environmental performance in organizations. The literature reported is necessarily restricted here due to space limitations. From the review of the literature, three main factors were identified. These were: motivational factors, organizational factors and technological constraints.

Motivational Factors

Bansal and Roth (2000), using analytic induction in a qualitative study of 53 British and Japanese firms, found three basic motivations that induce corporate environmental responsiveness: competitiveness, legitimation and social responsibility. Competitiveness focuses on profitability and encompasses initiatives that reduce costs, generate revenues or improve efficiencies. In contrast, the goal of legitimation is survival and hence, as a consequence, initiatives are based on satisfying government, local community and stakeholders and complying with norms and regulations in order to avoid penalties and lessen risks. Legitimation is concerned with satisfying external groups and would incorporate responding to pressures from environmental groups and not just regulatory bodies. The concern that organizations have for social good forms the social responsibility motivation where organizations act from “a sense of obligation, responsibility or philanthropy rather than out of self-interest” (Bansal and Roth, 2000). Social responsibility motivations are more altruistic in nature with ‘feel-good’ factors as the main goal and are the result of interests that are solely internal within the organization.

The competitive motives can be further separated into bottom line considerations and external competitive pressures. Bottom line considerations can be considered to be comprised solely of economic drivers such as tangible cost savings from IT operations (Molla, 2008). Competitive pressures may also arise from external market forces in the form of mimetic institutional pressures. This is when “organizational pressure to conform comes from other organizations and develops into an uncertainty-coping strategy” (Chen et al., 2008). Similarly legitimation motives can be separated into coercive and normative pressures. Normative pressures are “when cultural expectations press organizations to act in a legitimate way” (Chen et al., 2008) whilst coercive pressures refer to “when organizations are driven to act alike because of governmental laws and regulations” (Chen et al., 2008).

Organizational environmental strategy literature has shown these motives play varying degrees of importance in influencing the decision making process of organizations. A series of surveys conducted on UK firms (Faulkner, Carlisle and Viney, 2005; Ghobadian, Viney, Liu and James, 1998; James, Ghobadian, Viney and Liu, 1999), showed that legal requirements have been the most important factor in formulating environmental strategy when compared with pressures from market behavior and social expectation. Hahn and Scheermesser’s (2006) study of German companies found four distinct groups of reasons for corporate sustainability activities. Two groupings of these motivations were consistent with bottom line considerations such as revenue growth and cost savings. The study also found that legitimation pressures, such as those from societal stakeholders, and social responsibility pressures, such as ethics, were also distinct groups of motivators for corporate sustainability.

These motivations have also been demonstrated to be applicable in driving green IT initiatives however preliminary studies have suggested that the relevance of each motivation to green IT may differ from general organizational environmental strategy literature. Green IT adoption seems to be currently driven by cost reduction and ‘eco-efficiency’ rather than by legal requirements (Molla, 2009a, b). This was particularly true for US organizations where energy efficiency and cost cutting were identified as the primary considerations for undertaking green IT initiatives (Molla, Pittayachawan and Corbitt, 2009). These findings are also supported in interviews conducted by Sayeed and Gill (2008). It is expected that “government reporting, regulation and customer demand are potential drivers for the future” (Elliot and Binney, 2008) and there is also evidence that environmental considerations (Molla et al., 2009), responsiveness to staff concerns and client requirements are also significant motivators for engaging in green IT (Elliot and Binney, 2008).

These initial studies show the presence of each of competitive, legitimation and social responsibility dimensions within motivational factors influencing green IT within organizations. As organizations “adopt distinct sets of management practices that appease different external constituents” (Delmas and Toffel, 2008), it is imperative to understand the motives for

undertaking green IT so that it can be used to both predict future behavior and create incentives to foster more environmentally sustainable organizations (Bansal and Roth, 2000).

Organizational Factors

As with any organization undertaking, green IT initiatives will have impacts on human resources and organizational capabilities (Sayeed and Gill, 2008). An organization’s human resources and capabilities must be leveraged to manage environmental performance (Russo and Fouts, 1997). These factors, if not available in the appropriate quantity and at the necessary quality, may “constrain the company’s ability to act” (Ghobadian et al., 1998). The extent of green IT will be influenced by organizational capabilities such as ongoing operational costs, the complexity of processes, the availability of resources and the capability of the organization to adapt.

One of the most important internal organizational factors influencing green IT is management support. The importance of leadership and a senior management champion has been stressed in the literature (Ghobadian et al., 1998; James et al., 1999; Schein, 2004). Leaders shape the nature of organizations, determine the key issues the organization addresses and facilitate the requisition of necessary resources to undertake initiatives. Consequently, the extent of green IT in organizations should be significantly higher when senior management is strongly supportive of environmentally sustainable initiatives.

Technological Constraints

In contrast with models found in general organizational environmental strategy literature, this paper focuses specifically on IT and consequently, technological constraints may play a more significant role in limiting an organization’s ability to undertake certain green IT initiatives. The literature suggests that the technological context of the organization may also influence the extent of green IT in organizations (Molla, 2008) and in certain industries, technology facilitation may play a significant role in the decision making process towards environmental strategies (James et al., 1999). Some of the other potential technological constraints identified included the complexity of initiatives and the limitations posed by software, hardware and technological infrastructure. Given the exploratory nature of this study and the focus of the research in the IT domain, it was decided this area would also be examined.

Proposed Model

In summary the following model, which indicates the main factors proposed to influence the extent of green IT in organizations, was used to guide this study.

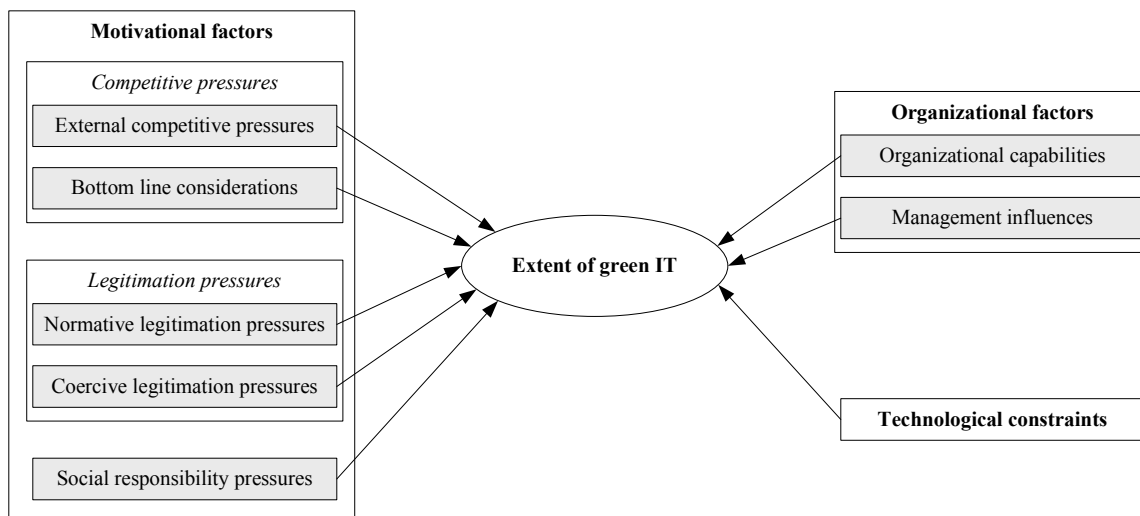


Figure 1. Research model showing the proposed factors which influence the extent of green IT in organizations

METHODOLOGY

A survey to test this model was pilot tested and administered to organizations through an online questionnaire targeting senior IT managers. The questionnaire items were mostly adapted from existing literature in corporate environmental sustainability including studies by Delmas and Toffel (2008), Hahn and Scheermesser (2006), and a longitudinal series of studies from the UK (Faulkner et al., 2005; Ghobadian et al., 1998; James et al., 1999). Respondents were asked to indicate the extent to which various factors influenced the use of IT to improve environmental performance in their organization using a 5 point scale.

As existing models to assess the maturity (Sayeed and Gill, 2008) and development (Elliot and Binney, 2008) of green IT within an organization were unsuitable for direct use in an online survey instrument, a self-reported six measure score was developed from these models to measure the extent of green IT within an organization. These six measures were each 5-point scales where respondents are asked to rate their organization along different continuums of opposing word pairs similar to semantic differentials. These word pairs were developed from keywords identified from the literature which were often used to describe the extent of green IT in organizations. These words, which included 'ubiquitous', 'mature' and 'developed' (Elliot, 2007; Sayeed and Gill, 2008) were matched with words that represented or closely represented their opposites to form the word pairs.

As the primary target respondents were senior IT managers, the sampling strategy of the study faced constraints in obtaining access these respondents as "surveying white collar-elites requires special techniques" (Neuman, 2006). Purposive sampling was selected as an appropriate strategy as, in the context of this study, potential respondents were "members of a difficult-to-reach, specialized population ... [and the] goal is to locate as many cases as possible" (Neuman, 2006).

The main strategy for data collection was to contact potential respondents within our professional networks whom we judged to be able to provide insight into the research area at their organization. Typically respondents judged to be appropriate were known to be senior managers and managers with environmental responsibilities with a good understanding of their IT department and its strategic decision making process. Invitations to participate in the study were sent by email which would contain a link to the online questionnaire. This method was undertaken as it was seen to have the most chance of a successful response when "access is facilitated when a prestigious source calls or sends a letter of introduction" (Neuman, 2006). Two email mailing lists which contained suitable target respondents were also utilized in this study. The first contained mainly senior representatives from the IT department of organizations which had a close affiliation with the information systems department of a large education institution in Australia. A second mailing list contained a group of Chief Technology Officers who were located in a major city located on the east coast of the US. The survey reached a total of 180 potential respondents with 43 responses received representing a 24% response rate (refer to Table 1).

Source	Sample size	Responses	Response rate
Network	60	33	55%
Mailing groups	120	10	8%
Overall	180	43	24%

Table 1. Response rate

The low response rate, which is below the recommended value of 50% (Babbie, 1998), forms a limitation of this study. However, given the inaccessible nature of the respondents, this response rate may be relatively acceptable compared with similar studies (e.g. Molla, 2009a) targeted towards CIOs which achieved a similar response rate of 16%.

As survey responses from our networks may have introduced bias, we conducted a Mann-Whitney test to indicate whether there may be issues with the representativeness of these responses. This test compared the responses obtained from our network sources with the responses obtained from the two mailing lists and found that only 5 out of 53 measures in the questionnaire revealed significant differences between these two sources.

Validity of the instrument was assessed in terms of content and construct validity. DeVellis (2003) recommends that in order to maximize the appropriateness when developing scales, an expert could review the items to determine relevance to the domain. In this study, support that the model and survey instrument both contained the main items in the domain area was found from experts in academia and industry. Initial interviews with practitioners supported the content validity of the proposed research model.

Cronbach's alpha scores were calculated for each of the factors identified from the exploratory factor analysis to test for internal consistency. As seen in Table 2, the scores for all constructs exceeds the 0.60 minimum value for exploratory research (Hair, Anderson, Tatham and Black, 1998) with most constructs demonstrating good internal consistency exceeding an alpha score of 0.85 (DeVellis, 2003). Independent variables were also tested for multicollinearity and it was found that the tolerance value was above 0.10 illustrating that multicollinearity should not be an issue in these models.

Construct	Cronbach's alpha score	Number of items
Extent of green IT	0.946	6
Competitive pressures		
External competitive pressures	0.852	5
Bottom line considerations	0.697	3
Legitimation pressures		
Normative legitimation pressures	0.643	3
Coercive legitimation pressures	--	1
Social responsibility pressures	0.867	3
Organizational factors		
Management influences	0.631	2
Organizational capabilities	0.890	6
Technological constraints	0.868	4

Table 2. Cronbach's alpha scores for each of the constructs in the model

RESULTS

Of the 43 responses received, 5 invalid responses were discarded. Consequently, the results of this paper are based on responses from 38 different organizations, most of which were collected in April 2009. Approximately 40% of respondents identified themselves as senior managers with positions such as chief information officer, executive director, president or head of IT, whilst approximately 42% identified themselves in other management roles such as information systems manager or general manager. The remaining 18% were other professional or technical staff such as IT specialist, project manager, IT advisor, analyst or engineer.

The participating organizations represented a variety of industries, mostly with a centralized IT structure with a majority headquartered in the USA (60%) and Australia (24%). The remaining organizations (16%) had their headquarters in the UK, Scandinavia or Mexico. Nearly all organizations were large with more than 500 employees (74%) and only a minority of organizations had less than 100 employees (5%).

Respondents reported strong adoption of a number of initiatives which reduce the impact of IT on the environment including virtualization (87%), data centre consolidations (74%) and having a policy for e-waste (74%). However, initiatives which use IT to improve the environmental performance in other areas of the organization were also widely adopted. These initiatives included collaboration technologies (87%), telecommuting (76%), using electronic/online replacements for paper (76%) and the reduction of paper usage through the use of printer configurations (71%). It is also interesting to observe that data centre consolidations is a much more prevalent practice compared to the adoption of data centre design improvements with a 40 percent point difference. This may be indicative of the higher potential return on investment of data centre consolidation compared with simply upgrading the data centre (Deloitte, 2008). The survey results also show that use of alternative energy sources are the least widely adopted initiative with only 18% of organizations using renewable energy sources.

Multiple regression was used to analyze the relationship between the extent of green IT and the research model's proposed factors. In particular, stepwise regression allowed the examination of each predictor variable's contribution to the regression model (Hair et al., 1998). Each of the constructs (competitive pressures, legitimation pressures, social responsibility pressures, organizational factors and technological constraints) and their related measures were loaded into the model against

the dependent variable extent of green IT. The results of the stepwise regression indicated three measures accounted for most of the variance in the extent of green IT in organizations. These were management influences, bottom line considerations and the organization’s normative legitimation pressures. These two measures accounted for 63.3% of the variance (adjusted R²=0.600) in the extent of green IT in organizations.

Table 3 details each of the models constructed during stepwise regression. The dependent variable in each of these models was the extent of green IT score with the predictor variables for models 1-3 respectively being:

1. Management influences
2. Management influences, bottom line considerations
3. Management influences, bottom line considerations, normative legitimation pressures

Table 4 details the variables of the final model from the stepwise regression.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	Sig. F Change
1	.723	.523	.510	.7250469	.523	39.502	.000
2	.764	.584	.560	.6867331	.061	5.129	.030
3	.795	.633	.600	.6548712	.048	4.489	.042

Table 3. Stepwise regression for the extent of green IT in organizations

Predictors (of Model 3 from Table 3)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-.233	.468		-.497	.622		
Management influences	.512	.116	.532	4.421	.000	.745	1.342
Bottom line considerations	.239	.108	.246	2.219	.033	.877	1.141
Normative legitimation pressures	.281	.133	.245	2.119	.042	.808	1.237

Table 4. Stepwise regression independent variable outputs for the extent of green IT in organizations

DISCUSSION

The influence of senior management accounted for 51% of the variance (adjusted) of the extent of green IT in the regression indicating that the extent of green IT, from the perspective of this sample consisting of mostly senior managers, is driven primarily by management. This is consistent with the study by James et al. (1999) which highlighted the “overwhelming importance of engaging a senior management champion” (James et al., 1999). In Elliot and Binney’s (2008) case study, it was also evident that the organization’s top executive group played a critical role in driving various initiatives for green IT. Further evidence of the importance of senior management was found from our own informal interviews where one of the CIOs stated “senior management buy-in” was a key factor to influencing the extent to which initiatives are undertaken within organizations.

The results from this study also supported bottom line considerations, which accounted for an additional 5% of the variance (adjusted), as a significant factor influencing the extent of green IT. Bottom line considerations consist of the internal goals

of cost reduction, revenue growth and identifying opportunities in new business fields. The focus on reducing cost is reflected in practitioner reports (Info-Tech Research Group, 2008) and is consistent with the study by Molla et al. (2009) which found that 80% of respondents considered reducing the cost of IT as one of the main reasons for pursuing green IT. Sayeed and Gill (2008) also found senior IT management preoccupied with operational efficiency such as cost cutting and energy conservation. The findings suggest that these considerations remain highly important with cost savings being the highest rated factor with a mean of 4.47 on a 5-point scale.

These two factors, which account for most of the variance in the refined regression model, are exemplified in one of the qualitative responses in the study :

“All of our current IT environmental concerns are driven by a current initiative by senior management to reduce overhead costs”

(survey respondent)

This indicates that (only?) those green IT initiatives that have a positive effect on the bottom line are the ones most likely to be implemented.

Normative legitimation pressures, consisting of the influences of environmental organizations, local communities and the media, accounted for an additional 4% of the variance (adjusted) in the refined regression model. This supports the study by Molla et al. (2009) which found that 71% of respondents considered social acceptance as one of the main reasons for pursuing green IT.

	Adjusted R ² change	Standard co-efficient (B)
Management influences	0.510	0.532
Bottom line considerations	0.050	0.246
Normative legitimation pressures	0.040	0.245
Total adjusted R²	0.600	

Table 5. Degree to which factors predict extent of green IT

The study found no support for external competitive constituents such as customers, suppliers and competitors influencing the extent of green IT. This is consistent with Molla et al. (2009) who found that these market forces had the least effect in motivating green IT uptake with only 48% considering pressures from clients and consumers, 20% considering pressures from competitors and 14% considering pressures from IT vendors as one of the main reasons for pursuing green IT.

The lack of influence from coercive legitimation pressures (i.e. from legislators and regulators) contrasts with much of the corporate environmental strategy literature such as the study by James et al. (1999) which found legal requirements were considered the foremost external factor. This may reflect the lack of green IT legislation (Sayeed and Gill, 2008), as most regulation is currently limited to restricting e-waste. Perhaps it is time for the legislation to consider the extent to which a company adopts green IT practices.

There was also no support for organizational capabilities and technological constraints influencing the extent of green IT which is consistent with Molla et al. (2009). They found only 36% of respondents indicated inadequate skills and training and only 41% indicated that the extent of IT sophistication were inhibitors of implementing green IT. James et al. (1999) also found that “capability seems to play a limited role in the development of environmental policy” (James et al., 1999) and argued that this suggested that capability is not viewed as a major issue when considering environmental issues. Whether this is actually because green IT does not require much in terms of organizational capacity or whether “policy decisions are being signed off without due consideration for the ability of the organization to support these policies” (James et al., 1999) is beyond the scope of this study. However, our informal qualitative interviews have suggested that the prevalence of outsourcing could mean that expertise and resources are often overcome with third party vendors.

There is a marked contrast between the views of non managerial IT practitioners and senior IT managers about the factors influencing the extent of green IT. While non managerial IT practitioners found that the organizational capability, coercive legitimation pressures and social responsibility pressures were the main factors accounting for the differences in green IT between organizations (Kuo and Dick, 2009), the sample consisting of mainly senior IT managers in this study believed that management, the bottom line and normative legitimation pressures accounted for the true differences.

LIMITATIONS AND CONCLUDING REMARKS

The results indicate that in organizations that have ubiquitous, maximal efforts towards the widespread use of IT to improve environmental performance, these initiatives are more likely to be driven by management, motivated from bottom line considerations and responding to normative legitimation pressures rather than being motivated from regulatory, social responsibility or external market forces. There was also no evidence that organizational capabilities affecting green IT initiatives nor was there any technological constraints.

Given the exploratory nature of the research, there are a number of clear limitations in interpreting these results. The small sample size limits the generalizability of these findings while the response rate of 24% may potentially raise concerns regarding the representativeness of the sample. Future research should undertake a more extensive study of this area with a larger sample.

Furthermore, the scale for measuring the extent of green IT can be more rigorously tested and developed further. Respondents more receptive to environmental concerns may have been more likely to have completed the survey leading to self-selection biases. The reliance of self reporting for this measure may be an issue as it is especially susceptible to social desirability biases given the recent popular trend towards 'green'. In-depth case study analysis may be required to validate this measure in order to gain additional confidence in the answers of respondents.

As environmental sustainability has grown in importance, business executives expect environmental concerns to become the foremost issue which impacts on shareholder value in the future (Bonini, Hintz and Mendonca, 2007). Environmental considerations now form important dimensions in corporate social responsibility, sustainability and strategy as well as the 'triple bottom line' measure of organizational success. These require major commitments from organizations throughout their value chains including their IT and IS. In this emerging field, these findings which are grounded in empirical data should be useful to assist other researchers in developing their own theories with regards to green IT. The high R^2 reported in this study indicates strong support for the model and provides a starting point for further research. This should lead to a better and more complete understanding of the factors influencing organizational adoption of green IT. IS may assist in both predicting future behavior and creating mechanisms to encourage more sustainable organizations.

Nevertheless, it seems from this study that organizations are not going to adopt green IT unless it is clearly in their financial interests to do so. This would suggest that regulatory authorities and governments are going to have to adjust and manipulate energy pricing structures to force a wider adoption.

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