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Green IT Adoption: A Motivational Perspective

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GREEN IT ADOPTION: A MOTIVATIONAL PERSPECTIVE

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Abstract

Although there is need for information systems (IS) empirical research that study the factors influencing the adoption of green technologies, most, if not all, of the published IS research on either Green IT or Green IS are characterized by a call for action to the IS community and a definition of the Green IS research and teaching agenda. This paper empirically investigates the influence of organizational eco-sustainability motivations on the adoption of Green IT. Drawing from the motivational theory and using data collected from a survey of 176 organizations, the paper develops and tests four hypotheses. The result shows that eco-efficiency and eco-effectiveness motives influence the adoption of technologies that improve the energy efficiency of IT infrastructure and subsequent pollution reduction. They also explain variations in the adoption of policy and practices that aim to improve product stewardship of the IT lifecycle from procurement to end of life management. We highlight some of the theoretical and practical implications of the findings.

Keywords: Green IT, Green IS, Motivation, Adoption, Eco-Sustainability

1 INTRODUCTION

The impact of information technology (IT) on the natural environment can be classified into two broad categories of first and second order effects (Köhler and Erdmann, 2004; Hilty et al, 2006). The first-order effect refers to the environmental impact of IT production, use, and disposal. This is related to Green IT. The second-order effect refers to the positive impact of using IT on environmental sustainability of business and economic processes. This effect relates to Green information systems (IS). This paper is mainly concerned with Green IT. Most, if not all, of the published information systems (IS) research on either Green IT or Green IS is thus far characterized by a call for action to the IS community (Watson et al 2010), a definition of research and teaching agenda (Dedrick, 2010; Melville 2010) and conceptual frameworks (Bose and Luo, 2011; Dao et al, 2011). Others use case studies to highlight the role of information systems as tools for improving sustainability (Bengtsson and Agerfalk, 2011) and understand why IT manufacturers design and produce environmentally sustainable products (Butler, 2011). A few emerging empirical studies focus on the adoption of policies, practices and technologies that improve the energy consumption of IT infrastructure and that prescribe the consideration of environmental criteria in both procuring and disposing IT (Chen et al 2008; Kuo and Dick, 2009). These few studies however focus more on market, technological, and managerial factors and less on the importance of organizational motivations. The exception is Molla's study (2009) which introduced a Green IT Motivation Grid. Although the Green IT Motivation Grid is developed using empirical data, whether or not the motives identified influence the adoption of Green IT has not been tested.

Organizational motive for IT adoption is a suitable, albeit largely under-used, theoretical lens in IT research (Grewal et al 2001, Rahim et al, 2010). Compared to technological, organizational and environmental contextual factors, organization motivation theory offers an explanation into the strong order drivers why IT implementation processes vary among organizations (Rahim et al 2007, Eklim and Rahim, 2008). Further, a motivational perspective helps to understand the motives for organizations' environmental initiatives and predict environmentally based behaviors (Bansal and Roth 2000). A motivational perspective to Green IT adoption therefore provides useful insights as to what extent eco-sustainability considerations are influencing the IT decision making process. It helps to discern if organizational concern for the natural environment, even if economic benefits are not tangible in the immediate short term, influence the adoption of IT. Understanding of the motivations is useful to IT managers and other practitioners as it helps them to justify their Green IT actions or inactions and to effectively participate in organizational eco-sustainability strategic discourses.

This paper therefore aims to empirically investigate the influence of organizational eco-sustainability motivations on the adoption of Green IT. The main research question the paper tackles is "what motivates organizations to adopt Green IT"? In pursuing this question, the paper addresses Dedrick's (2010) and Melville's (2010) call for a body of IS empirical research that studies the factors influencing adoption of green technologies and practices. The contributions of the paper rest on offering a snapshot of Green IT diffusion, on applying and showing the utility of a motivational perspective to Green IT research and on testing some of the theoretical propositions regarding the drivers of Green IT. Researchers can use this study to understand some of the factors that might facilitate or inhibit Green IT. Practitioners can benefit from the paper in justifying Green IT projects.

The rest of the paper is organized in six sections. The next section reviews background literature on Green IT and motivation theory. Section three develops the research framework and hypotheses. In section four, we detail the research method which is followed by analysis of the measurement and structural model. After discussing the main findings in section five, the last section highlights the main contributions and some of the limitations of the study that chart avenue for future research.

2 BACKGROUND

The potential of technology to create sustainable business and society is widely accepted (Olson, 2008). Sustainability is a broad concept and includes economical, social and ecological considerations. This paper however focuses only on the eco-sustainability dimension as until recently the role of IT in eco-sustainability has not been researched from an information system perspective (Dedrick, 2010). Eco-sustainability aims at coordinating organizational efforts to prevent pollution at the end of business and production processes; minimize the environmental footprint during production processes; use clean technologies to reduce polluting materials and develop environmentally friendly competencies (Hart, 1997).

2.1 Green IT

The production, use, and disposal of IT have a direct effect on the natural environment and eco-sustainability (Köhler and Erdmann, 2004; Hilty et al, 2006). Each stage of the IT lifecycle from manufacturing to usage and disposal poses environmental problems (Elliot and Binney, 2008). Estimates indicate that the IT industry account for 2% of global CO2 emissions, which is equivalent to the amount generated by the aviation industry (Goasduff and Forsling, 2007). In Australia, the carbon footprint of IT usage is estimated to be 2.7% of Australia's total carbon emission (Philipson, 2010). In addition, IT might have had an undesirable impact of increasing the expansion of environmentally polluting business undertakings (Chen et al, 2008). As the force of the Moorse law continues to shorten the average lifespan of IT, electronic-waste is emerging as one of the fastest growing waste that requires serious attention. For example, in Australia, over 1.6 million computers are dumped in landfills each year and e-waste is growing faster than general municipal waste (Harper, 2006). Further, energy consumption by IT facilities such as data centers indirectly contributes to CO2 emissions. Therefore, both IT hardware manufacturers and firms using IT need to apply principles of environmental sustainability, which include pollution prevention, product stewardship and sustainable development in managing IT. Green IT refers to such practices.

2.2 Organizational Motivation

The theory of organizational motivation explains the motives behind organizational actions (Simon 1998). It views an organization as a collective self whose behavior is influenced by human motivational factors (Li et al, 2003). Motives refer to the "specific need, desire, or want that guide actions" (Maehr and Braskamp, 1986). In the context of IT adoption, motives are defined as "*the desire that initiates the activities of an organization to adopt an innovative system such as an IT enabled information system*" (Rahim et al, 2010: 1907).

Motives can be seen in terms of their locus (source) or types (focus).The locus of motives is either internal or external to an organization (Rahim et al 2007). Internally, motives are embedded in missions, beliefs and value systems of an organization (Li et al, 2003). Externally, motives emanate from the intervention of formal (such as government) and informal (such as markets) institutions. There are two forms of institutional interventions – influence and regulation (King et al, 1994). Influence initiatives can change the behavior of those under the institution's way. This can be achieved without direct use of force and by providing resources. On the other hand, regulatory actions have the purpose of directly affecting the behavior of entities under their jurisdiction. This can be done through directives or actions that limit options and modify behaviors.

Related to locus, there are various classifications of the types of motives. For example, organizational motives for entering e-market are classified into economic objectives of enhancing efficiency and normative objectives of achieving legitimacy (Grewel et al, 2001). Rahim et al (2007) classify the motives for the adoption of inter-organizational systems into two broad categories of techno-economic and socio-political. Techno-economic motive refers to the adoption of technologies and systems to improve organizational and market performance, whereas socio-political motive refers to the adoption of systems either because of the influence of external forces or to create socio-political

pressure on others. In the context of ecological sustainability, Chen et al (2008) identified three eco-motivations as *eco-efficiency, eco-equity and eco-effectiveness*. Eco-efficiency refers to a business's desire to deliver "competitively priced goods and services…while progressively reducing ecological impacts" (*DeSimone and Popoff*, in Chen et al, 2008: 190). Eco-equity focuses on "equal rights of people to environmental resources" and a business's "social responsibility for the future generations" (Ibid: 192). Eco-effectiveness on the other hand, "aims to stop contamination and depletion…by directing individual and organizational attention to the underlying and fundamental factors of environmental problems …through a fundamental redesign of the system" (Ibid: 195). In the context of environmental responsiveness, Bansal and Roth (2000) identified three motives-*competitiveness, legitimation and social responsibility*. Competitiveness refers to the desire to achieve profitability by reducing cost and improving efficiencies. Legitimation refers to the desire to satisfy government regulations and stakeholders and comply with environmental norms and standards. Social responsibility refers to the desire to "do well" to the environment out of a sense of social obligation.

The application of the organizational motivation theory to IT and eco-sustainability implies that, an organization's belief and value system associated with eco-sustainability as well as the influence of external institutions can drive organizational actions to Green IT. Based on the review of the literature and using principal component analysis Molla (2009) developed the Green IT Motivation Grid. The Grid identifies four categories of motivations as indicated in Figure 1, each of these will be discussed in the following section.

		Locus of motivation	
		Internal	*External*
Focus	*Economic*	Eco-efficiency	Eco-responsiveness
	Socio-political	Eco-effectiveness	Eco-Legitimacy

Figure 1. The Green IT Motivation Grid (Source: Molla, 2009)

3 RESEARCH FRAMEWORK AND PROPOSITIONS

This study focuses on what drives organizations to engage in eco-sustainable practices directly targeting IT. Drawing from organizational motivation theory, we propose a research framework (Figure 2) that is a combination of ecological and operational performance considerations.

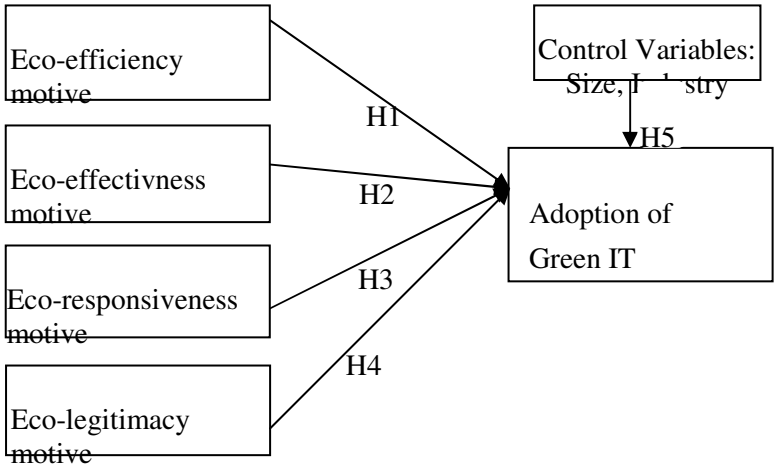

Figure 2. Research Framework

Eco-efficiency motive has internal locus and economic type of motivations. It refers to the desire to implement practices and technologies to improve the eco-sustainability of IT while at the same time pursuing economic objectives such as cost reduction. The expansion of global business and the need for keeping copies of the same data to comply with regulations and to meet business continuity strategies are leading to a meteoric rise in stored data (Dedrick 2010). More data implies larger server farms and more demand for power. As corporate demand for more data processing and storage capability continues to grow, energy costs are becoming a significant proportion of the total cost of running IT infrastructure (Rasmussen, 2006). The need for reducing the power, cooling and real estate costs and increasing data center efficiency might drive some organizations to turn to Green IT. Corbett's (2010) analysis of articles published in *CIO Magazine* shows that economic benefit, particularly cost saving, is the most commonly cited driver for Green IT. In Australia, the ANZ Bank's initiative to ban screensavers has resulted in approximately 4% reduction in annual electricity bill with an estimated value of AU$500,000 per year (Molla and Cooper 2010). The initiative has also reduced greenhouse gas emissions by an estimated 5,000 tons per year. Virtualizing the data center infrastructure improves the utilization of IT assets while at the same time reducing power consumption and carbon emissions (Pretorius et al, 2010). Most IT managers and professionals are therefore focused on reducing the direct environmental impacts of IT by making data centers and end user devices more energy efficient (Dedrick, 2010). Eco-efficiency motive can therefore lead to the adoption of practices to operate corporate IT assets in an energy efficient manner and the adoption of IT initiatives that yield cost reduction while at the same time reducing the environmental externalities of an organization. This leads to the following hypothesis

Hypothesis 1: The presence of eco-efficiency motive is positively related to the adoption of Green IT

Eco-effectiveness motives occur when organizations initiate Green IT initiatives due to their beliefs and value system associated with eco-sustainability and for reasons other than immediate economic gains. It refers to the desire to implement practices and technologies to improve the eco-sustainability of IT out of a sense of concern for the natural environment or in order to set a norm and become a thought leader. It has internal locus and socio-political type of motivations. Corbett (2010) used the concept of ecological embeddedness, which refers to a deep relationship with the natural environment and the ability to learn from it, to outline how managers and organizations that are ecologically embedded will show commitment to the adoption of sustainable practices. Embeddedness also refers to a "unique logic of exchange that results from the distinct social structure of organization networks and the micro-behavioral decision-making processes they promote" (Uzzi, 1997, 61). For example, a global survey of 1260 IT professionals indicated that 50% are concerned about climate change (Info~Tech, 2008). Overall, firms that are environmentally engaged are more likely to consider Green IT as an important undertaking and plan its implementation (Schmdit et al, 2010). The above leads to:

Hypothesis 2: The presence of eco-effectiveness motive is positively related to the adoption of Green IT

Eco-responsiveness motives occur at the intersection of external locus and economic focus. The emphasis is on Green IT initiatives that are induced to meet certain demands from the market environment such as green market opportunities. Green IT can lead to profitability through preferential access to markets that reward the greenness of companies (Mithas et al, 2010). It can also lead to launching new products and services to the market (Sayeed and Gill, 2010). Info~Tech's (2007) analysis of 13 green IT technologies and tactics indicates that some leading edge businesses are moving fast to increase their green credentials and might put a pressure on their suppliers, competitors and customers to follow suit. As businesses increasingly use green strategies as a basis for competition, they set the green norms of competition and motivate their competitors' adoption of Green IT. Chen et al (2008) used the notion of inducement-based coercion to show how supply chain partners can pressure the desire to implement Green IT. Previous studies of innovation adoption (Damanpour and Schneider 2006) also recognize the influence of market forces in driving adoption either through the effects of network externalities or through creating a critical mass of users. Eco-responsiveness motives therefore can lead to Green IT preferences that associate a business to market accepted norms of reducing emission, recycling, reuse and electronic waste management. Thus

Hypothesis 3: The presence of eco-responsiveness motive is positively related to the adoption of Green IT

Eco-legitimacy motives occur due to political and social pressures facing a company. The political pressure comes from government impositions in the form of regulations, standards and taxes (Tyteca 1996) whereas the social pressure comes from the maturity of the institutional environment within which a firm operates (Clarkson et al, 2008). The central thesis of this motive is that firms engage in Green IT projects when they face regulatory and social pressures that threaten their legitimacy. Regulatory requirements and legislative actions play very significant roles in the adoption of Green technologies and can force some businesses to accept a technology or practice even if they do not have a strong intention to do so (Olson, 2008). Governments, in particular, can encourage the adoption of Green IT by legislations that create the framework for the law carbon economy (Chen et al, 2008). National, professional and inter-governmental institutions often wield a great deal of influential power in relation to professional practice, which in turn, can have implications for the adoption of Green IT. These institutions are producing guidelines related to Green IT. Examples include the OECD recommendation on information and communication technologies and the environment, the European Union code of conduct on data center energy efficiency, the Greenpeace guide to greener electronics, and the European Commission directive on Waste Electrical and Electronic Equipment (WEEE). Overall, the pursuit of legitimacy within the wider social context could be one of the motivating factors affecting the adoption of Green IT. This leads to

Hypothesis 4: The presence of eco-legitimacy motive is positively related to the adoption of Green IT

The specific characteristics of a business such as sector, size and corporate citizenship might influence IT adoption (Damanpour, 1991). First, environmental issues are quite complex and tend to vary from one industry to another. We therefore include the industry as a control variable. Second, organizations differ in terms of their stock of IT assets which can influence their desire to engage in activities to Green IT. Small and service-oriented firms tend to have less IT facilities compared to larger firms. Thus we also include the size of organizations as another control variable. These lead to

Hypothesis 5: The influence of eco-motivations on the adoption of Green IT varies due to differences in industry and organizational size

4 RESEARCH METHOD

The data for this paper was extracted from an online survey conducted in Australia in the first quarter of 2010. The sampling frame was 1000 CIOs and IT managers were from a cross-section of business and government organizations. Invitation to participate in the survey was e-mailed together with the Web address of the questionnaire to potential respondents. After two rounds of reminders, a total of 176 completed responses from a cross sector of industries were received (see Table 1).

Industry Type	**Frequency**	**Employee Size**	**Percent**
Government Administration and Defense	35.8	20-99	10.8
Education, Health and Community Services	16.5	100-499	39.2
Manufacturing	11.4	500-999	15.3
Wholesale and Retail	9.7	1000-4999	26.7
ICT, Communications and Media	5.7	5000+	8
Personal, Professional and other Services	6.3		
Finance, Insurance, Business Services	14.8		
Total	**176**		

Table 1. Industry and Employee Number of Organizations

4.1 Measurement of Variables

The research deals with two sets of variables- organizational eco-motivations and Green IT adoption. The measures are summarized in Table 2. There are a number of technologies and practices that can be considered as Green IT (Corbett 2010, Molla 2009, Chen et al 2008, Info~tech, 2007). These include data center specific technologies such as server and storage virtualization, end user technologies such as desktop virtualization and practices such as policies for environmentally responsible IT procurement and disposal and for using IT to manage emission.

Given the complexity of Green IT, we choose only technologies and practices that focus on pollution prevention and product stewardship. Unlike Chen et al's (2008) work which only used a proxy measure of Green IT adoption, we use both actual scope of implementation and proxy and measures. To measure Green IT, six items were polled from Molla (2009), Chen et al, (2008) and Info~tech (2007) (Table 2). Three of the indicators refer to technologies that improve the energy efficiency of IT infrastructure and subsequent pollution reduction. These technologies are identified based on the survey findings of Molla (2009) and Info~tech (2007). These two surveys have indicated that server and storage virtualization and consolidation are the most widely used technologies to improve the energy efficiency of IT infrastructure. The other three items are adopted from Molla et al (2009) and Chen et al (2008) and refer to product stewardship issues focusing on IT lifecycle management from procurement to end of life IT management. Respondents were asked to indicate the extent to which they have implemented each of the technologies and practices on a six point scale with 1 representing no implementation and 6 for large scale (best practice) implementations.

The four eco-motivation variables were measured based on the instrument adopted from Molla (2009). Molla (2009) developed scales to measure eco-efficiency, eco-effectiveness, eco-legitimacy and eco-responsiveness based on a survey of CIOs in Australia, New Zealand and USA. Eco-efficiency was measured based on three items that emphasize cost reduction considerations in the adoption of Green IT. Eco-effectiveness was measured based on three items that focus on internal motives. Eco-legitimacy was measured based on four items that emphasize pressure from institutional forces. Eco-responsiveness was measured based on three items with emphasis on market forces' actions. All items were assessed on a six point Likert scale with one representing strongly disagree and six strongly agree.

The two control variables- industry and size-were measured using ordinal scales of whether an organization belongs to one of the seven industry and the five size categories (see Table 1) respectively.

5 ANALYSIS AND RESULTS

The data are analyzed using exploratory (such as exploratory factor analysis) and analytical (such as SEM- structural equation modeling) techniques. Using Maximum Likelihood extraction technique and Direct Oblimin rotation method, five factors were identified (See Table 3). The final factor structure containing fifteen items was obtained. The items that are purported to measure eco-legitimacy did not significantly load to any variable either independently or as a coherent group. Therefore the variable was dropped from further analysis. However, before dropping the variable, we conducted a confirmatory factor analysis (CFA) analysis which showed poor fit of eco-legitimacy measurement model to the data. The factor model for Green IT adoption identified two separate factors. Looking at the items loadings of the two factors and following Molla (2009), we labeled the first group (GIT1,2,3) as Green IT Technologies (GITTS) and the second group (GIT4,5,6) as Green IT Policy and Practice (GITPP).

Variable	Description	Items	Reference
Green IT	Implementation of technology and practices whose main purpose is to improve IT stewardship and reduce energy consumed by the IT infrastructure and IT related pollution	To what extent has your organization implemented the following GIT1: Server virtualization GIT2: Storage virtualization GIT3: Storage consolidation GIT4: Environment-friendly IT procurement policy GIT5: Policy on managing electronic waste GIT6: Measuring the environmental impact of IT	Chen et al (2008); Info~tech (2007); Molla (2009)
Eco-efficiency motives	Desire to improve eco-sustainability while at the same time pursuing economic objectives	How important are the following factors in DRIVING your organization towards implementing Green IT EcoEffi1: Cost of server energy consumption EcoEffi2: Efficiency of powering our ICT infrastructure EcoEffi3: Cost of desktop energy consumption	Molla (2009)
Eco-effectiveness motives	Eco-sustainability motives associated with beliefs and value system of the organization out of deep concern for the natural environment and to achieve socio-political outcomes	How important are the following factors in DRIVING your organization towards implementing Green IT and IT for Green EcoEff1:The organization's sustainability strategy EcoEff2: Corporate Social Responsibility EcoEff3: Senior management commitment	Molla (2009)
Eco-responsiveness motives	Desire to improve eco-sustainability either due to green opportunities or in response to actions and/or demands of competitors, customers, suppliers and market forces	How important are the following factors in DRIVING your organization towards implementing Green IT EcoRe1: The actions of our competitors EcoRe2: Pressure or marketing from ICT vendors EcoRe3: Market incentives	Molla (2009)
Eco-legitimacy motives	Desire to improve eco-sustainability due to political and social pressures facing a company	How important are the following factors in DRIVING your organization towards implementing Green IT EcoLe1: Government energy efficiency regulations EcoLe2: Encouragement from industry associations EcoLe3: Greenhouse gas regulations EcoLe4: Regulations on discarding e-waste	Molla (2009)

Table 2. Operationalization of Research Variables

The discriminant validity of the measurement model was tested using confirmatory factor analysis (CFA). First, each of the factors identified from the EFA were independently evaluated to test if the measurement models fit the data. During this process, two items (EcoEff3 and EcoRe2) were dropped but the remaining factors hold the structure identified from the EFA (see last two columns of table 3). Second the entire measurement model (network) was evaluated whether it fits the data. The result shows that the measurement model fits the data ($\chi^2 = 11.27$ at p =0.055; CMIN/DF=1.25; CFI = 0.98; NFI = 0.92 and RMSEA= 0.038; DF= 89). Overall, the EFA, CFA, comparison of the average

variance extracted (AVE)[1] to inter-construct squared correlation (Appendix 1) and reliabilities (Table 3) show that the measurement scale has acceptable psychometric properties.

Variable	Item	Exploratory Factor Analysis			Confirmatory Factor Analysis	
		Factor Loading	Cronbach's Alpha	AVE	λ	Goodness of fit measures
Green IT Technologies (GITTS)	GIT1 GIT3 GIT2	.703 .687 .660	0.84	0.64	.66 .63 .77	χ^2 = 1.726 at *P*= .189 CMIN/DF = 1.73 CFI= 0.993 RMSEA= 0.06
Green IT Policy and Practice (GITPP)	GIT6 GIT4 GIT5	.837 .789 .774	0.73	0.50	.77 .86 .77	χ^2 = 1.726 at *P*= .189 CMIN/DF = 0.87 CFI= 1 RMSEA= 0.05
Eco-effectiveness	EcoEff1 EcoEff2 EcoEff3	.920 .862 .671	0.85	0.68	.89 .89	χ^2 = 2.598 at *P*= .107 CMIN/DF = 2.59; CFI= 0.991; RMSEA= 0.09
Eco-Responsiveness	EcoRe1 EcoRe2 EcoRe3	.729 .727 .698	0.76	0.52	.79 --- .79	χ^2 = 3.490at *P*= .175 CMIN/DF = 1.745 CFI= 0.975 RMSEA= 0.06
Eco Efficiency	EcoEffi1 EcoEffi2 EcoEffi3	.819 .783 .780	0.86	0.63	.84 .79 .82	χ^2 = .284at *P*= .594 CMIN/DF = 0.99 CFI= 1 RMSEA= 0

Table 3. Validity and Reliability Analysis of Measurement Model

After ensuring that the model represents the data, the hypotheses were tested using SEM. Since the measure for eco-legitimacy did not pass the construct validity, H4 was not tested. We tested two separate models. In the first model (Figure 3a), we considered Green IT as a uni-dimensional dependent variable and calculated its composite score based on the six indicators (GIT1-6). In the second model (Figure 3b), we used the two Green IT domain substrata (GITTS and GITPP) identified from the EFA as dependent variables. The result shows that both the first (3a) (χ^2 = 17.409, d.f = 16 at p = 0.360; CFI = 0.998; RMSEA = 0.02; TLI= 0.996 and NFI = 0.973) and the second (3b) (χ^2 = 71.208, d.f = 57 at p = 0.098; CFI = 0.986; RMSEA = 0.04; TLI= 0.98 and NFI = 0.93) models represent the data very well. Both models (3a and 3b) show that there is strong support for H1 and H2 but not H3. The first model explains 38% of the variance in Green IT adoption. The second model explains 50% of the variance for Green IT technologies adoption and 25% of the variance for GIT policy and practice adoption. Furthermore, we test for the effect of the control variables by introducing them one at a time as constraints into each model and checking if the parameters of the constrained model are different from the unconstrained model. Both industry (Δx^2=60.39, $\Delta_{d.f}$=57, p > 0.05) and size (Δx^2=81.8, $\Delta_{d.f}$=57, p > 0.05) do not show any significant impact about the influence of eco-motivations on the adoption of Green IT, thus H5 is not supported.

[1] The AVE value for the measurement model (after EFA) is 0.62

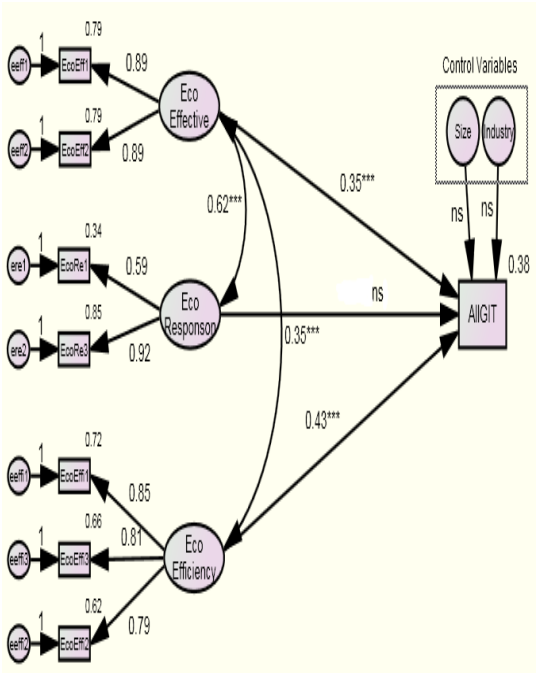

Figure 3a

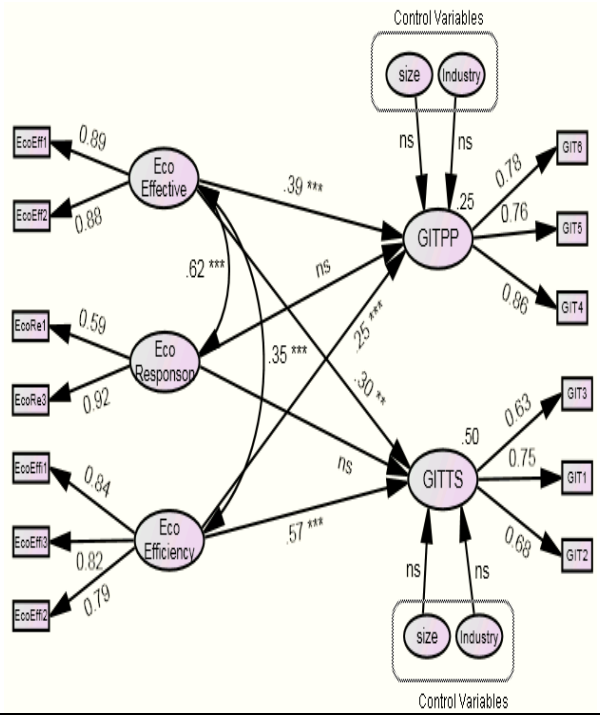

Figure 3b

**** Significant at 0.01; ** significant at 0.05; ns: not significant*

Figure 3. Results of SEM for Green IT Adoption

6 DISCUSSION

This study examines the influence of eco-sustainability motivations on the adoption of Green IT. The study has focused on four eco-motivations at the intersection of the locus (internal vs. external) and focus (economic vs. socio-political) of motives. We control for the effects of organizational size and industry. The empirical analysis shows four major findings that contribute to Green IT research and practice.

First, from the descriptive results of Green IT adoption, the most widely adopted Green IT relate to practices and policies to improve IT stewardship and prevent IT related pollution. Thus, 85% of all respondents have implemented environmentally-friendly IT procurement policies; 66% are measuring the environmental impact of IT and 50% have policies on managing electronic waste. These findings are consistent with Chen et al's (2008) finding, where policies for purchasing energy-efficient IT, evaluating the green track record of vendors in IT procurement decisions and disposing of IT in an environmentally friendly manner are among the most widely adopted Green IT practices. On the other hand, technologies that improve the energy efficiency of IT are not as widely adopted. Only 31, 26 and 38% of respondents have adopted server virtualization, storage virtualization and storage consolidation respectively. This finding suggests that organizations' green intentions (via policies and measures), have yet to be translated into actual actions and investments in green initiatives such as virtualization.These findings add to the empirical base of Green IT research.

Second, the structural model indicates that the locus of motives for the adoption of Green IT is mainly internal whereas the focus of the motives combines both economical as well as socio-political goals. In particular, eco-effectiveness and eco-efficiency emerge as the most important motives to influence the adoption of Green IT. Amongst these motives, while eco-efficiency has the strongest effect on the adoption of Green IT technologies, eco-effectiveness has the strongest effect on the adoption of Green

IT policy and practices (see figure 3b). This implies that within the sample organizations, a sense of corporate responsibility and environmental strategy are important predicators of the development and implementation of IT specific green policies. This is because when organizations formulate environmental strategies, they sometimes are motivated by the desire to pursue leadership in setting voluntary standards, environmental excellence and differentiation (Oresato, 2006). Furthermore, an organization's sense of social responsibility has been shown to be an important motivator for the adoption of corporate sustainability practices (Hahn & Scheermesser 2006).

Third, the finding regarding the impact of eco-efficiency as the most significant motivator of Green IT (figure 3a) corroborates Sayeed and Gill's (2008) case study which identified cost cutting and energy conservation as the main reasons for undertaking Green IT initiatives. This implies that when it comes to actual investments in technologies, the "bottom-line" view which underlines organizational desire to reduce operating costs and minimize environmental impacts of business processes dominates (Dedrick 2010; Orsato, 2006). Olson (2008) argues that Green initiatives take longer period to break-even. He further postulates that rather than hard dollar gains, softer benefits such as employee morale and good corporate citizenship motivate adoption. Further, Gonzalez's (2005) study of the adoption of environmental technologies identified better corporate image and the pressure of regulation as the main reasons for adoption. Our findings of motivations for adopting IT that can improve energy efficiency differ from Olson's (2008) assertion and Gonzalez's (2005) findings. However the significant covariance between eco-effectiveness and eco-efficiency imply that there might be interaction effects at play that need to be tested in future studies.

Fourth, the finding also suggests that the influence of market forces is insignificant at this stage. A number of IT vendors are marketing their products as green solutions and are at the forefront of setting the Green IT agenda. Our findings suggest that the influence of vendors and competitors' actions in motivating organizations to adopt Green IT has yet to emerge. This could be because there are a few organizations that leverage the investment in Green IT as potential source of competition. This trend might change as organizations start recognizing the strategic value of Green IT. Thus, pressure from market forces becomes a relevant mimetic motive when early adopters demonstrate favorable outcome out of their green practices (Chen et al 2008). Further, as Green IT can be considered at the early stage of development, it remains to be seen if economic concerns continue to dominate as the primary reasons for Greening IT or if market forces and regulatory considerations start to play in.

7 CONTRIBUTION AND CONCLUSION

This study examines how motivational factors influence the adoption of Green IT and IT for Green. Our research framework draws from the motivation theory and with a survey of 176 Australian organizations tests the impact of the four eco-motives identified in Molla's (2009) Green IT Motivation Grid. While one of the eco-motives failed the construct validity test and is therefore excluded from subsequent analysis, the model demonstrates a good fit with the data. Based on the hypotheses test, eco-efficiency and eco-effectiveness are found to strongly influence the adoption of Green IT.

The paper has several implications for research and practice. In terms of research, this paper addresses the call for a body of IS empirical research that studies the factors influencing adoption of green technologies (Dedrick 2010, Melville 2010). The study therefore represents one of the few empirical studies on the adoption of Green IT. The paper empirically tests the effect of eco-motivations identified in a previous study. Thus, it contributes to the emergence of a cumulative tradition in Green IT research. By separating the direct effects of IT on eco-sustainability from the indirect effects and focusing on the direct effect only, we have also shown a conceptual clarity about what constitutes Green IT and what not. Some studies, for example Kuo and Dick's (2009), mix both Green IT (the direct effect) and IT for Green (the indirect effect).

The research makes an original contribution by applying a motivational perspective to study the factors that influence Green IT. The result shows that the models explain 38% of the variation in Green IT adoption overall and 50% and 25% of the variance in Green IT Technologies (GITTS) and Green IT Policy and Practices (GITTP) respectively. For comparison, whilst Chen et al's (2008) institutional theory based model explains 35%, 29% and 27% of the pollution prevention, product stewardship and sustainable development policies and practice respectively in Green IT and Green IS, Kuo and Dick's (2009) organizational capability model explains 33.5% variance in Green IT. Thus researchers can use the models and hypotheses developed in this study in future studies either on their own or in combination with other perspectives. The paper also contributes to the use of organizational motivation theory to IT research. Organizational motivation theory is a theoretical lens that is not widely used in IT empirical research (Rahim and Shanks, 2010).

In terms of practice, the fact that eco-effectiveness and eco-efficiency are important determinants of Green IT adoption implies that there is a positive tangible (such as cost saving) and intangible (such as environmental thought leadership) gains associated with Green IT. Thus when regulatory and market mechanisms are either not strong enough or unclear to encourage the adoption of Green IT, managers that aim beyond regulatory compliance are likely to benefit from investing in Green IT. Organizations can signal the desire for ecological innovation through the development of policies and the provision of supervisory support and incentives. However, employees' perception and attitude is as equal, if not more, important as management's commitment and resource allocation in the transformation to a sustainable IT operation. Thus, organizations can take advantage of their employees' values and concern about the environment to identify Green IT opportunities and encourage green innovations.

We acknowledge the following limitations of the study that open avenues for future research. First the three eco-motives might not work in isolation and interactive effects are likely to have some influence. Future research that tests how the interactions between the eco-motives influence Green IT will shed interesting insight. Second, the measurement model for eco-legitimacy did not pass the construct validity test. Future studies can develop better measures to operationalize this construct. Related to this, both the field of Green IT and the organizational motivations towards eco-sustainability are likely to evolve. Therefore, revising the items for operationalizing both Green IT and the four eco-motives become important. Finally, the data were collected from Australia only. This limitation implies that the generalization of the findings documented here to other environments should be cautioned and requires further research. Future studies covering several countries would shed light over interesting questions such as: do the patterns identified in this study prevail in other environments? What other relationships exist and how are they different from the patterns that emerged in this study? The model described in this study constitutes a contribution to guide such further studies.

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Appendix 1: Correlations among Constructs

	GITTS	**GITPP**	**Eco-Effective**	**Eco-Efficiency**	**Eco-Response**	**Mean**	**Std. Dev.**
GITTS	1					2.99	1.24
GITPP	0.421, p< 0.01	1				3.97	1.39
Eco-Effectiveness	0.376, p< 0.01	0.429, p< 0.01	1			4.13	1.61
Eco-Efficiency	0.668, p< 0.01	0.384, p< 0.01	0.364, p< 0.01	1		4.66	1.24
Eco-Responsiveness	0.010, ns	0.171, p< 0.10	0.623, p< 0.01	0.023, ns	1	2.59	1.29

ns = non-significant