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Green IT Assimilation: Comparing the Influence of Contextual and Absorptive Capacity Based Models

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Abstract

As Green IT is a relatively new area in Information Systems research, the first wave of research has often focused on organisations' adoption of Green IT. In this study, we look beyond the initial adoption and investigate the assimilation of Green IT by organisations. We draw from and compare two theories – contextual theory and absorptive capacity – and investigate which of the two theories better explains the level of Green IT assimilation. Results from an international survey of 148 large organisations show that both theories explain Green IT assimilation, however while contextual theory has a medium to large effect, absorptive capacity has a small to medium effect.

Keywords

Green IT, Green IS, Assimilation, Absorptive Capacity, Organisation Technology Environment Context.

INTRODUCTION

Gartner first featured Green IT, narrowly defined as data centre energy efficiency, as one of the top 10 strategic technologies in 2007. In Gartner's terms, a strategic technology refers to a "technology with the potential for significant impact on an enterprise within three years. Factors that denote significant impact include a high potential for disruption to IT or the business, the need for a major dollar investment, or the risk of being late to adopt". Since then, Green IT has attracted the attention of both practitioners and researchers and has moved from a narrower conception and practice of data centre energy efficiency to cover strategies, practices and technologies that improve the environmental footprint of the production, use and disposal of IT such as computers, servers, and associated subsystems (Murugesan 2008) and that influence the beliefs and actions of IT professionals in preventing pollution, improving product stewardship and contributing to sustainable development (Molla *et al.* 2011).

A number of previous studies have contributed to the understanding and practice of Green IT, however defined. All are important in guiding practice, informing policy, disseminating good practices and building a cumulative body of knowledge that is beginning to make an impact. For the IS discipline, continued Green IT research demonstrates IS scholarship and scholars' engagement with and contribution to the development of environmentally sustainable social and business practices. Our overall intention in this paper is therefore to build on and contribute to the emerging Green IT body of knowledge by tackling three issues.

First, a number of the Green IT studies (Chen *et al.* 2010; Gholami *et al.* 2013; Rush and Melville 2012; Thongmak 2012; Zarnekow *et al.* 2010) focus on Green IT adoption. The adoption of a new technology implies the initial success and tells little if that technology has moved beyond the initial trial and becomes embedded into the routines of organisations, that is, the extent to which it is assimilated. Technology assimilation reflects to what extent a technology is utilised, both in terms of depth and breadth, and helps to unravel how organisations and other adopting entities leverage the advantages of a given technology (Zhu *et al.* 2006). In this paper, we focus on Green IT assimilation and extend previous Green IT adoption studies.

Second, theoretically, studies of Green IT mostly draw from contextual, such as the organisation, technology and environment (OTE) framework (Dao *et al.* 2011), diffusion of innovation (Bose and Luo 2011), institutional (Chen *et al.* 2010), and motivational (Molla and Abareshi 2012) theories. While these theories provide useful insight, we argue that a learning, that is, absorptive capacity, perspective might provide as good an explanation as

these theories but is largely missing, excepting (Cooper and Molla 2012a, 2012b), from previous Green IT literature. As environmental sustainability, which is the ultimate goal of Green IT practice, is inherently linked to learning and innovation, a learning perspective is important to Green IT research. Indeed while absorptive capacity, defined as the ability to recognise the value of new and external information, assimilate and apply it has been used in understanding IT (such as enterprise systems) assimilation (Roberts *et al.* 2012), this will be the first study to explore Green IT assimilation from a learning and absorptive capacity perspective.

Third and related to the second point, unlike previous studies of Green IT which mostly draw from a single theory, by comparing the absorptive capacity and contextual models we investigate which of the two theories provide a better explanation of Green IT assimilation. This has important implication for influencing managerial practice as well as advancing the theoretical foundation of Green IT scholarship. We are not aware of other Green IT research that attempted such an exercise.

The research questions we address are, therefore, *what influences Green IT assimilation?* and *which of the two theories – absorptive capacity vs. contextual, better explain variation in Green IT assimilation?* The remaining part of the paper is organised as follows. We first provide an overview of Green IT, IT assimilation and absorptive capacity. Next, we specify the models and develop the hypotheses and describe the research method. We then present and discuss the results. We conclude the paper with a summary of contributions, limitations and possibilities for future work.

BACKGROUND LITERATURE

Three areas of literature are relevant – Green IT, IT assimilation and absorptive capacity and are discussed in the following section.

Green IT

Green IT encompasses a number of practices and technologies including server and storage virtualisation (Bose and Luo 2011); data centre airflow and power management (Alaraifi *et al.* 2013); electronic waste management (Zarnekow *et al.* 2010); personal computer power management (Thongmak 2012); IT procurement practices that consider environmental criteria (Molla and Abareshi 2012); policies that prescribe the consideration of environmental criteria in both procuring and disposing IT and that encourage use of renewable energy to power the IT infrastructure (Chen *et al.* 2010); and the environmental awareness of IT managers and professionals (Gholami *et al.* 2013; Thongmak 2012).

Some of the key reasons for undertaking Green IT initiatives include the rising cost of energy (Alaraifi *et al.* 2013); environmental legislation regarding e-waste disposal and energy efficiency (Bose and Luo 2011); coercive, and mimetic pressures (Chen *et al.* 2010; Gholami *et al.* 2013); and organisational factors such as the importance of corporate strategy and public perceptions (Molla and Abareshi 2012). Further, within an organisation, top management support influences the perceived importance of Green IT which in turn influences the portion of overall IT spending allocated for and invested in Green IT (Mithas *et al.* 2010; Zarnekow *et al.* 2010). As indicated earlier in the introduction, most of these Green IT studies tend to focus on adoption and not assimilation. In the following section we discuss the IT assimilation construct.

IT Assimilation

IS researchers have distinguished between diffusion, the process whereby technology spreads across a population, and assimilation, being the process by which progress from initial awareness of an innovation to formal adoption and full-scale deployment is made. The “IT assimilation” construct has been defined in the IS literature in different ways. Massetti and Zmud (1996) provided one of the most widely used definitions of IT assimilation constituted of four facets: volume, diversity, breadth and depth. Volume represents the percentage of an organisation's processes that are handled through a system. Diversity refers to the variety of business functions that are performed routinely through a system. Breadth represents the extent to which an organisation has used a technology to conduct routine functions and depth refers to the degree of a system’s functionalities that has been established in performing the business processes. This definition is suitable for capturing the assimilation of a single system. So IT assimilation can also be defined as “the extent to which the use of technology diffuses across organizational projects or work processes and becomes routinized in the activities of those projects and processes” (Roberts *et al.* 2012).

In understanding IT assimilation, while most researchers draw from the context-based OTE framework (Liang *et al.* 2007; Tornatzky *et al.* 1990; Zhu *et al.* 2006), a few follow the absorptive capacity perspective (Roberts *et al.* 2012). The OTE provides a generic foundation that integrates the organisational, technological and environmental contexts to understand the factors that could affect the assimilation of technologies. However, the factors that constitute the three contexts differ from one study to another. For example, Zhu *et al* (2006) identify technology readiness, technology integration, firm size, global scope, managerial obstacles, competition intensity

and the regulatory environment as important contextual explanations of e-business assimilation. The determinants of ERP success have been identified as (a) the technological context of ERP attributes and expertise; (b) the organisational context of top management support, strategic alignment, managers' and users' involvement, reward systems and culture; and (c) the environmental context of institutional pressures and consultant effectiveness (Kouki *et al.* 2010; Liang *et al.* 2007).

Despite the differences in what constitutes the OTE contexts, the technological context refers to existing and new technology; the organisational context to firms' characteristics such as structure, size, scope and resource availability, and the environmental context to the realm in which an organisation performs its business such as industry, market, and government regulation (Tornatzky *et al.* 1990). While OTE factors can provide the contextual factors that influence IT assimilation, they do not capture the dynamics of learning, thus a few researchers have followed the absorptive capacity perspective.

Absorptive Capacity

Absorptive Capacity (ACAP) was first introduced to an organisational context by Cohen and Levinthal (1990) and refers to the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends. While scholars have shown great interest in the ACAP and its underlying constructs there is no consensus as to how ACAP should be conceptualised. One popular, and the most frequently cited model, is provided by Zahra and George (2002) who identify that ACAP comprises four interlinked processes: acquisition, assimilation, exploitation and transformation. Acquisition refers to a firm's capability "to identify and acquire externally generated knowledge that is critical to its operations" (ibid, p.189) and assimilation, being the firm's "routines and processes that allow it to analyse, process, interpret and understand information obtained from external sources" (ibid, p. 189). Transformation represents the firm's capability to "develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge" (Zahra and George 2002, p. 190) along with exploitation, which is the firm's ability to "refine, extend and leverage existing competencies or to create new competencies by incorporating transformed knowledge into its operations" (ibid, p. 190).

MODEL SPECIFICATION AND HYPOTHESIS DEVELOPMENT

Based on the review of the literature, in this section we introduce the two models and related hypotheses.

Model 1- Context-based Model of Green IS Assimilation

Because Green IT covers a range of technologies, practices and policies, we chose only the organisational and environmental contexts and excluded technological context (Figure 1). This is because the technological context, which usually describes the characteristics of technology innovation, works best if one is interested in a single technology or innovation rather than a cluster of innovations such as Green IT. Generally speaking, organisational context refers to descriptive measures such as slack resources, structural characteristics and the characteristics of leaders (such as their commitment) (Fichman 2000). Top management support and managerial knowledge are often cited as key elements in facilitating the assimilation of IT. Top management support, especially to support long term strategies and the use of technology provides a positive environment for the success of Green IT. Environmental commitment of managers can for example, lead organisations to embrace Green IT strategy. Actions undertaken by senior management can introduce complementary structures to facilitate Green IT assimilation, and modify and reinforce the norms that value the use of Green IT. There is a greater likelihood of Green IT assimilation when positive top management mind-set has been communicated effectively to the users. Thus we hypothesize

> HC1: Organisational context such as top management commitment, formal structure and resource commitment positively influences Green IT assimilation

Environmental context refers to the institutional and market environment within which organisations operate. Market and regulatory forces, when present and mature, can create conducive conditions for widening and deepening Green IT implementations (Molla and Abareshi 2012). Stakeholders such as suppliers, customers, industry associations and regulatory agencies have influenced the assimilation of technologies within data centre (Alaraifi *et al.* 2013) and Green IT policies (Chen *et al.* 2010). Market and non-market external pressures, in addition to directly affecting Green IT assimilation, can also influence managers to improve their environmental performance (Gholami *et al.* 2013). Therefore, as the institutional, industry and market dynamics for Green IT become favourable, organisations might commit resources, structure and support towards either exploring or exploiting various Green IT technologies and practices. On the basis of these, we formulate the following two hypotheses

> HC2: The environmental context for Green IT such as market, regulatory and institutional factors positively influences Green IT assimilation

HC3: The environmental context for Green IT positively influences the organisational context for Green IT

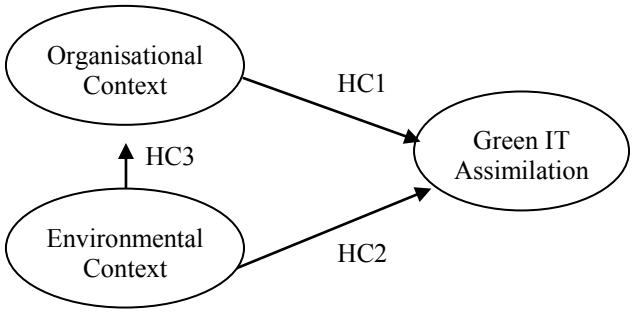

Figure 1: Context-Based Model of Green IT Assimilation

Model 2- Capability Based Model of Green IT Assimilation

Both the environmental sustainability and IS literature use absorptive capacity to understand the adoption of environmentally friendly technologies and IT assimilation respectively. In terms of environmental sustainability, Gluch *et al.* (2009) found that in the construction industry ACAP explains green innovation and environmental performance. Absorptive capacity has been found to explain the undertaking of proactive environmental strategy (Delmas *et al.* 2011), environmental commitment of Canadian SMEs (Roy and Thérin 2008), the diffusion of clean technology in the Spanish Pulp and Paper industry (del Río González 2005) and the development of clean technology and production (Vickers 1999).

In terms of IT assimilation, Roberts *et al*. (2012) provide a comprehensive review of the ways in which IS researchers have conceptualised, analysed and measured absorptive capacity. Their review of 98 papers highlights that one of the themes in the application of ACAP in IS research is IT assimilation. IS researchers have consistently found that there is a positive relationship between absorptive capacity and IT assimilation as high absorptive capacity in a domain increases the capability of the organisation to assimilate complex innovations in that domain (Roberts *et al.* 2012; Sharma *et al.* 2012). Thus IT education (e.g. new technology education and learning) and IT capabilities (e.g. investment in IT infrastructure), often triggered by external institutional pressures (Saraf *et al.* 2012), have been found to increase related knowledge and the diversity of knowledge held (i.e. absorptive capacity). This in turn improves IT assimilation. Further, Cooper and Molla (2012b), using a case study approach, have developed a set of propositions linking the processes of ACAP and Green IT capability development. Most studies also report that the ACAP of acquisition and assimilation, which are often referred to as potential absorptive capacity, indirectly, that is, through the ACAP of exploitation and transformation, usually known as realised absorptive capacity, influence assimilation. Based on Cooper and Molla (2012b); Gluch *et al.* (2009); Saraf *et al.* (2012); Sharma *et al.* (2012), we formulate the following six hypotheses (Figure 2)

HA1: The higher level of Green IT knowledge exploitation will lead to higher level of Green IT assimilation

HA2: The higher level of Green IT knowledge transformation will lead to higher level of Green IT assimilation

HA3: The higher level of Green IT knowledge acquisition will lead to (a) higher level of Green IT knowledge exploitation and (b) higher level of Green IT knowledge transformation

HA4: The higher level of Green IT knowledge assimilation will lead to (a) higher level of Green IT knowledge exploitation and (b) higher level of Green IT knowledge transformation

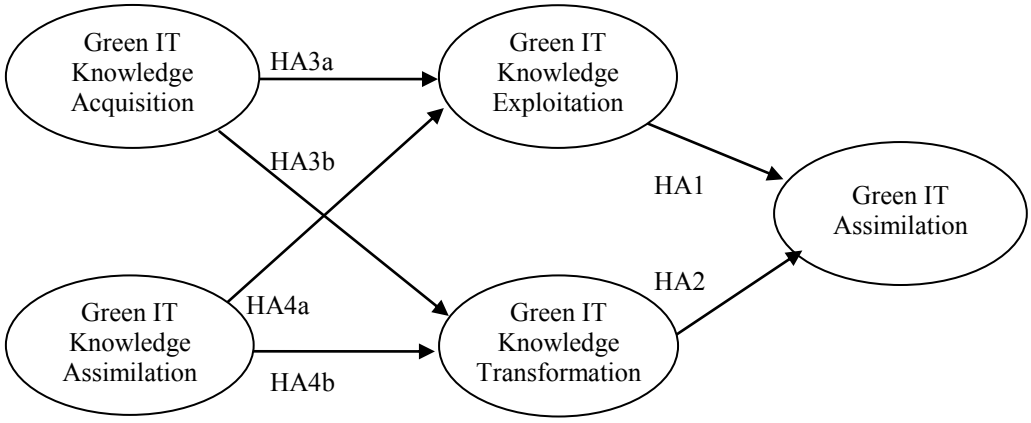

Figure 2: ACAP-based Model of Green IS Assimilation

RESEARCH METHOD

The data used in this paper was collected using a survey of IT managers from large Australian, New Zealand and US organisations. The survey had 179 responses (109 Australian; 21 New Zealand, 14 U.S. and 35 missing) out of which 148 were usable. Eighty percent of the respondents were senior IT managers (such as CIOs) working in large organisations (71%) (more than 500 full time equivalent (FTE) employees) in the services (23%), manufacturing (20%), utilities and transport (12%) and education and government (20%) sub sectors. The IT departments of most of the respondents' (72%) organisations have more than 10 FTE staff.

Respondents were asked to respond to questions on a five point Likert scale ranging from 1 = Very Low to 5 = Very High. Green IT assimilation is measured based on five items adopted from the G-readiness instrument (Molla *et al.* 2011). Organisational context is measured based on (Fichman and Carroll 1999) using three items covering top management support, formal organisational structure and resource commitment. Three items are drawn from Molla and Abareshi (2012) to capture the environmental context of regulatory, industry and market dynamics to benefit from Green IT. Items to operationalise the ACAP constructs are adopted from Gluch *et al.* (2009) and Zahra and George (2002). Here six items are used to capture the ability to acquire new knowledge on Green IT; four items to measure assimilation, that is, the routines and processes to interpret external knowledge; four items to assess the mechanisms for transforming and integrating new knowledge with existing knowledge, and four items to measure the routines and processes to exploit Green IT knowledge. See Appendix 1 for the list of questions and items.

The psychometric property (that is reliability and validity) of the instrument was tested using Partial Least Square. The result shows that the measurement model is valid and reliable. In terms of convergent validity, all factor loadings are greater than 0.7 and the average variance extracted is greater than 0.5 (See Appendix 1). The composite reliability and Cronbach alpha values are also greater than 0.7 providing evidence of internal consistency of the measures. Further, the square root of the AVE is larger than the off diagonal inter-construct correlation (see Appendix 2) and supports discriminant validity.

RESULTS AND DISCUSSION

After the instrument was validated the structural models were tested using Partial Least Square-Structural Equation Modeling (PLS-SEM) (see Table 1). PLS-SEM was selected because of its relative robustness in working with smaller and larger samples; flexibility achieved by having few limiting assumptions regarding the model specifications and data; provision of parameter estimates that maximize the explained variance of dependent constructs (thus supporting prediction or theory building aims); and its ability to also be used for confirmatory theory testing and model comparison (Hair et al. 2014).

Table 1 Structural Model Results and Comparison

Model	Hypothesis	Paths	Path Coefficient	t values	sig	R^2	R^2_{adj}	Q^2	f^2 Effect size	q^2 Effect size
Context	HC1	Organisational Context -> Green IT Assimilation	0.49	5.61	***	0.59	0.59	0.43	0.40	0.21
	HC2	Environmental Context -> Green IT Assimilation	0.34	3.52	***					
	HC3	Environmental Context -> Organisational Context	0.66	12.78	***	0.44				
Absorptive Capacity	HA1	Exploitation -> Green IT Assimilation	0.31	2.95	**	0.54	0.55	0.40	0.25	0.15
	HA2	Transformation -> Green IT Assimilation	0.46	4.38	***					
	HA3a	Acquisition -> Exploitation	0.16	2.14	*	0.62				
	HA4a	Assimilation -> Exploitation	0.66	8.77	***					
	HA3b	Acquisition -> Transformation	0.22	2.96	**	0.66				
	HA4b	Assimilation-> Transformation	0.64	8.41	***					

*Significant at 0.05; ** Significant at 0.01; ***Significant at 0.001; ns Not Significant

To estimate the significance of the path coefficients, 5000 sample bootstrapping was performed (Hair Jr *et al.* 2014). As indicated in Table 1, all paths of the two models are significant at a 0.05 confidence level and most at a 0.01 confidence level thus supporting all of the theoretical hypotheses. The contextual model explains 59% of the variance of Green IT assimilation whereas the ACAP model explains 54%. In addition, environmental context explains 44% the variance in organisational context, and Green IT knowledge acquisition and assimilation explain 66% of the variation in Green IT knowledge transformation and 62% of the variation in Green IT knowledge exploitation. Further, all of the variables in the two models significantly influence Green IT assimilation such that the total effects of the exogenous variables, that is, Green IT knowledge acquisition, Green IT knowledge assimilation, and environmental context on Green IT assimilation are 0.16 (*p= 0.05*), 0.49 (*p=0.01*) and 0.67 (p=0.01) respectively. This means of all the variables included in the two models, environmental context has a higher magnitude of total (direct and indirect) effect (but with medium effect size) whereas organisational context has a higher magnitude (Table 1) of direct effect (with medium effect size) on Green IT assimilation.

To compare the two models, following Hair *et al.*'s (2014, pp. 176-86) recommendations, we have used several tests, such as effect sizes, adjusted R^2 and Q^2 (see Table 1). Although both models explain more than 50% of the variance in Green IT assimilation, the model comparison test results show that the contextual model has a relatively larger adjusted R^2 and Q^2 values with a medium to large effect size whereas the ACAP model has relatively lower adjusted R^2 and Q^2 values with small to medium effect size. This means, at least in the current sample, organisational and contextual factors provide a marginally better explanation of why and how widely and deeply Green IT practices, technologies and values are embedded in the IT people, in the IT management and IT infrastructure of organisations.

With regards to the contextual model, the support for Hypothesis C1 indicates that organisational context has a strong impact on Green IT assimilation (0.49). The support of senior managers has been found to impact on IT assimilation generally (Armstrong and Sambamurthy, 1999) and this has been found to be transferrable to the context of Green IT assimilation. In Fischman and Carroll's (1999) review of factors having an impact on IT diffusion and assimilation, the communication environment was found to be important, as was structural characteristics of an organisation – although with mixed results. Some studies found that organisations with lower centralisation, formalisation and vertical differentiation are more likely to innovate, whereas other found that such firms will have difficulty reaching consensus about adopting innovations and less likely to sustain them. Our study suggests that there is a need for formal structures that enable the exchange of ideas to enhance Green IT assimilation. Further, the provision of sufficient resources will increase Green IT assimilation and this is consistent with wider research in IT assimilation whereby a firm's 'slack resources' and investment in, for example, training, affects IT assimilation (Fischman and Caroll, 1999).

The support for Hypothesis C2 shows that the environmental context has a medium effect on Green IT assimilation (0.34). Market demand for Green IT products, processes and services was found to have a positive effect on Green IT assimilation in our study, which is consistent with the work of Molla and Abareshi (2012) wherein market forces were identified as a motive of early adoption of Green IT practices. Institutional and industry dynamics were perceived to impact the ability of firms to assimilate Green IT. This finding, while consistent with studies that highlight institutional drivers as impacting on a firm's environmental performance (e.g. Zalani et al., 2012), is inconsistent with the finding of Melville and Salandha (2013) in their investigation of the antecedents for adoption of carbon management systems. This may be because their study operationalized external environmental factors in terms of global climate agreements whereas our survey did not tap into such agreements specifically. Through support for Hypothesis C3, our study indicates that the environmental context has a strong impact in terms of shaping the organisational context (0.66). This suggests that institutional theory (DiMaggio and Powell, 1983) may shed further light on organisations' response to environmental factors as they pertain to Green IT.

With regards to Model 2, absorptive capacity, the support for Hypotheses A2 and A1 indicates that firms that are able to transform and exploit a higher level of Green IT knowledge will be better able to assimilate Green IT. In the context of environmental innovation in the construction industry, Gluch *et al.* (2009) found that both transformation and exploitation capabilities impact green innovation and performance but transformation had a greater effect. Our study too, identified that transformation had a greater impact on Green IT assimilation than exploitation. However in contrast to Gluch *et al.* (2009) who identified a linear path from acquisition, assimilation, transformation through to exploitation in explaining environmental innovation, our study suggests that the processes within absorptive capacity do not necessarily follow a simple or a linear path. For example, the support of Hypotheses A3(b) and A3(a) show that a higher level of Green IT knowledge acquisition has an impact on the level of Green IT knowledge transformation (0.22) as well as exploitation, albeit to a lesser extent (0.16). Consistent with Gluch *et al.* (2009) our study indicated through support of H4(b) that there is a strong relationship between Green IT knowledge assimilation and Green IT transformation (0.64), however, whereas

Gluch *et al.* (2009) did not highlight a direct impact on knowledge assimilation and knowledge exploitation, our study, through support of Hypothesis A4(a) indicates that there is such an impact (0.66).

Interestingly, of all the variables in the absorptive capacity model, Green IT knowledge transformation was found to have the largest direct effect on Green IT assimilation while the others had a relatively small effect. This suggests that managers might consider focusing their efforts and limited resources on transformation processes. Transformation processes are concerned with developing and defining routines that combine new knowledge with existing knowledge, that is, embedding knowledge across the organisation such that it becomes institutionalised. In addition, developing and refining Key Performance Indicators (KPIs) is central to Green IT knowledge transformation and this can be undertaken through balanced scorecard approaches to Green IT performance measurement (Wati and Koo 2011). Yet the dominance of Green IT knowledge transformation in explaining Green IT assimilation does not render the other variables unimportant. Green IT knowledge acquisition and assimilation processes both have explanatory power for transformation, indicating that there must be sufficient understanding of Green IT issues in the first instance.

Organisations more proficient at acquiring new knowledge from a diverse range of sources (e.g. from relationships with external stakeholders, participation in Green IT interest groups and undertaking formal Green IT training programs), were found to have a higher level of Green IT knowledge transformation (HA3b) that ultimately impacts the level of Green IT assimilation. This is consistent with Gluch et al. (2009) and Roy and Therin (2011), whereby knowledge acquisition mechanisms were found to be a 'gatekeeper' for external knowledge to be available to the other absorptive capacity processes that ultimately impact on environmental innovation and environmental commitment respectively. Our results also indicate that Green IT knowledge assimilation is the greatest predictor of Green IT knowledge transformation and thus warrants careful attention (HA4b). Other scholars have noted the importance of this relationship as it connects a firm's potential absorptive capacity with its realised absorptive capacity (Zahra and George 2002). Assimilation is concerned with the routines and processes that enable an organisation to analyse, interpret and understand newly acquired knowledge and is thus a meaning-creating process. Ensuring that IT staff understand Green IT issues and concepts is important for organisations to go on and transform wider organisational routines and processes and assimilate Green IT. Our results indicate that conducting a lifecycle analysis of IT products and services, from sourcing, operations, use and disposal, is useful in assimilating Green IT knowledge, as is developing plans of action to achieve environmental goals. Such activities can potentially focus the Green IT learning of staff so that it has practical relevance and outcomes for the organisation. Further, such learning activities might facilitate the development of appropriate KPIs during the Green IT knowledge transformation process and thus in part explain the strong relationship between assimilation and transformation processes.

CONCLUSION, LIMITATIONS AND FUTURE WORK

This study was set out to address the questions of what influences Green IT assimilation and which of the two theories – ACAP vs. contextual – better explain variation in Green IT assimilation. We have shown, via a contextual model, that market, institutional and industry dynamics of Green IT as well as top management, formal organisational structure and organisational resources influence Green IT assimilation. We have also shown, via a model of ACAP, that the Green IT knowledge acquisition, assimilation, transformation and exploitation processes equally influence Green IT assimilation. The results further demonstrate that both models explain more than 50% of the variation in the Green IT assimilation of the sample. The explanatory powers of the models are better than Chen et al's (2010) institutional theory based model, Molla and Abarehsi's (2012) motivational theory based model and Gholami et al's (2013) managerial perception and belief based model. This means researchers can use the models and hypotheses developed in this study in future studies.

In terms of which model has better utility to understand Green IT assimilation, while the contextual model has a large effect, the ACAP model has a medium effect. This finding has two implications. First, if one is seeking to choose between the two models, our results favour the contextual model, which can be further improved by adding the influence of technological context variables. Nevertheless, as Green IT can be considered at the early stage of development, it remains to be seen if contextual factors continue to dominate the assimilation of Green IT or if this might change in the future as organisations move from reactive strategies and start integrating Green IT as part of building and renewing their overall IT capabilities. Second, if one is seeking a more comprehensive understanding of Green IT assimilation, a model that draws from both contextual and ACAP theories and that integrates the external context as triggers of Green IT ACAP and the organisational context as moderating mechanisms for building Green IT ACAP can be considered. Our study provides the foundation for undertaking theory building and explanation of Green IT as well as for influencing IT-enabled actions for addressing environmental sustainability, which is an original contribution to the Green IT literature.

In addition, our study adds to the empirical base of Green IT literature and can be considered as one of the few empirical studies to look beyond initial adoption of Green IT to understand its assimilation. Thus, researchers can

use our findings to compare what factors are common to influence both the adoption and the assimilation of Green IT and what factors are unique to each construct domain.

The study has a number of limitations that offer avenues for future research. First, we have developed the models on the basis of a single sample and did not have a hold-out sample to re-test the model. Second, our study has focused on large organisations and future research might investigate how each model explains Green IT assimilation in a variety of organisations. Research comparing Green IS assimilation and wider IS assimilation in firms would be an interesting avenue for future research. Future research to incorporate the technology context within the contextual model would be useful in order to identify whether this influences the level of Green IT assimilation. Also, integrating contextual and ACAP models and theoretically extending the current work is another avenue for future study

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APPENDIX 1

Table A1: Measurement Model Validity and Reliability

Factor	**Item**	**Factor Loadings**	**CR**	**ά**	**AVE**
Organisational	Please rate the extent to which each the following has facilitated Green IT:				

Context	O_fos Formal organisational structures	0.89	0.91	0.84	0.76
	O_res Provision of sufficient resource	0.88			
	O_tms Top management support	0.84			
Environmental Context	Please rate the extent to which each the following has influenced Green IT:				
	E_ind Industry dynamics	0.91	0.93	0.88	0.81
	E_inst Institutional dynamics	0.92			
	E_mkt Market demand	0.86			
Green IT Knowledge Acquisition	Please rate the capability of your IT department to acquire new knowledge on Green IT via:				
	ACQ1 Carrying out market research	0.72	0.90	0.86	0.59
	ACQ2 Sending IT staff to complete training courses	0.73			
	ACQ3 Participation in interest groups	0.83			
	ACQ4 Relationships with external stakeholders	0.83			
	ACQ5 Observation of approaches adopted by competitors	0.78			
	ACQ6 Compliance with environmental legislation	0.71			
Green IT Knowledge Assimilation	Please rate the capability of the routines and processes in your IT department to:				
	ASS1 Interpret and understand information on Green IT	0.86	0.93	0.88	0.76
	ASS2 Ensure newly acquired Green IT knowledge is understood by IT staff	0.88			
	ASS3 Conduct a lifecycle analysis of its products/services to identify their environmental impact	0.83			
	ASS4 Develop a plan of action on how to achieve environmental goals	0.90			
Green IT Knowledge Transformation	Please rate your IT department's capability to:				
	TFRM1 Develop effective routines to facilitate the combination of newly acquired or assimilated knowledge with existing Green IT knowledge	0.92	0.96	0.94	0.85
	TFRM2 Refine its routines to facilitate the combination of newly acquired or assimilated knowledge with existing Green IT knowledge	0.92			
	TFRM3 Develop Green IT performance goals (e.g. KPIs) to reflect understanding gained from newly acquired or assimilated knowledge	0.91			
	TFRM4 Refine Green IT performance goals (e.g. Key Performance Indicators) to reflect understanding gained from newly acquired or assimilated knowledge	0.93			
Green IT Knowledge Exploitation	Please rate the capability of your IT department's to develop and refine routines to:				
	XPLT1 Ensure that existing Green IT competencies are effectively leveraged in its operations	0.95	0.97	0.96	0.89
	XPLT2 Refine existing Green IT competencies	0.96			
	XPLT3 Extend existing Green IT competencies	0.95			
	XPLT4 Enable the creation of new Green IT competencies	0.91			
Green IT Assimilation	Please rate the extent to which your IT department has:				
	GR_att A positive Green IT attitude	0.79	0.94	0.92	0.75
	GR_gov Well-developed Green IT governance mechanisms	0.88			
	GR_pol Well-developed Green IT policy frameworks	0.87			
	GR_prc Well-developed Green IT practices	0.92			
	GR_tec Acquired and build an environmentally effective IT infrastructure	0.87			

APPENDIX 2

Table 2 Inter-construct correlations

	1	2	3	4	5	6	7
1. Green IT Knowledge Acquisition	***0.77***[1]						
2. Green IT Knowledge Assimilation	0.74	***0.87***					
3. Environmental Context	0.62	0.61	***0.90***				
4. Green IT Knowledge Exploitation	0.64	0.78	0.63	***0.94***			

[1] Diagonal values represent square root of AVE

5. Green IT Assimilation	0.64	0.69	0.67	0.70	***0.87***		
6. Organisational Context	0.61	0.60	0.66	0.65	0.72	***0.87***	
7. Green IT Transformation	0.68	0.80	0.58	0.86	0.72	0.60	***0.92***