

2008

GITAM: A Model for the Adoption of Green IT

Alemayehu Molla

School of Business Information Technology RMIT University Melbourne, Australia, alemayehu.molla@rmit.edu.au

Follow this and additional works at: <http://aisel.aisnet.org/acis2008>

Recommended Citation

Molla, Alemayehu, "GITAM: A Model for the Adoption of Green IT" (2008). *ACIS 2008 Proceedings*. 64.
<http://aisel.aisnet.org/acis2008/64>

This material is brought to you by the Australasian (ACIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in ACIS 2008 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

GITAM: A Model for the Adoption of Green IT

Alemayehu Molla
School of Business Information Technology
RMIT University
Melbourne, Australia
Email: alemayehu.molla@rmit.edu.au

Abstract

Over the last decade, an increasing number of businesses are undertaking initiatives to reduce their environmental footprint and improve their “green” credentials. As information technology (IT) has permeated most, if not all, business processes and supply chains, it offers an important means to tackle the climate problem. On the other hand, IT managers are pressed to reduce the total cost of IT operations and run energy efficient IT shops. Greening IT has therefore become one of the latest considerations to improve a business’s environmental sustainability whilst reducing the cost of IT operations. A growing number of consulting reports speculate the benefits of greening IT for both IT vendors and mainstream businesses that use IT. While the opportunities and potentials of Green IT might be attractive, the extent of Green IT adoption and the actual realization of the benefits that Green IT aficionados allude to remain unknown. Indeed, unless business organisations incorporate Green IT into their operations, the potential benefits of Green IT remain potential and not reality. Currently, there does not appear to be a model to systematically investigate Green IT adoption. This paper proposes such a model called the Green IT Adoption Model (GITAM). The model defines Green IT from four distinct but interrelated perspectives. It posits that the technological, organisational and environmental contextual variables, dynamic Green IT readiness dimensions and strong order Green IT drivers can predict the intention and the breadth and depth of Green IT adoption.

Keywords:

Green IT, Technology adoption, Readiness, Green Information System, Sustainability, Corporate Social Responsibility

INTRODUCTION

Global warming and climate change coalescing with limited availability and rising cost of energy has become a major concern for the global economy. Businesses of all sectors and sizes are coming under mounting pressure from green movements and regulators to reduce their environmental footprint. Typical responses to these challenges include corporate social responsibility (CSR) and business sustainability initiatives. Specific initiatives cover creating an organisational culture for environmental awareness and stewardship, increasing the proportion of green power supply, moving energy intensive operations to locations that are suitable for clean energy, using more recycled paper and office equipment, and recycling office waste (Olson, 2008, McWilliams et al, 2006; Hendry and Vesilind 2005; Rao, 2004; Carroll, 1991). Olson (2008) refers to these and similar initiatives as “enterprise level green strategy” and argues that such a strategy has a potential positive impact on the environment. However, the business case for green strategy should identify benefits to an enterprise’s revenue and/or cost.

Lately, greening IT has surfaced to the forefront of the debate on the environmental impact of businesses. In some organisations, IT is a major consumer of energy. Greening IT can therefore lead not only to reduction in carbon emissions but also to significant cost savings (Mines, 2008; Donston, 2007; Nunn, 2007). For example, Australian businesses’ use of ICTs is estimated to contribute over 1.5% of the national CO₂ emissions, which is more than the emission from the cement and civil aviation industries (ACS, 2007). This implies that greening IT can reduce a business’s environmental footprint. At a corporate level, energy costs make a significant proportion of the total cost of running a data centre (Rasmussen, 2006). Accenture (2008) estimates that US’s data centres and servers consume 1.5% of US’s total electricity consumption and cost over USD 4.5 billion in electricity costs. Greening IT can therefore reduce the total cost of technology ownership and increase the total environmental value of ownership (Tung, 2007). IT is also expected to play a lead role in supporting a business’s sustainability initiatives. Examples of such initiatives include the development of analytical tools and information systems that support dynamic routing of vehicles to reduce energy consumption, the implementation of emission management systems and the supplanting of carbon emitting business practices through video-conferencing and other online collaborative facilities (Esty and Winston, 2006; Jones and Mingay, 2008).

The potential of technology to create sustainable business and society is widely accepted (Olson, 2008; Gonzalez, 2005, Hart 1997) with only a few (Fuchs, 2008) questioning such potentials. Likewise, extant literature on Green IT, albeit dominated by reports of major consulting firms and popular press hail Green IT. They speculate that Green IT has a potential to create new competitive opportunities, to reduce carbon emissions, and to improve overall business efficiency (ACS, 2007; Baines, 2007; Gartner, 2008; Info~Tech, 2008a, 2008b; Jones and Mingay, 2008; Mines, 2008). Beyond Green IT specific literature, there is emerging evidence that a business's sustainability initiatives such as green strategy, green supply chain management, and implementation of environmental technology can build positive brand image, mitigate environmental liabilities associated with a firm's products and services and influence the mindset of customers and investors (Sen et al, 2006; Rao and Holt, 2005). As a result, the adoption of Green IT can be considered as a critical factor not only for the sustainability of businesses but also the success of the low carbon economy. A number of organisations are expected to jump on the Green IT bandwagon during the 2008-2010 window pushing the Green IT consulting services market to an estimated US \$ 4.5 billion by 2013 (Mines, 2008). While the opportunities and potentials of Green IT might be attractive, the extent of Green IT adoption and the actual realization of the benefits that Green IT aficionados allude to remain unknown. Beyond consulting white papers and internet yellow pages, there is virtually no systematic research on what drives Green IT adoption. Specifically, there does not appear to be a model that can be used to investigate the determinants of Green IT adoption among businesses. The purpose of this paper is therefore to propose such a model, which we refer to as the Green IT Adoption Model (GITAM).

THEORETICAL BACKGROUND

Green IT is a nascent field and there is virtually no academic research on the topic. In proposing a model for the adoption of Green IT, it is therefore instrumental that we draw from the mainstream IT/innovation, green technologies and green supply chain adoption literature. A number of studies have investigated the organisational adoption of IT by developing empirical research models that are based on a wide variety of perspectives, such as technological perspective (Rogers, 1995, Davis, 1989), managerial action perspective (Kraemer and king, 1981), organisational perspective (Orlikowski, 1993), and the institutional perspective (King et al, 1994). Studies on the adoption of clean and environmental technologies and green supply chains (Lee, 2008; Gonzalez, 2005; Johnston and Linton, 2000) also follow these perspectives.

Technology adoption frameworks address the technological related determinants of the adoption and diffusion of innovations. For instance, the Technology Acceptance Model (TAM) posits that, the acceptance of any technology is fundamentally affected by a user's perception of the ease of use and usefulness of the technology (Davis, 1989). Diffusion of Innovation (DOI), on the other hand, focuses on the characteristics (or perceived characteristics) of an innovation such as relative advantage, complexity, compatibility, trialability, and observability (Rogers, 1995). The managerial innovation model underscores that the adoption of new technologies depends on managers' awareness of problems and on organisational culture that encourages risk taking (Robey and Zmud, 1992). Studies also indicate that senior managers, via their attitude and decisions, could and do systematically influence the content and characteristics of organisational activities (Damanpour and Schneider, 2006). The literature further identifies antecedents such as organisational size, complexity, sector and availability of slack resources to technology adoption (Orlikowski, 1993, Damanpour, 1991). Institutional theories highlight the role of both formal (such as government and professional associations) and informal (such as markets forces, norms and rules of competition) as key potential drivers of innovation acceptance (King et al, 1994). Previous innovation adoption studies also make a distinction between the primary and perceptual characteristics of the innovation, organisational and environmental adoption contexts (Moore and Benbasat, 1991; Taylor and Todd, 1995 Kuan and Chau, 2001).

The adoption of green technologies, although to some extent could be similar to the adoption of other technologies, it has a number of differences (Olson, 2008; Gonzalez, 2005). Traditionally, environmental compliance has been perceived as an additional cost of doing business and managers fear that such initiatives might negatively affect a business's competitiveness (Mathur and Mathur 2000; Porter and Van der Linde, 1995). Olson (2008) opines that green initiatives take longer period to break-even and are likely to be motivated more by softer benefits such as employee morale and good corporate citizenship than by hard dollar gains. Regulatory requirements and legislative actions are likely to play very significant roles in the adoption of green technologies and can force some businesses to accept a technology even if they do not have a strong intention to do so (Olson, 2008; Gonzalez, 2005). The tension between the environmental and social case on the one hand and the business case for "top-line revenue and bottom-line costs" (Olson, 2008) on the other hand can influence the pace of green technology adoption (Esty and Winston, 2006; Gonzalez, 2005). These features imply that in seeking to explain the adoption of Green IT, effort should be exerted to cover all the domains of adoption.

From the review of existing innovation, green technologies, IT and e-commerce adoption literature, we found that the technology-environment-organization (TOE) framework (Tornatzky and Fleischer, 1990) and the

perceived e-readiness model (PERM) (Molla and Licker 2005a, 2005b) are comprehensive for unifying the primary and secondary characteristics of the four key domains of adoption, that is, technological, managerial, organisational and institutional. TOE posits that the technological (internal and external technologies), organisational (firm size, scope, centralization, complexity, slack resources) and environmental (industry and regulatory) contexts of a firm can either facilitate or inhibit the adoption of a given technological innovation. PERM, on the other hand, posits that perceived organisational (awareness, commitment and the stock of human, business and technological resources) and environmental (the readiness of market forces, government, and other supporting industries) e-readiness are critical in a business's decision to adopt e-commerce (Molla and Licker 2005a, 2005b).

A number of studies have tested both TOE (Iacovou et al , 1995; Xu et al, 2004) and PERM (Lai et al , 2006; Tan et al, 2007) and demonstrated their usefulness for studying determinants of innovation adoption in general and emerging innovation (such as e-commerce) in particular. In proposing the GITAM, we adopted these two models as our theoretical background. TOE helps to identify the static and primary contextual variables for Green IT and we will refer to these variables as Green IT Context. The PERM on the other hand is useful to capture the dynamic and perceptual readiness dimensions. These dimensions will be referred in the model as Green IT Readiness. However, we consider both the TOE and PERM constructs as second order facilitators and argue that in addition to these factors, drivers (strong order reasons) might also influence both the content and process of Green IT adoption. To identify these Green IT drivers, we draw from organisational motivation theory (DiMaggio and Powell, 1983; Merton, 1957).

THE GITAM

The general argument of the proposed model is that a combination of static Green IT contextual variables, dynamic Green IT readiness dimensions and strong order Green IT drivers can predict Green IT adoption intention and explain a significant proportion of the variance in the practice of Green IT. Figure 1 presents a higher level schematic representation of the proposed model.

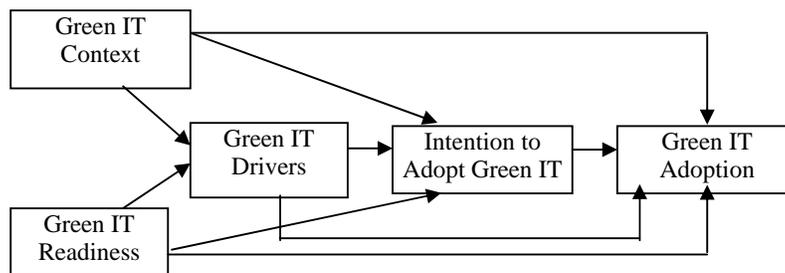


Figure 1: The GITAM: Basic Model

Conceptualising Green IT

Green IT means many things to different people. In order to conceptualise Green IT, we take insights from previous literature on the adoption of green process technologies and green supply chain practices and emerging practitioner oriented Green IT publications. From a process technology perspective, green process technologies can be classified as *end of pipe technologies* and *clean technologies* (Gonzalez, 2005). End of pipe technologies reduce the environmental impact of emissions without necessarily changing the production process. On the other hand, clean technologies cause significant changes in the production process and their adoption is intended to reduce the level of environmental impact along a product's life cycle from design to consumption. From a supply chain perspective green supply chain refers to integrating environmental thinking into the product design, sourcing, manufacturing, warehousing, distributing and end of life product management aspects of a supply chain (Srivastava, 2007; Rao and Holt, 2005). Thus, from a strategic perspective, green strategy articulates a business's intention to cultivate good environmental stewardship while at the same time pursuing economic goals (Olson, 2008).

Turning to IT, for most CIOs and IT vendors such as Dell, HP, Intel and Sun, Green IT is all about data centre efficiency. Therefore, narrowly defined, Green IT implies technologies and initiatives to reduce the power, cooling and real estate costs associated with data centre operations (Mines, 2008; Info-Tech, 2007c,d; Nunn, 2007; Rasmussen, 2006). However, as can be seen for a summary of definitions on table 1, Green IT is more than data centres.

Table 1: Summary of Selected Green IT Conceptualisation

Reference	Conceptualisation of Green IT
ACS (2007)	Concern “about energy consumption and subsequent carbon dioxide emissions from commercial ICT equipment”.
Mines & Davis, 2008)	“Green IT is part of a fundamental change in the economy and society. It is a subset of the larger green (sustainable) business trend, which reconciles sustainable business practices with profitable business operations” .
Info~Tech (2007c)	Identified 11 technologies and initiatives as indicators of Green IT. These include “equipment recycling, server consolidation and virtualisation, optimizing data centre energy efficiency, print optimization, data centre airflow management, rightsizing IT equipment, green considerations in sourcing and RFPs, hot aisle/cool aisle data centre layout, budget allocation for Green IT projects, liquid cooling for IT equipment, DC powered IT equipment, airside/waterside economizer, carbon offsetting”.
Gartner (2008)	Defines Green IT based on the role of CIOs. “For most CIOs greenhouse gas emissions and getting IT’s own house in order are the main issues. Their more important role, though is to help the enterprise address its enterprise wide environmental sustainability issues...[by playing] one or more of three roles: provide analytical tools, provide analytical/technical insight [and] lead change”.
Nunn (2007)	For IT hardware suppliers, Green IT is “running IT assets and services in a more energy-efficient way...how to limit and hopefully reduce the organisation’s overall carbon foot print”
Brocade (2007)	“Going green in the data centre have many facets such as reducing overall power consumption, maximizing power utilization, reducing the amount of hardware via consolidation, and decreasing the amount of storage required to meet data processing requirements”
Mitchell (2008)	In the data centre, going green is about energy efficiency first and foremost. Fortunately, efficiency is a natural by-product of solving the cooling, power and space challenges that today’s data centres face.

The definitions discussed earlier and those summarised in table one indicate that Green IT can span from a narrow data centre focus (Mitchell, 2008) to a much broader business sustainability and corporate social responsibility concerns (Olson, 2008; Mines & Davis, 2008). It also encompasses not only hard technological solutions (Info~Tech, 2007c; Gonzalez, 2005) but also soft business practices (Nunn, 2007; Gartner, 2008). Particularly, the insight from green supply chain literature (Srivastava, 2007) indicate that the boundary of Green IT conceptualisation can depend on the specific goal of a researcher and the scope can range from green purchasing through internal operations to end of life management. One useful way to navigate the different conceptualisation of Green IT is therefore to look at Green IT from an IT activity chain perspective- from sourcing to end of IT life management. This approach is consistent to notions of the three goals of sustainability, that is, *pollution prevention, product stewardship, and clean technology* (Hart 1997). Based on the IT activity chain, we define Green IT from four different but interrelated perspectives – sourcing, operations, services and end of IT life management.

From a sourcing perspective, Green IT implies the practice of environmentally preferable IT purchasing. This involves adoption of sourcing practices such as analysis of the environmental foot print of an IT hardware supply chain, evaluation of the green track record of software and IT services providers, incorporating green issues (such as recyclable design and packaging) in vendor evaluation, and inclusion of social concerns (such as use of child labour and presence of harmful materials in IT supply chain) in IT procurement decisions. It also covers an assessment of the environmental performance of products such as the adoption of the Electronic Product Environmental Assessment tool (Info~Tech, 2007b). Further, developing a clear policy statement on environmental IT purchasing and Green IT request for proposals can be used as indications of Green IT adoption.

From an operation perspective, Green IT implies improving energy efficiency in powering and cooling corporate IT assets and reducing IT induced greenhouse gas emissions. Rasmussen (2006) identifies two types of energy consumption reduction- *temporary and structural consumption avoidance*. While temporary avoidance refers to optimization of energy utilisation without reducing the installed power base, structural avoidance results in reduction in installed power capacity. A number of green technologies and practices related

to the two categories can be used as indications of the adoption of Green IT operation. Some of these are outlined in table one (Info~Tech, 2007c). Others include carbon offset programs (ACS, 2007), right-sizing the network critical physical infrastructure (NCPI) system to IT load, upgrading to energy efficient servers, retiring old systems, using efficient NCPI devices, and designing energy efficient systems (Rasmussen (2006).

From a service perspective, Green IT refers to the role of IT in supporting a business's overall sustainability initiatives. Adopting a Green IT from a services perspective therefore includes adoption of analytical tools for green supply chain management, environmental management and carbon foot print analysis. It also includes ICT based low carbon business solutions such as video-conferencing, thin client and web based business services, virtual collaboration and IP telephony (Olson, 2008; Nunn, 2007; ACS, 2007). Adoption of Green IT systems that integrate information from Green IT sourcing and operation technologies for management decision making is also another dimension (Mines, 2008). Further, desktop virtualization, and policies and practices for corporate wide PC power management, PC use and print optimisation regimes can be included in this category.

From end of IT life management perspective, Green IT refers to practices in reusing, recycling and disposing IT hardware. Due to the growth and rapid change of ICTs, electronic devices are making up the fastest growing proportion of waste materials (Kangand and Schoenung, 2005). Paradoxically, green IT initiatives to replace IT equipment with more energy efficient equipment would generate a surge in electronic waste and consume additional resources if equipment is replaced before the end of its natural life., unless complemented with would generate Some of these include hazardous materials and can contribute to a firms total environmental foot print. For example, UK's retailer Marks and Spencer has set an ambitious plan to be carbon neutral and aims that none of its waste (including IT) goes to landfills (Accenture, 2007). Leading IT vendors such as Sun, IBM and EDS and services providers such as Accenture have adopted e-waste recycling programs (Mines, 2008).

Green IT Adoption and Adoption Intention

We differentiated between intention and actual adoption of Green IT because emerging studies indicate that even if some business managers are concerned about the environment and are intending to do something about it, they have yet to take concrete actions (Olson, 2008; Esty and Winston, 2006). This shows a gap between awareness and action and offers a room to identify the specific Green IT context, readiness and driver dimensions that might convert intentions to actions. It also offers a chance to explore if the intention to adopt Green IT and its actual implementation are influenced by the same set of variables. Further, we propose two measures of Green IT adoption *breadth and depth*. Breadth refers to the coverage of Green IT in the above four areas. It gauges whether Green IT is permeating a business's IT activity chain. On the other hand, depth refers to the extent of Green IT adoption in one particular category, such as sourcing. For example data centre focused Green IT initiatives cover environmental considerations in the design and operation of both the site (lighting, power delivery, cooling systems) and IT infrastructure (servers, storage and network) of data centres. Depth of Green IT adoption therefore covers the extent to which a single IT activity domain has been influenced by green considerations. Together, breadth and depth can allow a comprehensive understanding of Green IT adoption among businesses.

Drivers of Green IT

Three drivers of Green IT can be identified: *economical, regulatory and ethical*. Although these drivers are not necessarily mutually exclusive, the prevalence of a dominant driver can influence the content and process of Green IT initiatives and can favour certain Green IT practices.

Economic driver refers to the need for greater IT efficiency and the pursuit of tangible cost savings from IT operations. 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 is leading to a meteoric rise in stored data. The volume of corporate data has surpassed one million terabytes in 2007 and is expected to reach a zetabyte by 2010 (IDC in Brocade, 2007). More data implies larger server farms and more demand for power. In the life of a typical data centre, the cost of powering and cooling the data centre is estimated to exceed both the cost of the IT and the electrical equipment (Rasmussen, 2006). As corporate demand for more data processing and storage capability continues to grow, real estate costs to accommodate those needs is becoming an additional challenge (Brocade, 2007). The need for reducing the power, cooling and real estate costs and increasing data centre efficiency might drive some organisations to turn to Green IT (Rasmussen, 2006; Info~Tech 2007d). For example, Data Domain, a provider of data "deduplication" storage systems uses Green IT design to reduce the cost of data centres (Intel, 2007). Efficiency drivers can lead to Green IT initiatives that yield tangible, near term cost savings. Some of these include electrical power usage analysis, analysis of electrical bill, server virtualisation, retiring energy consuming and idle systems, PC power saving plans, and redesign of data centre architecture (Info~Tech 2007d; Info~Tech, 2007c; Accenture, 2008). It can also lead to the adoption of fleet management systems and dynamic routing of vehicles to reduce the cost of transportation.

Regulatory driver refers to the pursuit of legitimacy within the wider social context (DiMaggio and Powell, 1983). The emphasis here is on actions that are induced because of the need to meet certain regulatory (both mandatory and voluntary) demands. A number of national, professional and inter-governmental institutions are producing guidelines related to green ICTs. Examples include The Commonwealth of Australia Green Office Guide (Commonwealth of Australia, 2001); US's Environmental Protection Agency (EPA) initiative to study energy use in data centres (Mullins, 2006); Australian Computer Society's (ACS) policy statement on Green ICT (ACS, 2007); European Commission directive on Waste Electrical and Electronic Equipment (WEEE). While at the moment, compliance to these and other regulations is voluntary, this is likely to change as more and more organisations set national emission targets and join carbon trading schemes (Mines and Davis, 2007). In the US and EU, IT's environmental footprint and substances used in manufacturing hardware, and electronic waste is coming under increasing spotlight. As legislations become enforceable, they motivate the adoption of certain Green IT practices despite a business's lack of intention to do so. The predominance of regulatory drivers can lead to minimalist strategy to Green IT adoption. It can encourage Green IT activities such as IT carbon footprint analysis, environmentally preferable IT procurement practices, IT end of life management and increasing the proportion of green power use.

Ethical driver refers to the pursuit of socially responsible business practices and good corporate citizenship. As the green movement permeates every aspect of corporate life, businesses are increasingly seeking social recognition as concerned entities of global and local communities (Mines and Davis, 2007). Organisations use CSR initiatives to capture the mind share of their key stakeholders such as investors, consumers and the general public (Sen et al, 2006). Nunn (2007) indicate that a growing proportion of customers and investors consider the environmental awareness of a business in their decision to conduct business and buy share respectively. He further claims that "more than 70% of MBA students from top schools are willing to accept a 10 to 20 percent lower salary to work for a responsible company". Where once corporate social responsibility was seen as a damage control and public relation exercise, it is now considered as a strategic issue with immense potential to unleash new source of competitive differential (Porter and Kramer, 2006). For example, a global survey of 1260 respondents indicated that 50% are concerned about climate change (Info-Tech, 2008). Another survey of about 150 IT procurement professionals indicates that for some (33%) environmental concerns in planning IT operations are very important and for others (52%) it is somehow important (Mitchell, 2008). Ethical drivers of Green IT can lead to Green IT preferences that associate a business to socially accepted norms of going green such as reducing emission, recycling, reuse and electronic waste management (Mines and Davis, 2007; Sen et al, 2006).

Economic, ethical and regulatory drivers can determine the basic motives for Green IT adoption. The locus of the force (whether internal or external or both) however depends on a business's technological, organisational and environmental contexts and on its readiness for Green IT. While businesses that have a better profile of readiness are expected to pull Green IT adoption perhaps driven by economic and ethical considerations, those that lack readiness are likely to come under push pressure. In the following two sections we discuss the Green IT context and Green IT readiness constructs of the GITAM.

Green IT Context

The Green IT context represents the primary characteristics that are inherent in the adoption context and can be assessed relatively objectively.

Technological context: Green IT is likely to flourish in organisations that have large installed IT assets. Businesses that run high density servers are likely to feel the pressure of rising electricity costs and the challenge of powering, cooling and housing those technologies. This might lead to the adoption of more energy efficient servers, and /or server consolidation and virtualisation technologies (Mitchell, 2008). The use of green manufacturing and logistics technologies is another technological context. Firms that have adopted green supply chain (Rao, 2004), green end-of pipe and clean technologies (Gonzalez, 2005) or environmental technology (Johnston and Linton, 2000) might create the permissive and conducive condition for Green IT adoption. Further, the proportion of green power an organisation purchases is likely to encourage Green IT adoption. For example, RMIT University which bought 2% of its power supply as green power in 2007 plans to increase this to 15% in 2008 and 20% in 2010. Clean technologies constitute the platform on which other green initiatives can be built. In particular, green power influences both the efficiency and CO₂ emissions from network critical physical infrastructure.

Organisational context refers to the descriptive properties of a business such as sector, size and corporate citizenship. Different sectors are likely to respond to Green IT differently. Utility companies such as oil, gas and electricity, as they have direct involvement in environmental policy, are likely to be early adopters of Green IT. Other information intensive businesses such as data storage providers, finance and telecom providers can also be expected to move to Green IT early. In the UK, the public sector is coming under increasing scrutiny to report its carbon emission and energy usage which may facilitate the adoption of Green IT (Mines, 2008). In terms of size,

while large corporations such as ANZ and Telestra tend to have dedicated data centre facilities, and medium businesses run server racks amidst other office facilities, small firms are less likely to be less concerned about Green IT. However, ACS (2007) indicates that small firms can participate in carbon offset programs. Another organisational context that affects the extent of Green IT usage is whether or not a business demonstrates good corporate citizenship in the form of clearly stated corporate social responsibility statements. Businesses that set out a CO₂ target to reduce corporate carbon footprint might expect IT not only to directly contribute to such targets but also to provide support and analytical tools to ensure compliance. A key strategy of Green IT use could therefore be the ability to integrate the many CSR and business sustainability initiatives to improve the overall environmental and social footprint while at the same time making business sense. Porter and Kramer (2006) argue that most CSR initiatives are disconnected from strategy and hence companies are missing opportunities to benefit society. The integration of CSR to business strategy has a potential to create significant business value, thus driving continued Green IT usage.

Environmental context: within the TOE framework the regulatory environment is a critical factor in creating the conducive and permissive environment for encouraging the use of some Green IT technologies. Governments and other inter-governmental organisations could encourage the adoption of Green IT by legislations that create the framework for the low carbon economy. Some of these include caps on green house gas emissions, institutionalising emissions trading, and banning the use of some hazardous materials. Existing legislations range from the Kyoto protocol on climate change to IT specific legislations. The European Commission has issued a document on the role of IT in tackling climate changes. In Australia, however, industry observes criticise the federal government on lagging in Green IT initiatives (Tang, 2007). Most of the existing green regulations and legislations are non-binding but this might change in the future (Mines and Davis, 2007) creating an environment for the breadth and depth of Green IT adoption. Further, the existence of regulatory support on waste management can influence a business's end of life IT management practice. Beyond legislation, as one of the major users of IT, governments can lead by example and establish the norm for Green IT adoption.

Green IT Readiness

Green IT readiness captures a dynamic assessment of an organisation's own and environment preparation to accept Green IT. It captures the perceptual characteristics of the adoption context. Kuan and Chau (2001:510) argue that "as many characteristics of innovation turn out to be secondary, many organisational characteristics turn out to be secondary as well. . . . [And arguably,] characteristics of the external environment also turn out to be secondary". Molla and Licker (2005b) concurred with this view and further argue that "even if two organisations have the same level of organisational resources and operate in the same context; they are likely to have different perceptions of the level of readiness and might make different adoption decisions." Therefore, based on Molla and Licker's (2005b) PERM, three dimensions of Green IT readiness can be identified-organisational, value network and institutional.

Perceived organisational Green IT readiness describes the awareness, commitment and resources of a firm relevant to Green IT. The extent to which IT and business leaders are concerned about the environmental and social effects of IT is a critical aspect for initiating Green IT. Info-Tech's (2008a) global survey on Green IT attitude for example revealed that while most respondents are concerned about climate change and reducing IT's power consumption, only in a few cases has Green IT featured in top management's radar screen. Strong business sustainability and green commitment is therefore essential for wider use of Green IT. In fact, behind the story of every successful green initiative, there is the commitment of the CEO. For example, in UK's Mark and Spencer the CEO personally sponsors the retailer's ambitious aim to become carbon neutral (Accenture, 2007) while in the ANZ Bank, IT participates in the change to green (Jones and Mingay, 2008). However, the commitment of the organisation as a whole from the apex to the core; the technocrat to the supporting staff is necessary (Info-Tech, 2007ca). The Green IT commitment of an organisation might be manifested through resource allocation; whether or not Green IT is on the radar screen of management and the extent of strategic involvement. All these influence the readiness of a business to go Green IT and the intensity and extensity of Green IT initiatives. The adoption of Green IT is also influenced by not only hard financial resources but also soft human resources such as the existence of corporate green community (Info-Tech, 2007c).

Perceived value network Green IT readiness refers to the readiness of a firm's suppliers, competitors, investors, partners and customers for Green IT. In terms of suppliers' readiness, a number of vendors are marketing their products as green solutions. Indeed, IT vendors have been at the forefront of setting the Green IT agenda (Nunn, 2007). While companies like Dell, HP, Intel and Sun have built advanced data centre design and optimization services, consulting giants such as Accenture, Deloitte and IBM are offering services on how to position IT as an enabler of green business initiatives (2008). 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 IT strategies as a basis for competition (Porter and Kramer, 2006), they set the green norms of competition and

motivate their competitors' adoption of Green IT. All these indicate that the perceived Green IT readiness of a firm's suppliers, competitors and customers can influence both the content, process and depth of Green IT adoption.

Perceived Institutional Green IT Readiness. Institutions refer to both formal entities such as government and professional associations and informal norms and practices. Businesses can differ in their assessment of governments' commitment to facilitate the institutional framework and the development of alternative and renewable energy sources. Favourable assessments can play a significant role in making Green IT an attractive proposition. On the other hand unfavourable assessment might encourage a wait and see approach. Government can also influence Green IT through direct subsidies. As one of the major users of IT, governments can also lead by example and establish the norm for Green IT use. Professional associations 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. For example, ACS's (2007) policy statement on Green IT and its launching of the online Green IT discussion group can play significant role in creating awareness and exchanging best practices in Green IT use. A business's assessment of the readiness of these institutional forces is therefore likely to influence the breadth and depth of Green IT use.

SUMMARY

Although the green movement is not new, over the last few decades, green aficionados, the media, and governments are increasingly holding companies to account for their environmental footprint. On the other hand, the global demand for more energy and the rising cost of traditional energy sources and their environmental impact is leading many to improve energy efficiency and search for cheaper and cleaner alternative energy sources. The role of IT both in causing and resolving green issues has become to the forefront in 2007. Gartner predicts that Green IT will continue to be a number one priority for the next couple of years.

Green IT is attracting a huge interest among IT vendors and consulting services providers mainly due to the increasing demand to power data centres. However, Green IT is not just about running efficient data centres. It encompasses IT's role in causing and tackling emissions. While IT can be held accountable for reducing its 2% of global CO₂ emissions, it has a role to play in tackling the remaining 98%. Therefore, greening IT affects not only a business's environmental footprint but also is consequential to strategy. Whether these potentials of Green IT will be "myths" (Fuchs, 2008) or will convert to economic and social realities remain to be seen.

This paper proposes a theoretical model for studying the adoption of Green IT. The paper's contributions lie on three counts. First, to the best of our knowledge this is the first attempt to discuss Green IT as a potential research area. As green issues permeate the IT agenda, it opens a room for exciting research opportunities as regards the role of IT in business sustainability and the low carbon economy. Second, the paper offers a comprehensive and holistic conceptualisation of Green IT from four perspectives. This implies that researchers have to be clear in their definition of the dependent variable. Otherwise, it will be difficult to make proper comparison of study outcomes that investigated for instance server virtualization with electronic recycling. Third, the paper also attempts to tease out not only the second order facilitators but also the strong order drivers of Green IT. The proposed model is based on two frameworks that have strong theoretical and empirical support and represents a foundation for future empirical studies.

The next step of the research is to test this model through large scale survey. At the time of writing this paper, the authors are in the process of conducting an Australian wide survey. Future research shall focus on exploring the complex interactions associated with Green IT adoption.

REFERENCES

- Accenture (2007) *The Green Link to High Performance in Retail*, Accessed on June 20, 2008 from www.accenture.com
- Accenture (2008) *Data Centre Energy Forecast Final Report*, Accessed on July 31st, 2008 from www.accenture.com
- ACS- Australian Computer Society (2007) *Australian Computer Society Policy Statement on Green ICT*, Available from www.acs.org.au
- Baines, S. (2007) *Why Must IT go Green?* Accessed on June 05 2008, from <http://www.computing.co.uk/computing-business/analysis/2199135/benefits-green-3420872>.
- Brocade (2007) *Storage Area Network: Going Green with Brocade*, Brocade communications systems, Inc. Retrieved 23 June, 2008, from www.greendatasystems.com.
- Common Wealth of Australia (2001) *The Green Office Guide*, ISBN 0-7311-5281-6.

- Damanpour, F. (1991) Organizational innovation: a meta-analysis of effects of determinants and moderators, *Academy of Management Journal*, 34(3), 555–591.
- Damanpour, F. and Schneider, M. (2006) Phases of the adoption of innovation in organizations: Effects of environment, organization and top Managers, *British Journal of Management*, 17(3), 215-236.
- Davis, F.D. (1989) Perceived usefulness, perceived ease of use, and end user acceptance of information technology, *MIS Quarterly*, 13, 318–339.
- DiMaggio, P. J. and Powell, W. (1983) The iron cage revisited: Institutional isomorphism and collective rationality in organizational behaviour, *American Sociological Review*, 48 (April), 147-160.
- Donston, D. (2007) Green IT generates fertile ideas, *eWeek*, 24(16), 46.
- Esty, D. C. and Winston, A. S. (2006) *Green to Gold: How Smart Companies Use Environment Strategy to Innovate, Create, Value, and Build Competitive Advantage*, Yale University Press.
- Fuchs, C. (2008) The implications of new information and communication technologies for sustainability, *Environment, Development and Sustainability* 10(3), 291-309.
- Gartner, (2008) *Going Green: The CIO's Role in Enterprisewide Environmental Sustainability*, Gartner EXP premier, May 2008.
- González, P.d.R. (2005) Analyzing the factors influencing clean technology adoption: A Study of the Spanish pulp and paper industry, *Business Strategy and the Environment* 14(1), 20-37.
- Hart, S. L. (1997) Beyond greening: Strategies for a sustainable world, *Harvard Business Review*, 85(3), 58-68.
- Hendry J.R. and Vesilind, A. P. (2005) Ethical motivations for green business and engineering, *Clean Technologies and Environmental Policy*, 7(4), pp 252-258.
- Iacovou, C. Benbasat, I. and Dexter, A. (1995) Electronic data interchange and small organizations: Adoption and impact of technology, *MIS Quarterly*, 19(4), 465–485.
- Info~Tech (2007a) *PC Power Saving Plans Reduce Costs and Environmental Impact*, Info~Tech Research Group, December 19, 1-10.
- Info~Tech (2007b) *Exercise Environmentally Preferable Purchasing for a Healthier Planet and Pocketbook*, Info~Tech Research Group, October 22, 1-9.
- Info~Tech (2007c) *11 Green Initiatives Your Peers are Cultivating*, Info~Tech Research Group, July 30, 1-14.
- Info~Tech (2007d) *Top 10 Energy-Saving Tips For a Greener Data Centre*, Info~Tech Research Group, April 11, 1-11.
- Info~Tech (2008a) *North America Underperforms in Green IT Attitudes and Actions*, Info~Tech Research Group, January, 1-15.
- Info~Tech (2008b) *Use EPEAT to Decrease Equipment Costs and Help the Environment*, Info~Tech Research Group, February, 1-3.
- Intel (2007) *Accelerating Data Compression with Intel® Multi-Core Processors*, Accessed on July 5, 2008 http://cache-www.intel.com/cd/00/00/37/74/377402_377402.pdf
- Johnston, D.A. and Linton, J.D. (2000) Social networks and the implementation of environmental technology, *IEEE Transactions on Engineering Management*, 47(4), 465-477.
- Jones, A. R. and Mingay, S. (2008) Executive Summary: Going Green: The CIO's Role in Enterprisewide Environmental Sustainability, Gartner Exp Premier, Accessed June 10, 2008 from www.gartner.com
- Kang, H. and Schoenung, J. M. (2005) Electronic waste recycling: A review of U.S. infrastructure and technology options, *Resources, Conservation and Recycling*, 45 (4), 368-400
- King, J.L. Gurbaxani, V. Kraemer, K.L. McFarlan, F.W. Raman, K.S. and Yap, C.S. (1994) The institutional factors in information technology innovation, *Information Systems Research*, 5(2), 139–169.
- Kraemer, K.L. and King, J.L. (1981) Computing policies and problems: a stage theory approach, *Telecommunications Policy*, 5(3), 198–215.
- Kuan, K.K.Y. and Chau, P.Y.K. (2001) A perception-based model for EDI adoption in small businesses using a technology-organization-environment framework, *Information & Management*, 38 (2001), 507–521.

- Lai, F. Dahui, L. Wang, J. and Hutchinson, J. (2006) An empirical investigation of the effects of e-readiness factors on e-business adoption in China's international trading industry, *International Journal of Electronic Business*, 4 (3-4), 320-339.
- Lee, S.-Y (2008) Drivers for the participation of small and medium-sized suppliers in green supply chain initiatives, *Supply Chain Management*, 13(3), 185-198.
- Mathur, L.K. and Mathur, I. (2000) An analysis of the wealth effects of green marketing strategies, *Journal of Business Research*, 50(2), 193-200.
- McWilliams, A. Siegel, D. S. and Wright, P. M (2006) Corporate social responsibility: Strategic implications, *Journal of Management Studies*, 43(1), 1-18.
- Merton, R. K. (1957) *Social Theory and Social Structure*. The Free Press, Glencoe, IL.
- Mines, C. & Davis, E. (2007) Topic Overview: Green IT , Forrester Research, Accessed on 23 June, 2008 from at: <http://www.forrester.com/Research/Document/Excerpt/0,7211,43494,00.html>
- Mines, C. (2008) The Dawn of Green IT Services, Forrester Research Accessed on 23 June, 2008 from <http://www.accenture.com/NR/rdonlyres/24ABF590-558E-42E6-B78B-143AFCF81A23/0/TheDawnOfGreenITServices.pdf>
- Mines, C. (2008) The Dawn of Green IT Services, FORRESTER Research Inc, February 2008, 1- 14
- Mitchell, R.L. (2008) Green by Default, *ComputerWorld*, Accessed on 23 June 2008 from http://www.computerworld.com/pdfs/LFG_green_IT_2008.pdf .
- Molla, A. & Licker P. (2005a) E-commerce adoption in developing countries: A model and instrument, *Information & Management* , 42(6), 877-899.
- Molla, A. & Licker, P. (2005b) Perceived e-readiness factors in e-commerce adoption: An empirical investigation in a developing country, *International Journal of Electronic Commerce*, 10(1), 83-110.
- Moore, G.C. and Benbasat, I. (1991) Development of an instrument to measure the perceptions of adopting an information technology innovation, *Information Systems Research*, 2(3), 192-222.
- Mullins, R. (2006) Bush signs law to study data center energy usage, *Computer World*, Accessed on June 30, 2008 from <http://www.computerworld.com/action/article.do?command=printArticleBasic&articleId=9006698>
- Nunn, S. (2007) Green IT: Beyond the data centre how IT can contribute to the environmental agenda across and beyond the business, Accenture, 1- 7.
- Olson, E.G (2008) Creating an enterprise-level "green" strategy", *The Journal of Business Strategy*, 29(2), 22-30.
- Orlikowski, W. (1993) CASE as organizational change, *Management Information Systems Quarterly*, 17(3), 309-340.
- Porter M, E . and Van der Linde C. (1995) Toward a new conception of the environment-competitiveness relationship, *Journal of Economic Perspectives*, 9(4), 97-118.
- Porter, M. E. and Kramer, M. R. (2006) Strategy and society: The Link between competitive advantage and corporate social responsibility, *Harvard Business Review*, 84(12), 78-92.
- Rao, P. (2004) Greening production: A South East Asian experience, *International Journal of Operations & Production Management*, 24(3), 289-320.
- Rao, P. & Holt, D. (2005) Do green supply chains lead to competitiveness and economic performance?, *International Journal of Operations & Production Management*, 25(9), 898-916.
- Rasmussen, N. (2006) Implementing Energy Efficient Data Centres, *APC White Paper # 114*, Accessed on May 12, 2008 from www.apc.com
- Robey, D.,and Zmud, R.W. (1992) Research on the organization of end-user computing: Theoretical perspectives from organization science, *Information Technology & People*, 6 (1), April 1992, 11-27.
- Rogers, E.M. (1995) *Diffusions of Innovations*, 4th ed. New York: Free Press, 1995.
- Sen, S. Bhattacharya, C. B. and Korschun, D. (2006) The role of corporate social responsibility in strengthening multiple stakeholder relationships: A Field experiment, *Journal of the Academy of Marketing Science*, Spring, (34), 158-166.

- Srivastava, S. K. (2007) Green supply-chain management: A state-of-the are literature review, *International Journal of Management Reviews*, 9(1), 53-80.
- Tan, J. Tyler, K. & Manica, A. (2007) Business-to-business adoption of eCommerce in China, *Information & Management*, 44 (3), 332-351.
- Taylor, S. and Todd, P.A. (1995) Understanding information technology usage: A test of competing models, *Information Systems Research*, 6(2), 144–176.
- Tornatzky, L. G. and Fleischer, M. (1990) *The Process of Technological Innovation*, Lexington, MA: Lexington Books.
- Tung, L. (2007) *Green IT will hit Australian govt 'like a ton of bricks*, Accessed June 30, 2008 from <http://www.zdnet.com.au>
- Xu, S. Zhu, K. and Gibbs, J. (2004) Global technology, local adoption: A cross-country investigation of internet adoption by companies in the United States and China, *Electronic Markets*, 14(1), 13-24.

COPYRIGHT

Alemayehu Molla © 2008. The authors assign to ACIS and educational and non-profit institutions a non-exclusive licence to use this document for personal use and in courses of instruction provided that the article is used in full and this copyright statement is reproduced. The authors also grant a non-exclusive licence to ACIS to publish this document in full in the Conference Papers and Proceedings. Those documents may be published on the World Wide Web, CD-ROM, in printed form, and on mirror sites on the World Wide Web. Any other usage is prohibited without the express permission of the authors.