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# ENVIRONMENTALLY SUSTAINABLE ICT: DEVELOPING CORPORATE CAPABILITIES AND AN INDUSTRY-RELEVANT IS RESEARCH AGENDA

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# ENVIRONMENTALLY SUSTAINABLE ICT: DEVELOPING CORPORATE CAPABILITIES AND AN INDUSTRY-RELEVANT IS RESEARCH AGENDA

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## Abstract

*Information and Communication Technologies (ICT) have made significant contributions to business innovation and wealth generation for organisations, societies and nations. ICT have also made significant contributions to environmental degradation. Confronted by the necessity to respond to growing environmental concerns in society, regulatory imperatives and market pressure, many executives express uncertainty about how best to proceed. IS researchers have investigated diverse aspects of ICT applications and practices in organizations over the last 30 years but IS research literature, to date, has provided little assistance to those organizations unsure about how, where and when to respond to imperatives for their ICT applications and practices to become 'Green'.*

*This paper aims to facilitate the development of corporate practice in the environmental sustainability of ICT and to promote an industry-relevant Information Systems research agenda. Its contributions are: an overview of the topic from a diversity of literature sources; proposal of a stages of development framework for corporate capabilities in ICT environmental sustainability based on the literature and on the experiences of a global ICT services corporation recognised as a leader in its environmental sustainability activities; and proposal of an industry-relevant IS research agenda. Implications of the framework for corporate practice and for IS research are discussed.*

**Keywords:** Environment, Sustainable, IS Research, Framework.

## 1 INTRODUCTION

During the last 50 years, Information and Communication Technologies (ICT) have become a major contributor to business innovation and wealth generation. In making these contributions, ICT has also become a major source of environmental contamination at all stages of the technology lifecycle: design, manufacture, operation and disposal. Toxic substances used to manufacture ICT products present occupational and environmental hazards from their production and from their disposal as, globally, hundreds of millions of computers and mobile devices are discarded in land-fill each year. Increasingly high levels of electricity consumption in the manufacture and operation of ICT products leads to increased carbon dioxide (CO<sub>2</sub>) emissions since, internationally, energy is predominantly generated by carbon emitting coal-fired power stations (Friedman 2007, GAO 2005, Gartner 2007, Greenpeace 2005, McKinsey 2004, UNEP 2005).

The volume of Green House Gas emissions produced world-wide is growing rapidly, increasing by 70% between 1970 and 2004 (IPCC 2007, p5). Consequently, maintaining current commercial practice, i.e., business as usual, is not a feasible option due to "increasing risks of serious, irreversible impacts from climate change" (Stern, 2007, pii).

Environmental sustainability cuts across most areas of organisational practice. An international survey of more than 10,000 consumers and global executives in 2007 shows climate change to be the single most important issue of concern for the next five years for both consumers and executives (McKinsey, 2008). While most executives are concerned about the issue, comparatively few are taking action (MCA 2007, p15).

This issue has particular relevance to the ICT industry and to ICT using organizations. Globally, the ICT industry accounts for approximately two per cent of CO<sub>2</sub> emissions. This estimate includes manufacture and operation of personal computers, servers, cooling, fixed and mobile telephony, local area networks, office telecoms and printers. While that percentage may seem modest, it is too large to be maintained. *"During the next five years, increasing financial, environmental, legislative and risk-related pressures will force IT organisations to get more environmentally sustainable,"* Simon Mingay, research vice president at Gartner (Jaques, 2007).

This issue is also central to the IS discipline since the IS discipline is distinguished from other disciplines as: *"it examines more than just the technological system, or just the social system, or even the two side by side; in addition it investigates the phenomena that emerge when the two interact."* (Lee, 2001, p iii). The environmental sustainability of ICT is located precisely at that point of interaction between technology and society.

The terms "Environmental Sustainability of ICT" (ESICT) and "Green IT", are used widely but lack common and consistent meaning. Many articles and papers focus on a particular aspect of the issue without acknowledgement of its multi-faceted nature. In this paper, a holistic definition is utilised:

*the design, production, operation and disposal of ICT and ICT-enabled products and services in a manner that is not harmful and may be positively beneficial to the environment during the course of its whole-of-life (Elliot, 2007)*

This definition encompasses ICT as a problem (e.g., creating contamination from its manufacture and disposal; contributing to carbon emissions through its consumption of electricity generated by coal-burning power stations) and as a potential solution to environmental problems. The definition's focus of analysis is primarily at organizational and industry levels. The scope of ESICT is based on organizational activities and responses. While the definition and scope of this issue lies clearly within the focus of IS research, to date IS researchers have failed to engage with the subject.

This paper aimed to directly address corporate and IS research uncertainties about how to respond to the challenges presented by the environmental sustainability of ICT by facilitating the development of corporate practice and contributing to the development of an industry-relevant Information Systems research agenda. Consistent with these aims, the research questions were:

1. *What contribution does current literature make to corporate practice in environmental sustainability of ICT;*
2. *What is current leading-edge corporate practice in environmental sustainability of ICT;*
3. *Can current literature and practice be presented in an integrated framework;*
4. *Can an IS research agenda based on this framework be proposed to facilitate industry-relevant IS research activity?*

The paper was structured to meet the research aims through review of a diversity of literature sources to identify the business problems and challenges for organizations; proposal of a framework of stages of development of corporate capabilities in ICT environmental sustainability to address the challenges; presentation of a case study of developing practice in a global ICT services corporation pioneering in its approach to environmental sustainability; comparison of literature and practice; and proposal of a revised framework for business practice that can better inform executives and IS researchers.

## 2 ENVIRONMENTAL SUSTAINABILITY OF ICT LITERATURE

A selection of current literature on environmental sustainability of ICT at a corporate capabilities level has been analysed to identify its contribution to informing organizations in five major areas: describing problems; identifying potential solutions and opportunities; providing a rationale for action; depicting possible actions; and discussing possible approaches for evaluation. Each of these areas represents an issue relevant to corporations seeking to address environmental sustainability. The literature was selected on the basis of potential relevance to organisations uncertain about how to respond to the emerging ESICT challenges.

Literature on this developing issue originated with the Brundtland Commission (1987) with its use of the term “sustainable development” to mean *“development that meets the needs of the present without compromising the ability of future generations to meet their own needs”*. A sustainable organization *“is one whose characteristics and actions are designed to lead to a desirable future state for all stakeholders over the longer term”* (Funk, 2003). Sustainability requires *“both an efficient allocation of resources over time and a fair distribution of resources and opportunities between the current generation and between present and future generations, and a scale of economic activity relative to its ecological life support systems.”* (Gray and Milne, 2002). A sustainable global economy is *“one that the planet is capable of supporting indefinitely”* (Hart, 1997).

To assist organizations’ awareness of the issues and to reduce uncertainty about potential responses, the selected literature has been classified into five categories and presented as a resource in Table 1.

<i>Category</i>	<i>Focus</i>	<i>Description</i>	<i>References</i>
<i>Problem</i>	ICT as a source of ESICT problems	ICT design, manufacture, use, disposal as a source of environmental degradation: E-waste and Green House Gases (GHG)	<u>E-waste</u> : Basel Convention 2006a, 2006b, Bhalla 2007, EU 2003a, 2003b, GAO 2005, 2006, Greenpeace 2005, 2007a, Hasan, 2002, UNEP 2004, 2005, <u>GHG</u> : Friedman 2007, IPCC 2007, McKinsey 2004, Stern 2007, WMO 2007
<i>Solution / Opportunity</i>	ICT as a potential solution or business opportunity	ICT and ICT applications as a potential solution or source of business opportunity	<u>Solutions</u> : Intel 2006, Sun 2006, Stern 2007 e.g., p394 <u>Opportunities</u> : Friedman 2007, Magretta 1997, McKinsey 2007
<i>Rationale for action</i>	Rationale for corporate action	Why should corporations respond to ESICT challenges?	EU 2003a, 2003b, Gartner 2007, Jacques 2007, McKinsey 2008,
<i>Actions</i>	The nature of corporate actions	What can be done & how to do it	De Groot 2000, Funk 2003, GeSI 2005, Hart 1997, Magretta 1997, MCA 2007, McKinsey 2004, Shrivastava 1995
<i>Evaluation</i>	Evaluation criteria	How to assess outcomes of ESICT initiatives	Elkington 1998, Gray and Milne, 2002, McDonough and Braungart 2002,

Table 1: *Classification of ICT Environmental Sustainability literature at a corporate level*

The literature presented in Table 1 above is from specialist environmental groups, practitioners and government and inter-governmental bodies with the addition of some academic papers from non-IS disciplines. Searches in the IS discipline’s top journals over 30 years reveals that IS researchers have not engaged with this topic.

In 2007, the Association for Information Systems' senior scholars group proposed eight journals as representing the pinnacle of IS research publications: the European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of the Association for Information Systems, Journal of Information Technology, Journal of Management Information Systems, Journal of Strategic Information Systems and the Management Information Systems Quarterly (see Saunders, 2007). In late 2007, these eight leading IS journals were searched for papers on the topic of ESICT by title and keyword for: environment, environmental, pollution, sustain, sustainable, and sustainability. A subsequent search was of paper's abstracts for the same keywords to identify related references that were not the main focus of the paper.

Since the first volume of the first IS journal in 1977, none of these journals has published a single paper focusing on ESICT. One paper was identified by keyword in the abstract (Howard-Grenville and Carlile 2006) and several other papers were identified by full text searches in a last resort to find papers with any mention of the keywords (e.g., Avgerou 2001, Saravanamuthu 2002) but ESICT was not the focus of those papers. Clearly, an opportunity exists for IS researchers to make rigorous contributions in industry relevant areas on an issue of global importance.

### **3 RESEARCH APPROACH**

Environmental sustainability of ICT presents numerous challenges of considerable and growing significance to society. These challenges have been shown above to be relevant to the mainstream of IS research. Many business executives confronted by the necessity to transform business activity to become more environmentally sustainable remain uncertain about how they could and should transform current business practice. Calls have been made for research to examine key issues in environmental sustainability and to identify and share organizational best practices (GeSi, 2005).

This paper's aims and research questions (see Introduction above) seek to facilitate the development of corporate practice for the environmental sustainability of ICT and to contribute to the development of an industry relevant Information Systems research agenda. The research scope and the unit of analysis are the corporation, with a focus on corporate capabilities and related research issues.

The approach most appropriate to address the research aims and questions was analysis of a diverse range of literature to identify a framework of developing organizational practice in environmental sustainability of ICT; preparation of a case study of leading-edge practice; and comparative analysis of the framework and the experiences and practices of a corporation pioneering in this area. The framework was reviewed and revised and an IS research agenda based on current leading-edge industry practice proposed. Since ICT manufacturers represent a small percentage of the total number of organisations using ICT, this study focused primarily on service providing organizations.

A stages of development framework to inform practitioners and researchers appeared suitable to meet the research aims as this type of model previously had been successful in raising organizational awareness: notably Nolan's 1970's seminal stages of development model to address uncertainties in IT management (Nolan, 1979). Unfortunately, no generally applicable models or frameworks of organizational stages of development in ICT environmental sustainability were identified in the literature. Table 2 proposes a composite structure and activities for a stages of development of environmental sustainability framework based on elements from diverse publications. These sources include: a 2x2 matrix to compare organizational strategies with sustainable objectives (Hart, 1997); a chemical company's approach to sustainability (Magretta, 1997); a 10-step model for an IT manufacturer to progress from regulatory compliance, product stewardship, partnerships with environmental activists to incorporation of social aspects in business strategies (de Groot, 2000); advice on how to prepare a business case for sustainability with value creation models (Funk, 2003); key issues in environmental sustainability for the IT industry (Gartner, 2007) and consideration of how

business could adapt to a low-carbon world (MCA, 2007). In Table 2, the stages, titles and activities were derived from the literature, CSC's two columns from the case and the agenda for research and practice column was developed from both literature and the CSC case.

Computer Sciences Corporation (CSC) was selected as an IT-services organization recognised as a leading-edge performer in the environmental sustainability of ICT. The unit of analysis was the CSC Australia (CSCA) subsidiary as a whole to capture the range and diversity of sustainable activities and experiences and to place the sustainable ICT activities into context. Triangulation was obtained by data collection from corporate websites (publicly accessible and intranet), public and internal corporate reports and presentations, and interviews with the Chief Financial Officer and Chair of the GreenWay Committee; the Chief Technology Officer and Director of the Office of Innovation; the Chief Information Officer; and the Environmental Sustainability Manager(ESM). Within the organization structure, the ESM reports to the CIO who reports to the CFO. A range of staff suggestions for environmental sustainability initiatives were also examined. Each interview was for approximately one hour. Interview transcripts were provided for verification and subsequent follow-up discussions were held as required.

## 4 CSC CASE

CSC is a *“leading global consulting, systems integration and outsourcing company ... with the mission to provide customers in industry and government with solutions crafted to meet their strategic goals and enable them to profit from the advanced use of technology.”* (CSC, 2008a). In 2007, CSC generated revenues of \$US 14.8 billion with 79,000 employees in 80 countries worldwide (CSC 2007, 2008a).

CSC is recognised as a global leader in Green IT. A survey of 20,000 global users ranks CSC second out of 4,540 outsourcing vendors across a variety of industries (Brown-Wilson, 2007). CSC's major Green IT initiatives have been undertaken in the UK and in Australia (CSC 2007, p6).

This case study focused on developments in Green IT in CSC Australia (CSCA). Outcomes of the Australian developed initiative, GreenWay, are being adopted throughout CSC in 2008 for all environmentally sustainable activities. GreenWay represents improvements, such as virtualisation, to existing IT technology but extends to improving all environmental aspects of operations from: solutions provided to clients; operations in data centres; and efficiency improvements in facilities. The range of GreenWay activities expands well beyond IT, e.g., to water conservation; power consumption from lighting; and air-conditioning in offices. The major goal for GreenWay in 2008 is to reduce carbon emissions by 25% by 2010 (from 2007 levels).

Based on their initial experiences, CSCA considered it to be more appropriate to integrate all conservation initiatives within the organization rather than fragmenting the initiatives into separate areas of focus, e.g., IT, office infrastructure or transportation. The Chief Financial Officer assumed responsibility for environmentally sustainable initiatives to ensure an integrated, cross-organizational approach.

### 4.1 Developing capabilities

After conducting background investigations over several months, in February 2007, Dr Derek Binney (Chief Technology Officer and Director, CSCA Office of Innovation) raised the following question at a meeting of CSCA's top executive group: *“How green does CSC Australia want or need to be and how will we get there?”* He presented a discussion paper outlining how CSC could identify its carbon footprint and develop a process towards greening the company. The report focused initially on three areas: the 'being in business' footprint e.g., real estate, travel; the service provision footprint e.g.,

<i>Stage</i>	<i>Title</i>	<i>Activity</i>	<i>CSC's activities</i>	<i>CSC's ICT actions, e.g.,</i>	<i>Agenda for Research &amp; Practice</i>
8	Business opportunity	Seeking business development & other market opportunities	GreenWay	Collaborative projects with clients	Seeking strategies to exploit sustainable business opportunities with existing customers and in new lines of business
7	Integration	Integrating organisation-wide options	GreenWay	Green Data Centres, set organ'l. ES targets & monitor, ISO14001 capabilities	Integrating solutions across organisation, seek new technologies to enable innovative solutions. Implementing environmental management systems & reporting
6	Proliferation	Determining, championing & implementing organisation-wide options	GreenWay – medium to longer term	Procurement criteria ES, server virtualization Collaboration ICT. KPIs.	Proactively seeking & implementing organisation-wide strategies to reduce energy consumption, & prevent pollution. Environmental reporting
5	Evaluation	Solution evaluation	Project Kermit - medium term	Power management options, e.g., efficient h/w, e-waste disposal	Determining appropriate, organisation-wide metrics and evaluation processes. Determining actual contributions, developing informed business cases
4	Action	Solution implementation & monitoring	Project Kermit & Power Save Pete! – short term	Power management with current facilities, e.g. Data Centre temperature	Implementing solutions to reduce energy consumption & / or prevent pollution. Developing capabilities & means of evaluation. Engaging staff.
3	Determination	Solution seeking	Project Kermit & Power Save Pete!	CIO hires ESM to coordinate activities in ICT & organ. wide	Determining & monitoring environmental impact of ICT activities, identifying drivers, identifying & examining potential solutions, preparing business cases
2	Investigation	Problem identification & scoping	Project Kermit & staff forums	ICT impacts all business areas, CIO investigated issues across company	Building awareness of general problem areas & business drivers, commencing data collection on energy consumption, pollution contribution & regulatory requirements
1	Awareness	Issue identification	By CTO & local staff forum	Identify internal & external issues	Becoming aware of carbon footprint & e-waste pollution issues; relevance to ICT & organisation unclear

*Table 2: ICT Environmental Sustainability: Stages of Corporate Development Framework (developed from Hart 1997, Magretta 1997, de Groot 2000, Funk 2003, Gartner 2007, MCA 2007, & CSC case)*

customer services, data centre operations, equipment selection and disposal; and the internal IT footprint i.e. addressing internal IT needs. Note that at this earliest stage, the company's CTO was

proposing that environmental sustainability was a broader issue than just green IT. CSCA decided to get more information by investigating the size and nature of its carbon footprint.

Concurrently, a query was percolating from the grassroots in a remote location up to the top executive group in CSCA. The nature of the outsourcing business involves the company acquiring and operating facilities in different locations. CSCA developed a practice of establishing staff forums in each business location to deal with issues common to all staff working in that location, regardless of the different business units they may work in. Common issues range from the workplace environment at a location to social events. Membership of the staff forums is voluntary. A formal structure that enabled staff in a location remote from the regional head office to raise a query at the highest level in the region was unusual in CSC and, at that time, so was the question: “*What is CSCA doing about environmental sustainability?*”, This question came to the CFO:

*“Initially, I was sceptical about the issues of environmental sustainability and climate change but I changed my mind after seeing the Al Gore documentary, An Inconvenient Truth.” (CFO).*

In response to the query, the staff forum was asked what they thought CSCA should be doing.

*“When they showed the level of their passion and enthusiasm for this area, I started to consider what might be produced with some focus and a little budget.” (CFO).*

The CSCA top executive group considered several options and decided to run a competition between CSCA locations to save energy costs. The nation-wide Power-Save-Pete (PSP) competition was launched in March 2007. Its major objectives were to: reduce energy costs; demonstrate to staff that action on this issue was being taken; promote awareness; and encourage participation by staff at local level, nationally. Presentations of the Al Gore documentary were shown in all CSCA locations.

Staff in various locations became very involved in the competition. One site is located near a major arterial road with a large illuminated sign advertising CSC. This is a very useful instance of brand promotion at a local level. In their enthusiasm to reduce power consumption, the local office turned off the sign.

The competition ran for three months and resulted in energy savings of \$300-\$400,000 with very little cost. It showed that environmental initiatives could produce significant dollar savings as well addressing staff concerns. Two of CSC’s three major stakeholders: shareholders and staff, benefited from energy cost savings. Customers were not involved since it was an internal project. Competition proved to be a powerful force in organizational change but it needed to be subject to the organization’s commercial requirements. The potential for environmental sustainability was quickly seen to be broader than just within CSCA.

*“The scope of an environmental sustainability strategy is not restricted to an individual organisation but needs to consider the sustainability of an organization’s suppliers and their customers.” (CTO).*

Project Kermit was established to investigate CSCA’s carbon footprint. The major areas in developing and implementing CSCA’s environmental sustainability strategy were: Facilities: buildings and data centre; Travel: business travel versus use of collaboration technologies; Purchasing: including supplier lifecycle sustainability; Equipment: energy and sustainability ratings as selection criteria; Purchasing/trading offsets; Consumption: power, water and consumables; Recycling: equipment disposal; water; paper; aluminum cans; IT Technology options: PCs vs. appliances, virtualization, power efficient hardware, and collaboration technologies. In addition to the areas listed above, other issues were raised that may be particularly relevant to the IT industry i.e. the green cost of off-shoring to countries with a poor sustainability records and environmental costs of maintaining legacy systems.



The next step was GreenWay, the trademarked brand for CSC's environmental sustainability policy internationally, developed by CSCA. Launched in December 2007, this policy recognises the importance to a provider of IT services of "minimizing its impact on the environment as a key business principle." GreenWay objectives for 2008 include achieving and maintaining certification as complying with the capabilities for ISO 14001 Environmental Management Systems.

## 4.2 Drivers

Environmental sustainability is increasingly viewed as part of a company's social responsibility contract and this is an important indirect driver to CSCA. The direct drivers are cost reduction (shareholder benefit); responsiveness to staff concerns (staff and shareholder benefit) and clients having their requirements met (shareholders, staff and client benefit).

*"Our clients need to have all of their business requirements met and increasingly this includes the minimisation of resource usage and reduction in power consumption." (Environmental Sustainability Manager (ESM)).*

Government reporting, regulation and customer demand are potential drivers for the future:

*"We can expect sustainability will become an evaluation criteria when our customers seek new IT services, and almost certainly will be criteria when we re-enter our contract renewal cycle. (ESM).*

## 4.3 Evaluation & returns

CSCA's evaluation approaches and criteria are evolving over time. Within a period of three months, the PSP competition showed energy savings were possible. The savings represented about an 8% reduction in total energy costs over the period. CSCA's tests showed that fluorescent globes can provide up to a 30% reduction in energy costs for lighting. The effectiveness of a competition as a means of raising staff awareness and engaging them in sustainable initiatives was clearly shown. To acknowledge staff contribution there was a strong desire to give something back to staff. Ultimately, it was decided to purchase each staff member a tree by donating funds to eTree ([www.ETree.com.au](http://www.ETree.com.au)).

Metrics used for monitoring progress towards objectives include: electricity and water consumption, waste generated (e-waste as well as paper, cans / PET bottles, and office waste) and travel for internal purposes.

*"We assess our progress against our goals on a monthly basis for electricity and are working towards that timeframe for our water and waste goals. No goals are set for each division so the goals are measured against CSC as an entity rather than its individual departments. An example of a goal is a 25% reduction in Green House gases by 2010, but no intermediate goals have been set." (ESM).*

CSCA is still determining how to assess savings for their facilities projects. The cost for the GreenWay project for their next financial year is estimated to be around \$300,000. GreenWay represents a cost due to lighting conversions to fluorescent lighting, virtualization of servers, water reduction initiatives etc. The total cost is unclear at this early stage but it is also difficult for CSCA to put a price on the cost of not having the program, although:

*"Based on our limited but positive experiences to date, we expect two to three times the costs in benefits." (ESM).*

## 5 CHALLENGES AND LESSONS FROM LEADING PRACTICE

As a result of their experiences, CSCA now has a good understanding of what it is doing, but this has not always been the case. Future activities, particularly over the longer term, remain uncertain:

*“Probably the biggest initial challenge was to understand the scope of what we wanted to do. Basically translating a desire to “be green” into an actuality is a mammoth task and we are still learning what needs to be done.” (CFO).*

The CFO receives a business case from the GreenWay Committees for each initiative to save costs of power or water and could approve them on his own authority but takes them to top executive group to ensure there is full support for the projects and everyone is aware of the benefits being realized.

*“There are tremendous opportunities in pro-actively engaging with environmental concerns and driving solutions that take them into account. In many ways helping the environment is about reducing consumption and improving the efficiency of existing practices.” (CFO).*

One of the key challenges was the lack of critical data. With the exception of electronic-waste, CSCA’s systems or service providers did not provide sufficient detail to report on impacts from either volumes and / or types of waste nor the emissions from couriers or taxi use. Consequently, these impacts are not included in the scope for overall impacts. CSCA is working with its service providers and internal systems to provide the information required to more effectively manage these components of environmental impact. Similarly, values for CSC internal server usage are estimates based on the percentage of CSC internal servers within a data centre as individual figures are not available.

A major lesson was that initiatives do not have to be big to make a difference. In some situations, significant cost savings can be achieved with little effort or impact. Raising the air-conditioning temperature setting in offices over summer from 22C to 23C and in data centres from 16C to 17C can have a huge impact on cost with little or no impact on people or operations. This one degree Celsius change in temperature reduces power consumption costs by 12% (i.e., around \$500,000 annually at current costs).

CSCA recognized at an early stage that IT had significant potential to contribute to sustainability beyond the data centre. As part of collaboration opportunities to reduce carbon footprint, CSC is investing in international tele-presence technologies to better facilitate business internally and for clients while reducing travel. CSC regularly coordinates with vendor partners to better understand technologies and practices that could reduce impact on the environment.

*“Our objectives are, in some ways, being constantly revised as we learn from our journey. Internally we wanted to satisfy our staff that they worked for an environmentally responsible company. We wanted to satisfy our shareholders needs for investing in a sustainable corporation and obviously our client’s requirements for efficient, cost effective solutions that minimise environmental footprints were high on the agenda.” (CTO)*

Irrespective of the objective or focus of environmental sustainability initiatives, CSCA has learned that integration of effort across the organization requires structural support with Key Performance Indicators and financial incentives:

*“The CIO has four major areas of responsibility: IT operations for both internal and external clients; business excellence; environment; and strategic initiatives. The manager of each area receives their performance bonus only if all four managers achieve their targets” (CIO).*

## 6 CONCLUSIONS AND IMPLICATIONS

The environmental sustainability of ICT presents numerous challenges of considerable and growing significance to society. Business organizations are confronted by the necessity to transform business activity to become more environmentally sustainable but experience uncertainty about how they could and should transform current practice. Despite the significance of this issue to society and to business, and notwithstanding the issue's direct relevance to the IS discipline, to date leading IS research journals have not published a single paper focused on this subject.

To address business uncertainty and IS research inaction, this paper aims to facilitate the development of corporate practice for the environmental sustainability of Information and Communication Technologies (ICT) and to contribute to the development of an industry-relevant Information Systems research agenda. Consistent with this paper's aims, the research questions were:

1. *What contribution does current literature make to corporate practice in environmental sustainability of ICT;*
2. *What is current leading-edge corporate practice in environmental sustainability of ICT;*
3. *Can current literature and practice be presented in an integrated framework;*
4. *Can an IS research agenda based on this framework be proposed to facilitate industry-relevant IS research activity?*

The paper addressed each of the research questions. To assist executives and IS researchers confronted by uncertainty about this area, Table 1 presents analysis of more than 30 papers and reports relevant to the environmental sustainability of ICT in practice. The literature is sourced from specialist environmental groups, practitioners, government and inter-governmental bodies as well as some academic papers from non-IS disciplines. The papers on Table 1 are categorised as focusing on the environmental sustainability of ICT: as a problem, as a solution or opportunity, with a rationale for corporate action, and with possible actions for implementation. Table 1 also includes references on approaches to evaluating initiatives. No IS research is included on Table 1 since searches of the major IS research journals over a period of 30 years failed to identify a single paper focusing on environmental sustainability of ICT.

CSC is recognised internationally for its leadership in environmental sustainability of ICT among outsourcing organizations and CSC Australia is one of the leading subsidiaries in this field within CSC. Although the literature search did not identify a comprehensive framework or model dealing with the development of corporate capabilities in environmental sustainability of ICT, a composite framework based on elements from six papers was proposed (see Table 2). CSCA's activities and actions proved to be consistent with the stages and activities in the composite framework and were readily incorporated within its structure. CSCA's experiences were applicable to all stages of the development framework and the activity descriptions for each stage based on the literature were confirmed and informed by CSCA's experiences.

Based on the literature and the experiences of an internationally-leading organization, a research agenda is proposed for IS research and practice at each stage in the development of corporate capabilities in environmental sustainability. The implications of this research agenda for practice is as a means of assisting organizations to address uncertainty about how to respond to pressures to change current business practice to become more environmentally sustainable. IS researchers can utilise the agenda to contribute to environmental sustainability by developing investigations based on the literature and leading practice.

The applicability of the ICT Environmental Sustainability Stages of Corporate Development framework may be limited by the literature selected and by the nature of the source firm confirming

and informing its elements: a consulting, systems integration and ICT outsourcing corporation. It is likely that this Framework is applicable more generally to service organizations, although this contention will need to be tested through further research. The Framework is based on corporate-level drivers to transform its current business practices to become more environmentally sustainable and so it may not be applicable to manufacturing organizations exposed to external drivers such as regulatory imperatives for change in jurisdictions penalizing environmental pollution or mandating reductions in energy consumption.

With allowance for these limitations, this paper contributes to addressing the challenges and opportunities of ICT environmental sustainability that apply to most aspects of business practice. The categorization of relevant literature, the ICT Environmental Sustainability Stages of Corporate Development framework and the supporting case details combined provide sufficient information and justification to overcome uncertainty and to place this issue firmly on the executive agenda.

This paper also contributes to the Information Systems discipline, which has its own challenges as well as those relating to the environmental sustainability of ICT. Challenges to IS include calls to increase the industry relevance of its activities and to address major issues confronting the global community. The environmental sustainability of ICT presents a logical area for IS research focus since it falls within the scope of the discipline. The opportunity clearly exists for IS researchers to make rigorous contributions in industry relevant areas on this issue of global importance.

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