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IS-ENABLED INNOVATION TO OVERCOME RESISTANCE AND IMPROVE CONTRIBUTIONS TO SUSTAINABILITY BY UNIVERSITIES: AN IS RESEARCH AGENDA

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Abstract

Since 1987, universities have been acknowledged as having the potential to make a crucial contribution to addressing the challenges of sustainability. Although many universities have attempted to make contributions towards sustainability at some level, few have succeeded in realizing their potential to make significant contributions in research, education or as adopters of sustainable practices within their institutions.

This paper aims to assist universities to improve their contributions to the challenges of sustainability by clarifying the drivers and inhibitors of organizational initiatives and by proposing a model of IS-enabled innovation for universities to promote renewed efforts. An IS research agenda is proposed that is integrated with the model of IS-enabled organizational innovation to support adoption and diffusion of IS-enabled innovation in this domain.

Keywords: Adoption and Diffusion in a resistant domain, Sustainability, Universities, IS-enabled Innovation, IS Research Agenda

1 INTRODUCTION

Sustainable development was popularized by the United Nations' Brundtland Commission's report, *Our Common Future*, which defined the term as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN 1987). The principles of sustainability and sustainable development are embodied in the UN Millennium Development Goals (UN 2010) and the UN Global Compact (UNGC 2010). These principles require action to address issues relating to: poverty; universal education, gender equality; health; and the environment (UN 2010; UNGC 2010) as well as human rights; labor relations and corruption (UNGC 2010). The concept of sustainability is dynamic, entailing the continual engagement of an organization with a diversity of manifestations that may arise over time (UNGC 2010).

Environmental sustainability is receiving considerable attention at political and organizational levels as the imperative for action is becoming increasingly urgent (IPCC 2007; Stern 2007). Scientific evidence that human behavior is creating such an adverse impact on the environment that current behavior is not sustainable has been accepted by the Intergovernmental Panel on Climate Change (IPCC 2007), the British government (Stern 2007), the European parliament (EU 2003a; 2003b), the United States government (NIC 2008), and the governments of 192 countries ratifying the United Nations Framework Convention on Climate Change (UNFCCC 2007). Consequently, there is broad-based, international determination for fundamental change in current political, social, and economic practices to achieve environmental sustainability.

The Brundtland Commission appealed to educational institutions and the scientific community to, "play a crucial part in putting the world onto sustainable development paths, in laying the groundwork for our common future" (UN 1987, p.16). Universities can realize this potential by actively promoting research and scholarship, through education to all students on aspects of sustainability, through outreach activities to their local, regional, national and international communities, and by achieving sustainability at all levels within their institutions (Sharp 2002).

A number of studies have investigated sustainability initiatives in different universities with published details of their experiences (e.g., Brinkhurst et al. 2011; Carpenter and Meehan 2002; Clarke 2006, Kurland 2011; Sharp 2002; Stubbs and Schapper 2011; Wright 2002). But do these predominantly individual experiences constitute a satisfactory response to the Brundtland Commission's appeal for educational institutions to put the world onto the paths to sustainability?

Twenty years after the Brundtland report, a national survey was taken of sustainability activities in US universities. The survey's purpose was to, "track trends and advance knowledge about environmental stewardship, sustainability activities and related curricular offerings in higher education" (NWF 2008). The findings, from over 1,000 institutions (27% of all US colleges and universities), were that many activities aimed at "greening" campuses had been implemented but that only one-third of respondents had undertaken a strategic, integrated approach to sustainability with at least six of eight operational activities to improve energy efficiency and the use of renewable energy, campus-wide (NWF 2008). The survey also found that in recent years the level of education on sustainability issues was at best static, if not in decline.

The success rate of one-third of colleges and universities meeting global sustainability objectives is similar to the rate of thirty to forty percent completely or mostly successful identified by a global survey on the management of organizational change of more than 1,500 executives in business, government and non-profits (McKinsey 2006). Acknowledged difficulties in affecting change in organizations are directly relevant to implementations of sustainability policies and strategies since initiatives to address sustainability require change to existing human behaviors and organizational practices, such as to reduce energy consumption, improve waste recycling or harvest rain water.

Apart from difficulties in affecting organizational change, a root cause of the problem of limited progress, or relative decline, in sustainability appears to be uncertainty about the meaning of the term and about how best to proceed to address the challenges of sustainability by changing current human behavior. These uncertainties have been identified in calls for: further research into effective implementations of sustainability in universities (Carpenter and Meehan 2002; Wright 2002); greater efforts to overcome resistance and to affect systemic transformation of universities into more sustainable organizations (Sharp 2002); and greater assistance to university administrators seeking

more sustainable operations (ACTS 2011). Concerns that the current lack of assistance to universities was acting as an inhibitor to adoption / diffusion of technology-enabled initiatives in sustainability led to the Australasian Campuses Towards Sustainability (ACTS) joint appeal with the UK's Environmental Association for Universities and Colleges (EAUC) for improved tools to implement sustainability initiatives in higher education (ACTS 2011).

Consistent with the PACIS 2012 theme of IS innovation in the Asia-Pacific region, and in response to the limited contributions by higher education to sustainability despite considerable economic, educational, moral, and political motivation, this paper aims to promote a more strategic approach to sustainability in universities. This is undertaken by: identifying drivers and inhibitors of sustainability in universities; facilitating the adoption / diffusion of innovative, IS-enabled sustainability behaviors and practices in higher education; and identifying opportunities for greater contributions to the challenges of sustainability in an innovative IS research agenda.

To address these aims the paper's structure is: an introduction to the topic; establishment of its relevance to IS; description of the research approach; review and categorization of a purposively selected range of relevant literature presented to show diversity in local, national, and international sources on sustainability practices in higher education; proposal of a model for a strategic approach to sustainability based on the literature; and conclusions and implications for IS researchers in an innovative agenda.

2 RELEVANCE TO INFORMATION SYSTEMS (IS)

ICT is recognized as an essential source of solutions to the changed behaviors required to achieve sustainability (Stern 2007) and innovative applications of ICT can mediate, moderate and monitor solutions designed to improve global sustainability (Elliot 2011). But is sustainability a mainstream issue for IS?

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). Adoption and diffusion of ICT applications in support of responses to environmental sustainability is located at that point of interaction between technology and society and so is central to the IS discipline.

The IS discipline has been called on to undertake more high visibility research with high impact to avoid becoming marginalized (Agarwal and Lucas, 2005). Sustainability is one field of study that is poised to make a critical contribution to society and also to the universities. This is an opportunity not to be overlooked by the IS research community as it seeks to make a highly visible contribution in an area of its expertise.

To date, theoretical contributions in this domain have been limited (Elliot 2011) but a recent review of the IS discipline (Lee 2010) called for greater commitment by IS researchers to theory relating to professional practice. This 'theory-in-use' presented as generalizable frameworks and models based on analysis of examples of professional practice may serve to assist practitioners realize their goals while also increasing the relevance of IS researchers' empirical and theoretical contributions. Examples of such theory of use include creating models for developing and managing IS in information dimensions (e.g., tokens, syntax, representation and adaptation) and systems dimensions (e.g., technological, organizational and data subsystems) (Lee 2010). A model of theory in use based on analysis of academic and managerial practices is proposed in Figure 1.

3 RESEARCH APPROACH

This paper's investigation into improving contributions to sustainability by universities and IS researchers was guided by four research questions. Consistent with the paper's aims, the research questions were:

1. How can universities enhance their sustainability behaviors and practices to realize their potential? (Carpenter and Meehan 2002; NWF 2008);

2. What drivers and inhibitors might influence improved contributions by universities? (Bartlett and Chase 2004; Sharp 2002; Velaquez et al. 2005);
3. Can applications of technology facilitate increased contributions by universities through supporting drivers and mitigating inhibitors and, if so, how? (ACTS 2011; Sharp 2002; Kurland 2011);
4. How and where might IS scholars support universities to resolve their sustainability challenges?

The most appropriate approach to address the research aims and questions was analysis of a diverse range of literature to: promote the necessity for universities to address the challenges of sustainability; identify applicable drivers and inhibitors; and determine potential areas for applications of technology. To assist universities in their endeavors based on the literature, an integrated impact model of changed behaviors and an agenda for IS scholars have been proposed.

A selection of relevant literature has been purposively selected, reviewed and categorized (Miles and Huberman 1994). Consistent with the paper's aims, the range of literature was selected for its capacity to inform universities of key issues in planning and implementation of strategic, IS-enabled sustainability programs.

Seven empirical frameworks and models were selected to display the focus and scope of sources directed at facilitating sustainability initiatives by universities, see Table 1. To ensure educational responses were not undertaken in isolation from industry and government responses with similar objectives, several non-education based models were also selected for comparison (Alcorta and Piper 2005; ESAP 2005; ISO 2011; WSAP 2005).

In addition, seven academic frameworks and models were selected and analyzed to identify details of prior experiences available to inform university executives, see Table 2. Based on these models and experiences, and prior work on models of organizational change to support sustainability initiatives, a model of theory in use (Lee 2010) was proposed to demonstrate the integration of policies, strategies, operational activities and infrastructure in addressing sustainability objectives, see Figure 1 and section 5. All analysis and categorization was undertaken by the authors.

4 SUSTAINABILITY IN UNIVERSITIES

In this paper the various cases, frameworks, models and plans selected from the literature will be referred to collectively as models. A selection of current models from the environmental sustainability literature relevant to higher education has been identified and analyzed to examine potential sources of assistance to university executives seeking to make a greater contribution to sustainability principles and practices. Table 1 presents an overview of selected empirical models with their origin, focus, scope and breadth of implementation. While all of the selected models are relevant to higher education, the models were selected for their diversity of origin and focus to cater for a variety of institutional requirements. A broader range of sources encompassing a range of experiences may assist to increase the potential level of generalizability of this article's outcomes across the sector. The initial issue to be examined is drivers and inhibitors of change.

A case study of recent developments in a large California public university with over thirty years of experiences in sustainability presents a detailed analysis of drivers and inhibitors of change (Kurland 2011). Drivers of change over that period confirmed prior research (e.g., Bartlett and Chase 2004) including: leaders' core values with commitment to sustainability, availability of financial incentives to support initiatives, communications and community outreach. Significant drivers particular to the case also included a natural disaster causing \$400 million in damage to

Source of model	Talloires	ISCN-GULF	AASHE- STARS	MSI-SCG	WSAP-ESAP	TEFMA ESD	ISO 14001
Development date	1990	-	2009	2006	2005	2003	1996
Origin	International scheme founded in Talloires, France	International scheme administered in Switzerland	USA, Canada	Australia-wide university scheme	State of NSW, Australia	Asia-Pacific scheme	International Standards Organization, Switzerland
Focus	High level commitment, engagement, institutional missions	Principles for universities: mission, plans, targets, impact buildings, outreach	Comprehensive framework to benchmark universities and colleges	Higher level framework to benchmark universities and colleges	Example of a government compliance requirement - the top 200 energy and water users in state to show plans to cut use	Facilities management benchmarks for universities and colleges	International standard for evaluating and benchmarking environmental management systems for all organizations
Scope	Policy, strategy, operations at high level	Principles for policy, strategy, operations, infrastructure	Policy, strategy, operations, infrastructure in detail	Principles for policy, strategy, operations, infrastructure	Specific operations & supporting infrastructure	Specified operations & information infrastructure	Strategy, operations, infrastructure
Universities implemented?	433	31	66	27	4	65	Not available
Non-universities implemented?	?	?	?	?	196	?	> 200,000
References	Talloires 2001, 2008	ISCN-GULF, 2010	AASHE 2010	MIS-SCG 2008	WSAP 2005, ESAP 2005	TEFMA 2010	Alcorta and Piper 2005, ISO 2012

Table 1. A range of empirical frameworks and models focusing on sustainability applicable to higher education

Source of model	Brinkhurst et al. 2011	Carpenter and Meehan 2002	Clarke 2006	Kurland 2011	Sharp 2002	Stubbs and Schapper 2011	Wright 2002
Development date	2010	2001	1990- 2005	1980s-2010	1993-2001	2009-2010	1977-2002
Origin	University of Guelph, 18 Canadian universities	ANU, 10 universities in Australia/ New Zealand	Dalhousie University, Canada	California State University, Northridge	Harvard University, USA	Monash University Australia	Compares declarations & policies of university signatories
Focus	Examines roles of campus stakeholders, focusing on roles of faculty and staff	High level analysis for environmental management as a mainstream university issue	Detailed description of initiatives and approaches at Dalhousie U.	A longitudinal study of how the campus sustainability network developed over 30 years	Case details on Harvard's Green Program. General insights on change	Introduction by individuals of two standalone courses in mainstream business degree	High level analysis of sustainability declarations & universities' policies.
Scope	Policy, strategy, operations	Principles for policy, strategy, operations, infrastructure	Policy & operations. Lack of strategy until 2002	Operations & infrastructure. Lack of policies & strategies until 2008	Policy, strategy, operations, infrastructure	Limited curriculum development. Lack of policy/ strategy / infrastructure	Policies, key priorities, and areas for future research
Universities implemented?	?	?	1	1	1	1	?

Table 2. A range of academic frameworks and models focusing on sustainability applicable to higher education

buildings and other infrastructure that necessitated a rebuilding program at the same time as a state government mandate to improve energy efficiency in all buildings.

Inhibitors of change in this case also confirmed prior research (e.g., Velazquez et al. 2005): funding constraints; lack of communication and information sharing among campus stakeholders; lack of appropriate campus or government policies to support change; lack of shared values to promote change; shortage of time to commit to initiatives; and lack of capabilities to lead or teach due to lack of training (Kurland 2011).

Although similar in their domain of interest, the empirical models are distinguishable by focus, scope and breadth. In terms of focus, models may be more conceptual (ISCN-GULF 2010; MSI-SCG 2008; Talloires 2008), or comprehensive (AASHE 2010). A more comprehensive model may provide greater assistance for institutions confronting similar situations to the experiences reflected in the model. Conversely, greater detail may challenge institutions with contrary experiences or contrasting contexts. The model's scope may broadly encompass institutional policies, strategies, operations and infrastructure (AASHE 2010; ISCN-GULF 2010; MSI-SCG 2008; Talloires 2008), or be more narrowly focused on operations and infrastructure issues, particularly relating to water and energy consumption (ESAP 2005; TEFMA 2010; WSAP 2005).

Both empirical and academic models selected for analysis were developed for a variety of institutions. Universities experiencing uncertainty may be informed about a range of sustainability activities from different sectors by reference to these selected models. In terms of utilization, the standout environmental sustainability management tool is the International Standards Organization's (ISO) suite of standards. Since its initial development in 1996, the ISO 14001 suite of standards has been applied in more than 200,000 organizations world-wide in a variety of sectors and countries (ISO 2012).

University executives considering sustainability initiatives who seek assistance from these empirical models, understandably, may be overwhelmed by the diversity of approaches, focus, scope and breadth presented by the models.

A selection of academic papers published in the premier journal in this field, the *International Journal of Sustainability in Higher Education*, presents additional perspectives to the empirical models, see Table 2. As with the empirical models, the academic models are shown with details of their origin, focus, scope and breadth of implementation. The academic perspectives mainly report on the experiences of a single institution (Clarke 2006; Kurland 2011; Sharp 2002; Stubbs and Schapper 2011) although two papers include survey findings in addition to the single institution (Brinkhurst et al. 2011; Carpenter and Meehan 2002). To assist universities attempting to affect change, a selection of international declarations on sustainability is compared with policies prepared at universities ratifying the declarations (Wright 2002). Several high level themes relating to sustainability implementations are identified including, sustainable physical operations, sustainable academic research, interdisciplinary curriculum, external partnerships and public outreach (ibid).

Two critical problems have been identified from the literature reviewed: the low level of commitment to address the challenges of sustainability and the decline in educational programs. The first problem is based on three sources: the relatively small number of universities implementing sustainability models (see Tables 1 and 2); a survey of university practices in the USA (NWF 2008); and a review by an expert in the field (Sharp 2002). The second problem is based on a survey of universities that had introduced education in sustainability previously but were withdrawing from their educational programs (NWF 2008).

The current situation is that there are many sustainability initiatives, although these are frequently undertaken in isolation at an operational level. Isolated activities can lead to difficulties in maintaining momentum and progression towards a target, particularly in the absence of both a holistic goal and high level executive support. A supportive infrastructure can assist development of isolated initiatives by monitoring, mediating and reporting on activities which may result in a positive feedback loop. High level executive support for a holistic approach to institutionalize the change program may also help to maintain momentum to the point where the change program becomes self-sustaining.

Analysis of the models selected for their diversity of approaches shows limited attention to providing infrastructure support for institutions seeking to implement environmentally sustainable practices. Two of the seven empirical models have little if any reference to establishment or development of an

infrastructure to support sustainability initiatives, technology enabled or not (Talloires, TEFMA). Two models address this requirement at a principles level (ISCN-GULF; MSI-SCG). One focuses exclusively on supporting infrastructure at an operational level (WSAP-ESAP) and only two (AASHE-STARS and ISO 14001) see a supporting infrastructure as being integral to initiatives.

The academic models provide less support with four having little or no reference to supporting infrastructure (Brinkhurst et al. 2011; Clarke 2006; Stubbs and Schapper 2011; and Wright 2002). One paper addresses supporting infrastructure at a principles level (Carpenter and Meehan 2002). Two studies (Kurland 2011; Sharp 2002) consider technology enabled infrastructure to be integral to the success of sustainability initiatives. Of the 14 models reviewed, only two empirical and two academic models consider that a comprehensive technology infrastructure is essential for institutions seeking innovation organization wide. The role of a technology infrastructure is examined in the following section.

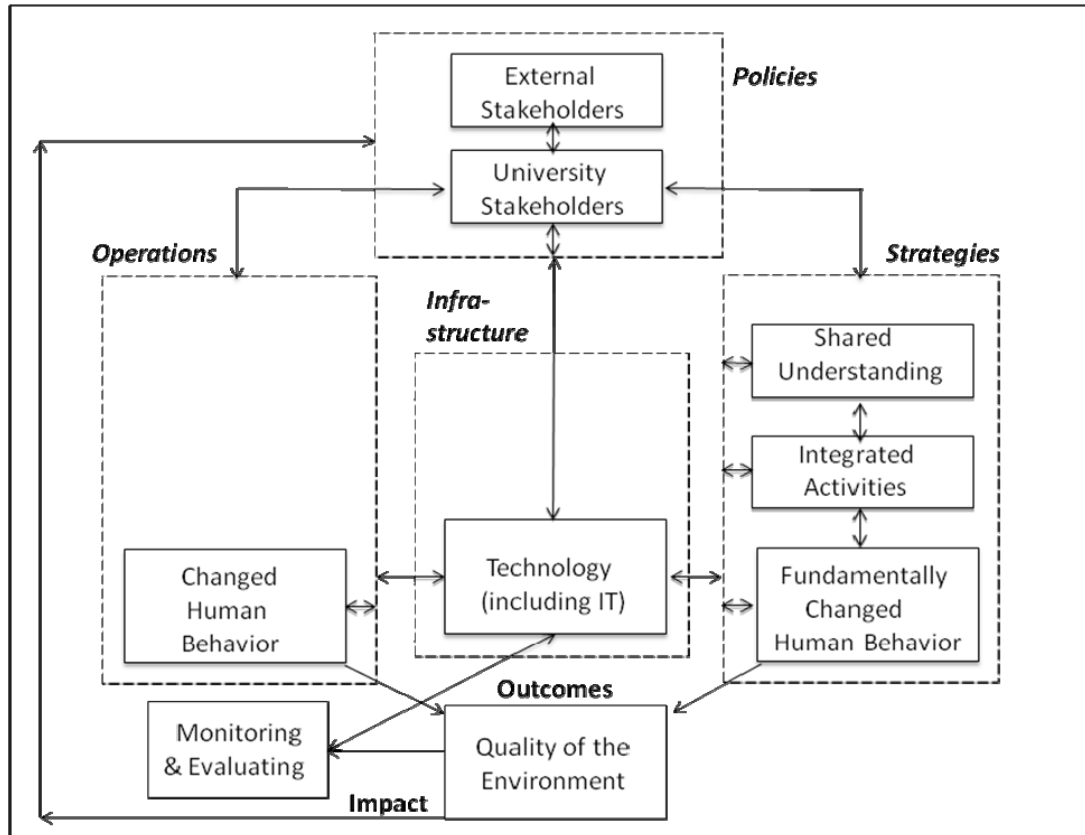


Figure 1: Conceptual Impact Model of the Cybernetic Relationship between University Stakeholders, University Policies, Strategies, Operations, Technology Infrastructure, Intended Outcomes of Technology-enabled Changed Behaviors and the Quality of the Environment (developed from Elliot 2011)

5 A CONCEPTUAL IMPACT (CI) MODEL

A conceptual impact model of relationships in a university between human beings (categorized into stakeholders), technology, changed human behavior and an intended outcome of reduced degradations in the environment based on the literature is shown in Figure 1. Description of the model's elements follows. The intended outcome of changed behavior with an operational focus is an incremental reduction in environmental degradation to address a particular issue in a specific area. Conversely, policies and strategies intended to achieve significant progress towards sustainability targets at a whole of organization level require shared understanding and integrated activities leading to fundamentally changed human behavior.

Different technologies form an infrastructure to assist implementation of these changed behaviors. Depending on the university's policies and strategies, the technology infrastructure may range from specialized equipment for energy generation to applications of general-purpose IT. Applications of IT include: mediating communications within and among stakeholders; facilitating changed human behavior within and among stakeholders; and supporting monitoring and evaluation of behavioral change and reporting on environmental impacts. There is also a potential future role for applications of IT in moderation of the impacts of deteriorating quality of the environment. Potential roles in the future are acknowledged but have not been shown in Figure 1 since this paper seeks to address current issues.

The empirical models reviewed above tend to be either at such a high level as to provide little assistance or at a detailed level prescribing a course of action that may not be appropriate, (see Tables 1 and 2, Focus and Scope). The CI model (Figure 1) represents the relationship between a university's policies, strategies, operations, technology infrastructure and outcomes of changed behaviour as being cybernetic, i.e., each element in the model is a system that interacts with the other parts such that all parts of the model are systems within a system (Elliot 2011, von Bertalanffy 1996).

Interactions in the cybernetic relationship are represented by directional arrows, such that stakeholders determine policies with operational and/or strategic impact that may lead to changed behaviour at an operational level (e.g., turn off lighting in your office when you leave work) or at a strategic level (e.g., commitment to a target for reduction in greenhouse gas emission by a particular date). The activities constituting changed behaviour are observable by stakeholders or facilitated, monitored and evaluated by the technology infrastructure. The intended impact on the quality of the environment, if determinable, is evaluated and reported to the stakeholders. Fundamentally changed human behaviour requires a shared understanding among stakeholders and a commitment to achieve an organization wide target of, for example, reduced emissions of greenhouse gases.

Fundamental changes to human behaviour need activities to be integrated across the organization, such as: lighting in all buildings to be controlled by timers and motion detectors; implementation of renewable energy generation and/or purchase of renewable energy; acquisition of a low emission fleet of vehicles; a program to improve building insulation; a program of car pooling etc. The technology infrastructure supports achievement of organization-wide sustainability goals either directly (e.g., through reduced energy use) or indirectly (e.g., through facilitation, mediation, monitoring and evaluating progress compared with targets and reporting to stakeholders).

Executives and educators seeking guidance from the academic and empirical models reviewed in the previous section will be disappointed at the limited amount of detailed assistance available. Table 1 (focus and scope rows) demonstrates that the frameworks and models available to assist and inform universities are predominantly focused at a policy level or on specific issues in operations administration. Practical assistance to implement policies or to provide non-administrative initiatives, such as educational offerings, receives little attention. Consistent with General Systems theory (von Bertalanffy 1996) the CI model shows how changed activities at an operational level may have some impact on the quality of the environment. However, if the organization's intended impact on the quality of the environment is to be significant then fundamental changes to existing human behaviours that require shared understanding as part of integrated initiatives across the organization are essential (Elliot 2011).

Where the policy changes are for educational offerings, individual activities in isolation may have some impact on the level of quality of the environment. Fundamentally changed programs with depth and breadth across a range of disciplines, however, can develop capabilities in sufficient quantities of students to influence behaviours across a range of organizations, leading to the potential for significant impact on the quality of the environment. The CI model represents a response to Lee's (2010) call for IS researchers to pay greater attention to development of generalizable, practice-based models of theories in use that can assist managers in organizations to apply technology to address their challenges. Utilization of the CI model in conjunction with the models presented on Tables 1 and 2 may be of assistance to executives in two ways. The CI model clarifies the implications of focusing on operations and/or strategies. Executives can then refer to Tables 1 and 2 to determine where and how prior experiences in the field may be utilised. As the models have different aims and objectives, this approach is limited in its assistance since the executives will need to become sufficiently familiar with the various models to determine the advantages and disadvantages of each model. A more comprehensive level of

executive assistance requires development of an integrated model based on the full range of sustainability practices in universities.

6 CONCLUSIONS AND IMPLICATIONS

Universities are recognized as being essential contributors in addressing the challenges of environmental sustainability (UN 1987) but, despite many initiatives and as a whole, universities have not succeeded in realizing their potential. This situation is addressed by this paper and its research questions. The aims are to facilitate the development of behaviors and practices in the university sector that are more environmentally sustainable by addressing limitations in existing management models.

The first research question was, how can universities realize their potential contribution to resolving the challenges of sustainability? This question arises from the limited details available in current models to assist university executives (see Table 1 and 2). The question is addressed directly by the proposed Conceptual Impact (CI) model (Figure 1). This model shows the direct impact of the level of quality of the environment on university stakeholders and how university behaviors may impact on the quality of the environment. The CI model presents links between university policies, strategies, operational activities, changed behaviors, shared understanding, integrated activities, fundamentally changed behaviors, technology infrastructures, monitoring and evaluation, intended impacts on the level of quality of the environment and the impact of level of quality of the environment on university stakeholders (Elliot 2011).

The second research question, what drivers and inhibitors influence university initiatives, has been addressed through the review of purposively selected literature (Miles and Huberman 1994), see section 4 above. Major drivers include: leaders' commitment to sustainability, availability of financial incentives, communications, and compliance with a government mandate. Resistance was fuelled by: funding constraints; lack of communication and information sharing among campus stakeholders; lack of appropriate campus or government policies for support; lack of shared values; and lack of capabilities to implement the initiatives. Drivers and inhibitors are implicitly incorporated in the CI model in the processes of determining policies, strategies and operational activities and in consideration of the impact of these sustainability initiatives as monitored, evaluated and reported by the technology infrastructure.

The third research question, can applications of ICT facilitate increased contributions by universities, was addressed by the CI model (Figure 1) with technology-enabled infrastructure identified as being a previously overlooked driver and facilitator of the changes required. The capability for universities to readily monitor, evaluate and report on the outcomes of sustainability initiatives will tend to promote successful initiatives and contribute to the organization learning from its own experiences for more sustainable success. Organizations seeking to address sustainability issues without an appropriate technology infrastructure will tend to generate individual activities in isolation that are unlikely to produce determinable outcomes as they lack the capability to evaluate progress towards a goal.

The critical contribution of an appropriate technology infrastructure addresses the final question, how and where can IS scholars support universities to address sustainability challenges. As seen in Figure 1, the technology infrastructure in the CI model assumes a central role in facilitating strategic initiatives by the universities by facilitating shared understanding and integrated activities and by cost effectively monitoring, evaluating and reporting change and fundamental change as well as the impact of change on the level of quality of the environment.

The technology infrastructure comprises a range of technologies interacting with the university community. This is exactly the nature of interaction between technology and society envisaged as being at the core of the IS field of study (Lee 2001, p iii). The organizational context of a university may not be the context generally considered in IS research and universities' mission statements will certainly be different from business or government but the interactions between technology and the university community will be similar. The capability for IS researchers to contribute directly to global sustainability goals in their own institution as a mainstream research activity presents an opportunity for high impact, high visibility research that should not be ignored.

The more general applicability of the CI model may have been influenced by this paper's research design decisions, the experiences contained in the literature selected and the analysis of those details.

However, this initial effort to address a persistent challenge for universities in addressing a global problem suggests that the CI model has utility in identifying gaps in current models of how sustainability initiatives may be applied in institutions of higher education. This contention will require testing through further research. The implications for university executives are in addressing uncertainties inhibiting effective initiatives to address sustainability challenges, clarifying drivers and inhibitors, and identifying that an appropriate technology-enabled infrastructure is essential to support the various initiatives and to achieve the shared understanding and integrated activities required for fundamentally changed behavior. The cybernetic model also identifies the necessity for suitable policies and strategies, shared understanding, integrated activities and for fundamentally changed human behaviors to affect significant reduction in the current level of environmental degradation.

This paper contributes also to the IS discipline, which has its own challenges as well as those relating more generally to sustainability. Challenges to the IS discipline include calls to increase the relevance of its research and learning and to address global issues (Agarwal and Lucas 2005). The environmental sustainability of ICT presents a logical area for IS research focus since it falls clearly within the core of the discipline. Sustainability initiatives require application of IT for their success. Universities require assistance in addressing the challenges in transforming current behaviors into more sustainable practices.

The implications for IS researchers are to make rigorous contributions to their employers, their communities and their students through application of the proposed CI model. This model focuses attention on IS applications for mediation, facilitation, monitoring, evaluation and reporting progress, and, as may be required in the future, in moderating the impact of a dynamically deteriorating environment on universities and their societies. In these ways, the IS discipline could contribute to reducing uncertainties inhibiting universities from making effective contributions to sustainability, supporting drivers of change, overcoming resistance to change, and addressing the diverse challenges of environmental sustainability, for the benefit of all concerned.

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