AMCIS 2010 Proceedings

Americas Conference on Information Systems (AMCIS)

8-2010

Developing and Justifying Energy Conservation Measures: Green IT under Construction

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ABSTRACT

In order to achieve the large-scale reductions in carbon emissions necessary to reduce the impact of climate change, fundamental technological changes will be required. In this regard, Green IT and IS may be able to play a pivotal role; however, such initiatives require new skills of IS leaders that are not sufficiently addressed in current university programs. In the process of developing practical and relatively simple energy conservation measures (ECMs) for organizations, we identify three critical challenges that organizations will face as they engage in this process: dealing with different perspectives, setting the boundaries and context of the ECM, and researching information. Based on this experience we propose that multi-disciplinary perspectives to decision-making and experiential learning be incorporated into the Green IT/IS curriculum.

Keywords

Green IT/IS, IS education, multi-disciplinary, experiential learning, environment, sustainability.

INTRODUCTION

Since the United Nations Climate Change Conference in Copenhagen, there appears to be renewed international focus on setting targets for global emission reductions. Although the level of these targets and whether they will be sufficient to avoid catastrophic outcomes will continue to be subject to scientific and political debate (Stern 2008), one thing is certain: fundamental technological changes will be required to achieve large-scale reductions in carbon emissions (Sterner and Turnheim 2009). Proponents of Green IT and IS have suggested that information technologies and systems should play a pivotal role in this technological revolution (Boudreau, Chen and Huber 2008). For the IS field, this is especially important as the use of IT/IS is exploding, growing two times faster than the Gross World Product (Siegler and Gaughan 2008), quickly surpassing air transportation in terms of its carbon footprint (Dembo 2008).

In practice, efforts around Green IT have focused primarily on immediate and direct effects, such as power consumption and end-of-life disposal (Bradbury 2009). However, as the 'low-hanging fruit' gets picked, there is increasing recognition of the broader implications of Green IS. Green IS is expected to have indirect effects through the transformation of business processes (Bradbury 2009) in much the same way as IT has changed organizations (Brynjolfsson and Hitt 2000). For example, investments may include the enhancement of video-conferencing and electronic document systems to reduce both the costs and lost productivity associated with travel (Jenkin, Webster and McShane 2009). However, Green IS differs from traditional information systems in that environmental initiatives require new knowledge and skills of IS leaders.

Organizations are beginning to provide environmental education to a wide range of stakeholders, particularly employees and customers (Bhandari and Abe 2001) and it is important that environmental concerns be brought into the IS curriculum. For example, Watson et al. (2010) suggest that higher education should introduce green computing, design courses encouraging the creation of environmentally sustainable systems and organizational processes, and awareness around environmental sustainability. They propose the augmentation of textbooks and the creation of case studies. Similarly, the environmental literature suggests education and environmental awareness are critical to changing people's behaviors and it has been suggested that the fundamental characteristics of universities uniquely qualify them as vehicles for this needed social change (M'Gonigle and Starke 2006). Environmental studies programs, which represent a holistic approach using tools from a range of disciplines, have been initiated but are focused on their own students, missing the opportunity to provide training across the broader range of disciplines.

While we agree that these changes to post-secondary education are necessary, our experience suggests that current approaches are not sufficient. Two recent books, "Planet U" (M'Gonigle and Starke 2006) and "The Sustainable MBA" (Weybrecht 2010), have tackled the issue of environmental sustainability; however, for the most part, they provide little direction for IS educators. For example, Weybrecht (2010) devotes major chapters to the traditional business school areas, such as accounting, marketing, and strategy, but does not include a chapter on IS/IT. Furthermore, in terms of promoting sustainable development, both research and practice have demonstrated that traditional educational efforts aimed solely at raising the awareness about the threats of environmental degradation are not sufficient for lasting behavioral changes (Dobson 2007). Therefore, we propose a new way of approaching education as it relates to Green IT/IS. In particular, we focus on how business schools can incorporate Green IT/IS education into all of their programs from undergraduate business degrees to graduate research and executive education. Our approach draws on our experience related to building energy conservation measures for Green IT/IS in organizations and incorporates several key characteristics, specifically the adoption of multi-disciplinary perspectives to decision-making and experiential learning.

This paper is organized as follows. In the next section we briefly describe our research and experience related to the construction of energy conservation measures. Then we highlight three main challenges we faced in the process. Following that, we present two opportunities for enhancing Green IT/IS education in business schools and conclude with some final thoughts.

DEVELOPMENT OF ENERGY CONSERVATION MEASURES

As part of a three-year research project on Green IT/IS, we developed several templates for specific Green IT/IS energy conservation measures (ECMs). ECMs are discrete and actionable changes that organizations can make to lower their energy consumption and environmental footprints. Through this exercise we put ourselves in the place of IS leaders and experienced first-hand the process, learning requirements, and challenges that they are likely to face as they begin to implement Green IT/IS in their organizations.

Since the creation of ECMs requires expertise in several areas, the first step in the process was to assemble a multi-disciplinary team. The team included an Economist, an Environmentalist, an Engineer, and two MIS members. By scanning both the practitioner and academic literatures related to Green IT/IS, a list of potential ECMs was created, ranging from relatively simple initiatives such as double-sided printing to more complex projects, such as implementing renewable energy sources for data centers. The ECMs were then prioritized and development work began. For the purposes of this paper, we draw on the experience of one ECM, replacing business travel with desktop video-conferencing (DVC). In this ECM, we calculated cost, energy, and environmental savings for substituting selected face-to-face meetings with DVC.

We started with a general data gathering phase, searching information from library systems, the internet, and local providers. In parallel with data collection, our Economist began development of the ECM spreadsheet based on a preliminary template from a previous ECM. For the template we identified five main sections: 1) the introduction, providing an overview of the ECM with a simple worked example; 2) the input page, used by the organization to enter information relevant to their particular situation; 3) the projected savings from economic, environmental and energy perspectives; 4) the executive summary, showing results of the calculations and highlighting benefits of the ECM to the particular organization; and 5) assumptions and references.

Given the dependencies between data collection and ECM tool we adopted an iterative development process. The alternative would have been a more traditional staged approach; however, we felt the iterative approach allowed us greater flexibility to incorporate new information quickly and to collectively develop the ECM. The result was that while the Economist was initially the main architect of the ECM tool, at various times other members of the group contributed to the format, content and calculations within the ECM.

After several iterations on the ECM tool, we conducted group review sessions to assess the calculation logics, tool layout and design, and quality of the data sources and assumptions. From these meetings additional changes were made. Once we were satisfied with the overall ECM tool, the MIS researchers reviewed the ECM with senior business managers from accounting and IT. During these meetings we discussed three key elements of the ECM: availability of data, presentation of the tool, and reasonableness of the underlying assumptions. Using this feedback, we made final modifications to the ECM and released the first version on the open source appropriate technology website, Appropedia (see http://www.appropedia.org/File:ECM006_travel_-_videoconferencing_Dec11.xls).

Challenges to ECM Development

In the preceding section, we presented a highly simplified version of the ECM development process; while in actuality it was significantly messier as we iterated through different phases. Reflecting back on the process of creating the ECM, three main challenges emerged: dealing with different perspectives, setting the boundaries and context of the ECM, and researching information. These are summarized in Table 1 and are now discussed in turn.

I. Dealing with different perspectives

As noted, our team included individuals with expertise in diverse areas and we received feedback from other senior business professionals. While the incorporation of multiple perspectives was certainly necessary to capturing environmental, energy, and financial aspects, it also resulted in a significant amount of time being devoted to reconciling these different perspectives.

From the outset, each team member viewed the development process from a different perspective (see Appendix). For example, the Engineer was concerned with issues around transparency and credibility. The Economist focused on the rational aspects of financial analyses. The Environmentalist wanted quick progress and felt frustrated with delays. The MIS team members were surprised by the ambiguity around the development process. These differing perspectives resulted in a considerable amount of time delay. We often went from thinking that we had a shared understanding of an issue, finding out later that this was not the case, and then 'translating' what we meant to each other. For example, we had different understandings of the term 'transparency'. To the MIS members, this meant being able to view a formula in the spreadsheet and trace its logic. In contrast, to the Engineer, transparency meant that that all complex formulae were broken down into component parts and were easily printable. Perhaps surprisingly, it took multiple meetings for us to understand and resolve this single misunderstanding in terminology which resulted from our different perspectives.

II. Setting boundaries around the ECM

During the process, we quickly learned that we needed to set boundaries on the scope of the ECM, otherwise, it would spin out of control. For example, certain members wanted to include both room and desktop VC in this ECM; however, the MIS team members knew that the cost/benefit analyses (and users' use of video-conferencing) would be very different for the two types and argued that separate ECMs should be developed.

One of the most vexing problems when determining environmental impacts for the ECM was how far to go in the life cycle and where the practical boundaries of organizational responsibility ended. For instance, in order to implement DVC, an organization may need to acquire webcams and speakers. From a true life cycle perspective, the environmental footprint of this hardware, including shipping to the organization's location, should be considered. However, there is debate about whether this environmental impact should be borne by the organization or the hardware manufacturer. Additionally, although some organizations are beginning to provide product-related environmental footprints (ClimateBiz 2010), we found a paucity of research specifically relevant to this ECM and thus decided not to include it in the initial version.

III. Researching information

We did not anticipate that finding the necessary information to use in the ECM would be so difficult. One feature of the ECM that we like to include is a baseline value for key variables (i.e. hardware or software costs). However, for the DVC ECM, it was hard to determine specific and accurate values. For example, in calculating the environmental impacts of travel, we first looked to publically-available calculators. Unfortunately, they seemed to use "average" carbon emissions for (unknown) cities and we required a higher level of accuracy. We considered having users type in city names, but this would then necessitate a detailed look-up table that was beyond the level of complexity we wanted to include in the ECM. As a compromise, we decided to use data from a North American air carrier to interpolate the carbon emissions based on travel distances entered by the user. This is just one example of the difficulty in researching and calculating information for this ECM; there were many others (see Table 1).

PROPOSED APPROACH FOR GREEN IT/IS EDUCATION IN BUSINESS SCHOOLS

Based on this experience, we believe that there are two significant opportunities for enhancing Green IT/IS education in business schools: decision making strategies and the importance of experiential learning.

Challenges	Issues	DVC Examples	Reconciling Issues
I. **Dealing with Different Perspectives**	How to determine requirements/design of ECMs?	We all had different visions of the design based on past experience, such as the Engineer developing ECMs for engineers, the MIS members' experience with designing systems, and the Economist's expertise with spreadsheets.	To settle disagreements, the MIS members interviewed and later demonstrated the ECM to organizational decision makers.
	How to make others' tacit knowledge explicit to MIS members?	The Engineer knew what he wanted for the ECM, but this did not become clear to the rest of the team until we had worked on the ECM for several months. For example, the credibility and transparency of information used in the calculations was crucial for the Engineer.	To discover what the Engineer wanted, we projected the ECM on the room display and painstakingly walked through it line by line as a group. Every piece of information was linked to its source on a separate sheet of assumptions and links.
	How to make tacit MIS knowledge explicit to others?	From our MIS background in "knowing the user", we had an understanding of how to effectively present information to a user. We assumed that the Economist would have the same understanding, but he did not. Instead, he designed an ECM that made sense to him, but would not make sense to a typical user. He was more concerned with the accuracy of calculations than with how the ECM looked and was documented.	MIS took on the role of 'naive user' and provided examples to the Economist of things that would not make sense/were not clear. At various times, MIS members took control of the spreadsheet and made changes directly.
II. **Setting boundaries**	How far should we go in the life cycle of an ECM?	The team debated whether to include the construction of the camera used for DVC and the impact of its ultimate disposal.	After conducting research to determine whether the necessary environmental information existed (and if the impacts should be borne by the organization), we decided to exclude some items from the ECM.
	What unit of measurement to use for environmental impacts?	The team was unsure whether we should focus on all environmental impacts (waste, water, air, etc.) or just greenhouse gases or CO_2 emissions.	We converted all environmental impacts to CO_2-equivalents, consistent with generally accepted practices in this area.
	Delineating the scope of the ECM	MIS members wanted to focus on DVC; some others wanted to include all types of VC, including room VC. MIS members thought that the major differences between the two types of VC were 'obvious'.	MIS members drew on their past research with DVC and room videoconferencing to argue that cost points and employee reactions were very different across the two media.
	Where to focus effort most (cost/benefit or environment)?	Based on past experiences with organizations, the Engineer thought we should focus more on cost/benefit than the environment in order to encourage organizational change.	MIS found themselves arguing for the environment with the Engineer. MIS interviewed organizational decision makers to see what information they preferred.

Challenges	Issues	DVC Examples	Reconciling Issues
	At what point in ECM development should it be piloted in the field?	The Environmentalist believed in making changes to benefit the environment as soon as possible; she wanted to implement ECMs immediately, before completion. The MIS team members wanted to wait until an ECM was credible for for-profit organizations.	We delayed going into the field until we felt that the ECM could be used by an actual organization.
III. Researching information	How/where to determine resource usage before and after a change?	We were challenged to determine what mileage rates and costs should be assumed for car travel before implementation of the DVC.	We used published government rates, but allow for companies to change these in the ECM.
	How precise to be in measurement?	We debated whether to determine averages based on flights of certain lengths, or calculate more accurate numbers between actual cities with specific types of aircraft and typical aircraft loads. Additionally, there was the problem of reconciling differing values across differing sources.	We compromised by including average values and providing flexibility for the user to adjust as appropriate for their situation.

Table 1: Challenges of Developing Green IT/IS Energy Conservations Measures

First Lesson: Decision-Making Strategies for Multidisciplinary Development

During this process, we found that multidisciplinary development requires much more justification of our data and calculations. Looking at the last column of Table 1 -- in which we outline how we reconciled each of the challenges -- we see that they fall into three main categories: relying on external expertise, internal expertise, and satisficing. In particular, external expertise was most important; that is, calling on an outside party whom we could all respect (e.g., the U.S. Environmental Protection Agency) helped to quickly resolve an issue. If this was not possible, we used our internal expertise to argue around issues. Finally, we often had to satisfice, or make adequate rather than optimal decisions (Simon 1979), because the environmental information we needed was just not available.

As educators, we may believe that we already address multidisciplinary perspectives when we teach students about the importance of 'knowing the user department' for effectively developing systems. However, the boundary spanning required for the development of ECMs appears to be an order of magnitude more complex than regular systems development. Not only must developers understand the needs of user departments, they must understand and communicate environmental and economic issues in a comprehensive, rather than a superficial, way. In addition to revising systems textbooks, we need to go further to provide business students with hands-on experiences working with other disciplines that are critically involved in environmental sustainability programs, such as engineering, the sustainability office, and finance.

Second Lesson: Experiential Learning

Students cannot learn the complexities of taking the environment into account without experiencing the process firsthand. No case or textbook can present the ambiguities and conflicting views that we experienced. Thus, we suggest that educators focus on service learning (also called practice/problem-based/experiential learning).

Service learning presents a type of teaching method that combines community service with academic instruction; it focuses on critical, reflective thinking and civic responsibility. There is a growing body of literature showing that service learning outcomes have been positive for students, faculty, educational institutions, and community partners (Bringle and Hatcher 1996; Panici and Lasky 2002; Pearce & ter Horst 2009). For example, the Kellogg Commission has concluded that service learning "should be viewed as among the most powerful of teaching procedures, if the teaching goal is lasting learning that can be used to shape student's lives around the world" (Kellogg 1999, p. 29). The largest benefactors of this approach are the students, who are more motivated, work harder, learn more, and experience lasting benefits from their experiences (Cohen and Kinsey 1994; Pearce and Russill 2005).

The very real need to drastically reduce greenhouse gas emissions provides a clear opportunity to couple service learning with the implementation of ECMs. Therefore, following the success of previous work utilizing service learning projects to improve energy efficiency (e.g., Pearce and Russill 2003, 2005), we suggest that IS educators focus on improving the economic, energy, and environmental efficiency of the business community by encouraging Green IT/IS initiatives. This may include, for example, engaging students in a process of developing new ECMs and implementing them in organizations.

CONCLUSION

Although environmental sustainability and climate change are long-term problems, we cannot afford to be complacent in our approach to dealing with them. Fairly immediate and dramatic changes within organizations need to be made in order to avert potentially disastrous outcomes in the next 50 years (Stern 2008) and the application of Green IT/IS represents a significant opportunity to make a difference (Jenkin, McShane and Webster 2010). However, when technology advances almost daily, our scientific knowledge about the impact of climate change grows, and the political environment changes, there is the potential for inertia to set in, for organizations to wait to do 'something' until it is more clear what that something is. Additionally, as a result of current limitations in business school curriculum, there is the potential that even when managers want to make changes, they are not equipped with the right knowledge or skills. As partners with business practitioners, it is incumbent on the academic community to address this gap. We propose that the incorporation of multi-discipline decision making and experiential learning represent two excellent opportunities to do just that.

ACKNOWLEDGMENTS

We thank Tracy Jenkin for her early project support, Ana Ortiz de Guinea for her useful comments, and the Social Sciences and Humanities Research Council of Canada for financial support.

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APPENDIX: CROSS-DISCIPLINARY FOCI - FOUR VOICES

Economist:

The road to success is full of invisible obstacles that will slow down the development process. From the economist's perspective, the first difficulty is to explain the economic decision criteria (NPV, IRR, payback period, etc.) and how cost/benefit analysis works to the other participants of the project. The criteria to be used must be decided in the beginning of the process to eliminate misunderstandings and time-consuming modifications in later stages. Furthermore, considering that even the best projects cannot precisely predict the economic benefits in the long-run, a certain degree of flexibility in the projections is necessary and sensitivity analysis should be implemented to determine critical economic points that will make the project infeasible or unprofitable.

Benefits may not be restricted to energy savings for the new technology/method. Most of the time, energy efficiency comes with the state-of-art technology. Adoption of this technology may not only lower the energy bill for the end-user but also brings higher productivity advantages through lower labor-hours. Also, the environmental benefits must be visible, verifiable, and superior to the technology used by industry peers (which will motivate the firm).

There may be other indirect benefits of adopting an ECM such as higher employee performance thanks to better technology. Although the presence of indirect benefits may be clear, quantifying the benefits can be hard. This may result in ignorance of such extra benefits during decision making.

The possible way to alleviate this problem is to utilize sensitivity testing, where relaxing assumptions and the worst case scenario results matter.

Environmentalist:

The first thing to consider is time and scope of the project. Given time constraints, it is vital to focus on the ECMs with the greatest impact. Also, it is difficult to know if economic savings will always be the first priority for the companies or if environmental issues may take an equal weight as oftentimes the two are quite comparable.

Coming from an environmental studies background, which is heavily based on multidisciplinary approaches, I understand the need for collaboration between different fields of study. An important aspect to this kind of project is communication. From the outset, everyone should have attended the development meetings to make sure their views were fully known (and their vision plausible) to the team. This would have minimized unnecessary edits, guessing, time loss and generally helped build confidence and momentum for the project. Working across multidisciplinary boundaries can indeed be difficult at times, but it is the only way different perspectives can be brought together to address complex issues, otherwise we are left vulnerable to problems we simply do not see or, worse yet, do not want to acknowledge.

Although our methods and visions differed at times, our main objective (recognizing the need to improve the efficiency and sustainability within the Green IT sector) was a common goal and kept the project on course. To say I did not notice friction at times would be an understatement; after all new ideas take time to sink in and come together, but this type of collaboration will truly be the future of education and great ammunition to solving global problems.

Engineer:

In order for an ECM to be valid for an engineer, the methodology must be transparent and rigorous, the technology must be realistic, and the sources of input information and assumptions must be trusted. Thus in developing the ECM templates it is imperative for the engineers on the team that each calculation be easily traced back to an equation (accomplished with hyper links), which is also easily verified. In addition, all the variables must be limited to realistic values and only reliable sources utilized for data inputs. In addition to being time consuming, this can be a substantial constraint as some ECMs depend upon proprietary information or software, which can make claims difficult to verify. Another factor is the time investment necessary to construct a rigorous business case for a given ECM.

ECMs within industry are often not implemented because after engineers compare an ECM to some standard practice, they determine a simple payback time. But decision makers often short-sightedly reject these ECMs because of what they view as a prohibitively long payback time. It is clear that the lifetime of the project or technology must be taken into account for a return on investment to be determined and a good business decision made. Thus, just as it is imperative for future engineers to be able to communicate effectively to business decision makers, it is also necessary for business students to understand how engineers approach energy conservation projects. Engineers who consider full life cycle economics in decision making are the minority, as engineers have generally been trained that their primary constraints are costs, safety, and time (fixed deadlines).

MIS:

We had already developed a previous ECM, so we knew some of the challenges: the importance of finding reliable information, the major categories of calculations, and the overall format of our spreadsheets. However, although the other MIS team member had extensive work experience in the financial industry and I had conducted research on both desktop and room videoconferencing, I felt confident that we understood the important issues. Even then, the development process surprised me.

We spent too much time debating basic issues (and revisiting these issues that we thought had been resolved), such as what cost/benefit measures organizations want to see and whether we should create the ECM for DVC or for both DVC and room VC. I felt frustrated with these debates, as I felt that our experience in these two areas was not valued by other members. We also spent a considerable amount of time trying to figure out reasonable baseline assumptions. It was hard to nail down how detailed and accurate our calculations needed to be.

I kept thinking that this isn't the way we (teach how to) develop systems. That we were using a prototyping approach wasn't the main issue here. Rather – although ECMs are deceptively simple – the requirements kept spiraling out of control, mostly because of the ambiguity. To satisfy the various members of our team and the goals of our project, our ECM needed to be verifiable and believable by an organization. And, this issue will become even more important in the future as organizations will be required to provide third-party verifications of their environmental performance.