Encouraging Sustainable Energy Use in the Office with Persuasive Mobile Information Systems

Research-in-Progress

Divinus Oppong-Tawiah
Queen's University
Kingston, Ontario, Canada
divinus.oppong-tawiah@queensu.ca

Jane Webster
Queen's University
Kingston, Ontario, Canada
jwebster@business.queensu.ca

Sandy Staples
Queen's University
Kingston, Ontario, Canada
sstaples@business.queensu.ca

Ann-Frances Cameron
HEC Montreal
Montreal, Quebec, Canada
ann-frances.cameron@hec.ca

Ana Ortiz de Guinea
HEC Montreal
Montreal, Quebec, Canada
ana.ortiz-de-guinea@hec.ca

Abstract

Faced with growing pressures to be more environmentally sustainable, many companies are increasingly exploring innovative ways to incorporate "green" practices into their business processes. We focus on employees and their potential contributions to organization-wide sustainability goals through their pro-environmental behaviours. This article reports on current progress with a multi-year study targeting the use of mobile media to encourage pro-environmental behaviours. To do so, we provide employees with feedback on their computer-based energy usage. We discuss our combined design science and experimental approach to developing and studying a mobile application with embedded persuasive characteristics. Our future interventions will use this persuasive media platform to examine the impact of social-psychological theories on encouraging more sustainable energy use by employees.

Keywords: Green Information Systems, Persuasive Designs, Pro-Environmental Behaviour, Energy Conservation, Mobile Media

Introduction

A large portion of organizations' electricity costs (and concomitant greenhouse gas emissions) is due to computer-related energy use (e.g., for office buildings, 26%; for data centers, 95%) and more than half of this energy is typically wasted by inefficient technologies, poorly designed systems, or uninformed behaviours (Hodges and Gaughan 2008). Smarter use of information technologies and systems (IT/S) could reduce global emissions by 15% (The Climate Group 2008). Consequently, this study focuses on improving employees' pro-environmental behaviors related to IT/S.

Environmentally responsible behaviours in organizations, or pro-environmental behaviours (PEBs), represent any actions taken by employees that they believe would improve the environmental performance of their organization (Ramus and Steger 2000). These may include such behaviours as conservation of resources, recycling, pollution prevention, and advocacy for environmental change (Russell 2007). Specific to information systems, these PEBs may include employee behaviours such as substituting desktop videoconferencing for travel, turning off computer equipment when not in use, choosing new equipment based on its environmental footprint, using less paper when printing, donating or recycling old equipment, and influencing coworkers to do the same. Here, we focus on reducing employees' computer-based energy usage by providing usage information and feedback through the use of a social media application.

Although information systems have great potential to affect environmental sustainability in organizations, little research has examined their potential (for exceptions, see Elliot 2011; Jenkin et al. 2011; Melville 2010; Watson et al. 2012). Most of this research is theoretical and situated at the organizational level of analysis, rather than empirical research examining employees' sustainable behaviours. In addition to strategic and organizational applications, focusing on individuals' behaviours is also important, as their effects can go well beyond themselves (Swim et al. 2010). In contrast to citizens (i.e., people who act individually or within a close-knit family unit or circle of friends), employees can have influences on a wider-ranging network of diverse people. Not only may their own behaviours change, but they may also influence both their peers and managers to act more responsibly (Smith and O'Sullivan 2012). Thus, it has been argued that the primary role of information systems in sustainability transformation is to help employees engage in sustainable practices to reach their pro-environmental goals (Siedel et al. 2013).

The objective of our research is to understand and create lasting behavioural change in order to reduce employees' environmental footprints with respect to IT/S in the workplace. Specifically, we develop an application that tracks employees' energy usage on their computers and encourages them to reduce their energy consumption. To design this application, we applied persuasive design techniques (Fogg 1999, 2003) to create a social media application to engage employees, and thus encourage them to conserve energy in the workplace. For this study, we have three inter-related objectives: (1) to extend existing research and persuasive theories that examine interventions with citizens (e.g., recycling) to employees, (2) to design and develop a persuasive social media application that effectively enables an intervention, and (3) to implement this application and study its impacts over time in an organization. For this study, our social media application uses the metaphor of a garden on the user's smartphone and includes three subsystems: a Consumption module for metering the amount of energy consumed on the user's computer, a Feedback module for changing the garden display on the user's smartphone, and a Communication module to send prompts and recommendations to the user's smartphone. In the following sections, the literature on PEBs, persuasive technologies, and PEB interventions are reviewed, the study method is described, the timeline of the project is given, and ideas for future research are outlined.

Literature Review

Employees contribute significantly to organizational energy use through direct (e.g., consumption of electricity on the work floor and work-related car travel) and indirect (e.g., paper) consumption of energy (Bolderdijk et al. 2013). To reduce the organization's environmental footprint, organizations need to motivate employees to curtail their use of existing equipment and materials (e.g., by turning off unused appliances, driving efficiently, and printing less often) (Gardner and Stern 2002). While at home, many people seem willing and motivated to engage in conservation behaviors, particularly when the target behavior does not require too much time, money, or effort (Abrahamse, Steg, Vlek, and Rothengatter 2007; Diekmann and Preisendörfer 2003). On the other hand, motivating conservation behaviors in the workplace may prove more difficult (e.g., Carrico and Riemer 2011; Siero et al. 1996; Staats, Wit, and Midden 1996). Unlike at home, employees typically receive no feedback on how their individual behaviors contribute to energy conservation. As such, employees may not feel personally responsible for reducing the organization's environmental footprint. Together, these circumstances may explain why people are less motivated to conserve at work than at home (Carrico and Riemer 2011). We propose that employees will be motivated when their behaviours are visible to them through the use of a mobile media application that provides feedback. Mobile media, such as smart phones, enable near anytime, anywhere access and are expected to be the main driver of mobile internet usage in the next few years (Kaplan and Haenlein 2010). These media are high in social presence, self-presentation, and self-disclosure, allowing for the development of relationships, the management of impressions, and social modeling, which in turn influence behaviours. Although research on other types of media would be valuable, we believe that the persuasive nature and ubiquity of smart phones warrant attention. Thus, we base our application design on persuasive design principles.

Persuasive Technologies

Persuasive systems are "computerized software or information systems designed to reinforce, change or shape attitudes or behaviors or both without using coercion or deception" (Oinas-Kukkonen and Harjumaa 2008, p. 164). Combining the positive attributes of interpersonal and mass communication, social media have affiliation, access and participation characteristics that make them suitable as a persuasive technology platform (Corbett 2013; Khaled et al. 2006; Oinas-Kukkonen and Harjumaa 2008). Some types of social media (e.g., Facebook) have been examined as persuasive technologies, demonstrating their potential to influence individuals' behaviours (Fogg and Iizawa 2008; Weiksner et al. 2008). In particular, smart phones are conducive to persuasion because of their mobility, convenience, and connectedness (Fogg 2003).

Technology can help persuade in three basic ways: as a tool, as a medium, or as a social actor (Fogg 1999). As a tool, persuasive systems can provide tailored information, lead a person through a process and increase behavioural self-efficacy. Computers as media can help influence people by providing simulated or vicarious experiences that help them learn about possible behaviors. Examples of working as persuasive social actors include providing social support, modeling behaviors, or leveraging social rules. Drawing on Fogg's functional triad, Oinas-Kukkonen and Harjumaa (2008, 2009) created 28 design principles related to supporting users' tasks, supporting users in reaching target behaviours, motivating users via social influence, and enhancing system persuasiveness via credibility.

Persuasive designs for sustainability have been popular in the human-computer interaction area. These have included ambient displays using sensor technologies (Kappel and Grechenig 2009), ambient computer widgets (Kim et al. 2009; Kim et al. 2010), social network applications for sharing environmental data (Foster et al. 2010), persuasive games (Ham et al. 2009), and interactive visual displays (Chen et al. 2012). To date, most research has lacked mechanisms to evaluate the intended changes for a variety of reasons. Limitations include: short field studies (typically 3-4 weeks) that do not go beyond novelty effects to detect long-term behavioral changes; small sample sizes (typically less than 10) (Brynjarsdottir et al. 2012); and only exploring a design methodology and implicitly assuming behavioral changes (Froehlich et al. 2009; Kim et al. 2009). In addition to a focus on design in detriment to a focus on studying targeted behavioural changes, most research has examined domestic rather than organizational consumption, has placed little emphasis on developing metrics to measure changes in PEBs, and has rarely used causal models to explain how persuasive systems can lead to behaviour changes (Brynjarsdottier et al. 2012).

PEB Interventions

An intervention represents a treatment or manipulation that, in our context, encourages employees to conduct more PEBs. Although there is little research on interventions encouraging employee PEBs, some literature does exist in environmental psychology and social marketing, focusing mainly on citizens (e.g., Abrahamse et al. 2005). This approach draws on psychology research on social influence and persuasion (e.g., Cialdini 2009; Cialdini and Goldstein 2004; Petty and Briñol 2012). In our research, we design interventions for employees to extend theoretical perspectives that have been proven impactful for research with citizens. In contrast to descriptive studies, applying interventions is important because we can more objectively study the relative effects of different treatments (Osbaldiston and Schott 2012).

Research on citizen PEBs can provide some important lessons for employee behaviours; however, it needs to be extended and tested in the organizational context. To help identify which interventions to examine, we relied on a recent meta-analysis of citizen PEB experiments (Osbaldiston and Schott 2012). Osbaldiston and Schott found that interventions with citizens generally fall into one of four broad categories: feedback, information, convenience, and social-psychological processes. Feedback and information have been found to be effective and provide the basis upon which many other interventions (such as social-psychological ones) are built. They are the focus of our present work and, as described below, we will use them as a platform to test additional interventions in future research.

For this first phase of our research, we draw on persuasive guidelines to design our application (see Table 1). Our design primarily provides a *monitoring system* to track user performance, providing them with feedback in the form of a *simulated* garden, offering personalized content for user (*personalization*), and providing suggestions for users during the system use process (*recommendations*) (Fogg 2003; Oinas-Kukkonen and Harjumaa 2008).

Method

Our application consists of an employee interacting through three (consumption, communication, and feedback) subsystems with a mobile application, a power monitoring system, and a database system. A design science approach was used to construct this application and a field experimental approach will be used to test its effectiveness (i.e., whether employees' consumption of energy decreases). This research approach is particularly appropriate in our study because the process of constructing and exercising innovative IT artifacts enables us (as design-science researchers) to understand the problem addressed by the artifact and the feasibility of our approach to its solution, while the field experimental approach enables us (as behavioural science researchers) to understand the organizational phenomena in context. We focus on using pro-environmental goals to inform design rather than on the theoretical context of design, and hence our study is anchored in the IS design science paradigm of constructing an artifact as an experimental apparatus (Vaishnavi and Kuechler 2004). Design science emphasizes how to design and develop an artifact that can be a technological product or a managerial intervention (Gregor and Jones 2007; Simon 1996; Walls et al. 1992). The artifact may refer to software products, such as databases, methods, or software development methodologies. IS design science has been recognized as satisfying one of the five theoretical perspectives relevant to IS (Gregor 2006) and places emphasis on the context affecting the design (Hevner et al. 2004).

As the principal aim of this study is to determine 'what' and 'how' IS can support PEBs in the work context, the adopted approach is one in which design-science and behavioural-science research complement each other. For such purposes, Havner et al. (2004) explain that if existing artifacts are adequate, then design-science research that creates a new artifact is unnecessary. However, no artifact in the persuasive sustainability literature has been identified that is capable of addressing frequent, unobtrusive, and interactive engagement with employees while at work. For example, like many other studies, the persuasive system by Chen et al. (2012) does not isolate consumption from specific user devices and consumption measurement is obtrusive (e.g., users could unplug metering devices). This justified the design of a new IS artifact to explore our study's goals. Our design science method follows the design science model described by Vaishnavi and Kuechler (2004) which involves awareness of the problem, suggestion of a solution, development of the solution, evaluation of the solution, and conclusion. The model includes an iterative loop between developing various persuasive elements and evaluating their behavioral impacts until conclusive contributions can be made concerning which elements of our system in Table 1 are likely to be most effective.

Design of Application

For green IS designs, the material properties required to allow environmentally sustainable work practices include: monitoring, analysis and presentation features; information access and interaction features; file sharing, configuration, and communication features (Siedel et al. 2013). Thus, we designed our application with three subsystems to allow employees to monitor their power usage on their computers and share information regarding good energy conservation practices. As outlined earlier, the Consumption module meters the amount of energy consumed on the user's computer, the Feedback module changes the display of the garden on the user's smartphone, and the Communication module sends prompts and recommendations to the user's smartphone (as well, a future Social module will include suggestions from low power users rewarded with "superpower" rights, who will make recommendations to other users).

The overall metaphor for the application is a garden display that changes as energy usage changes. In the Consumption subsystem, energy usage is measured unobtrusively by directly accessing energy usage from a built-in power metering system on user computers and the measured values are transmitted in real-time to a back-end database. Consumption data are then calibrated to thresholds that are pushed to the Feedback subsystem. The mobile application is comprised of a dynamic garden that shows different states

Persuasive Design Guideline (adapted from Fogg 2003)	Persuasive Element in our System	Design Specifications Applied to our System
1. **Simulating experience** ***Principle of Cause and Effect*** *Simulations can persuade people to change their behaviors by enabling them to observe immediately the link between cause and effects* ***Principle of Kairos*** *Mobile devices are ideal for offering suggestions at opportune moments*	Feedback in the form of a virtualized ecological system with level of power consumption corresponding to different virtual object states	A dynamic ecological garden system in an interactive mobile application
2. Monitoring and Tracking ***Principle of Self-Monitoring*** *A system that helps track one's own performance or status supports in achieving goals (Oinas-Kukkonen and Harjumaa 2008) in a less tedious way*	Unobtrusive tracking of power usage with consumption metrics set at different thresholds	Threshold Level 1 – Low power consumption
		Threshold Level 4 – Normal power consumption
		Threshold Level 7 – High power consumption
3. Gameful and seductive techniques ***Principle of Attractiveness*** *A computing technology that is visually attractive to target users* ***Principle of Competition*** *Leveraging o natural drive to compete* ***Principles of Praise and Rewards*** *Offering praise, via words, images, symbols, or sounds* ***Principle of Recognition*** *Offering public recognition (individual or group)* ***Principle of Social Comparison*** *Providing information about how people's performance compares with others in a similar to group*	Delighters and humor effects	Dynamic garden environments with mix of plants and flowers that 'grow'
	Surprises	Changing number of plants in the garden, garden grows or becomes depleted based on threshold level
	Appropriate challenges	Thresholds for achieving certain garden states based on reasonable daily use of computers at work
	Variable rewards	Watering cans and other garden equipment available on achieving/maintaining certain thresholds over some period
	Reputation and identity	Super-power rights allocated to high achievers, with opportunities to recommend energy saving tips for other users
	Performance comparisons	Consequences (e.g., # of trees necessary to absorb CO2 emissions from current consumption) compared to those of other colleagues or group average.
4. Recommendations ***Principle of Suggestion*** *Suggestions at opportune moments* ***Principle of Tailoring*** *Information/suggestions tailored to the individual's needs or usage context.*	General advice on targeted behavior and personalized feedback based on consumption behavior	1) Standard periodic notifications about good energy consumption practices 2)Triggers based on events (notifications when a computer / program runs on for too long), or on performance targets

Table 1. Persuasive Design Guidelines Applied to our System

corresponding to different thresholds based on measured consumption levels (see the third column of Table 1). In a typical use case scenario, 'low' consumption is indexed to feedback of a vibrant, green, healthy garden state on the employee's mobile phone, whereas 'high' consumption is indexed to a less healthy, stagnant garden state (see Table 2). The Communication subsystem sends prompts and recommendations to the smartphone. The prompts encourage users to access the app to view changes to their gardens; the recommendations suggest actions for reducing IT-related electricity consumption and were compiled from a variety of online sources (e.g., http://www.bchydro.com/guides_tips/green_your_business/office_guide/Turn_equipment_off_when_not_in_use_.html).

In order to determine the mechanism for changing the garden states in the mobile app, we conducted a pilot study: that is, we analyzed consumption data collected from three employees during their regular working hours. The next step was to determine an appropriate baseline for calibrating consumption thresholds for different power usage patterns: our pilot data suggested that a unique consumption baseline for each individual would be more practical for our study (than an average based on the three pilot employees). Therefore, for each participant, we are collecting two weeks of baseline energy consumption data to calculate their unique baselines before providing them with the smartphone application. Once they start using the smartphone application, consumption threshold levels for changing their garden states are determined based on standard deviations from their baselines, as outlined in Table 3.

Our development was conducted through an iterative prototyping approach. More specifically, a team consisting of the primary researchers and system developers (including a computer scientist/software engineer, a database/mobile app programmer, and a graphics designer) met weekly to evaluate newly developed prototypes. These meetings often resulted in evolving requirements as the primary researchers monitored the system to ensure that technical solutions offered by developers did not undermine the behavioural theories underlying the proposed designs. Development was continuous over a three month period, at the end of which the system was "frozen" to allow for testing before deployment to participants in the behavioural portion of the study.

Experimental Method

After conducting a series of pilot studies, we will be testing our application in a field experiment using a pre-test/post-test design, that is, a quasi-experimental method. We are studying employees in their 'natural environment', that is, in their workspaces. Baseline consumption data will be collected by tracking and recording participants' computer energy usage for two weeks. At the end of this period, the mobile application will be installed on participants' smartphones and tracking and recording of energy usage (the dependent variable) will continue over the next two weeks. Then the smartphone application will be removed, but energy tracking will continue for a further two weeks. Pre and posttest surveys will also be administered to assess employees' motivation to conserve energy use, their perceived levels of energy use, and their perceptions of the application (using valid and reliable measures from the literature, such as perceived energy use from Carrico and Riemer, 2011).

Results: Progress and Timeline

We have pretested the power metering system with multiple individuals, we have developed use cases, we have programmed and tested the smart phone application, and we have conducted a series of pilot studies over the summer. We plan to run our full study in early fall, with results available to present at ICIS 2014.

Future Research and Conclusions

The first phase of our research, described above, focuses on providing feedback and information within a persuasive design perspective. Future phases will use our application as a platform to build on and study social-psychological interventions. Osbaldiston and Schott's (2012) social-psychological process category in their meta-analysis encompasses setting goals, social modeling, consistency, and commitment (see Table 4). These interventions resulted in the strongest effects in citizen PEB experiments, but have been studied less frequently than other types of interventions. They require more engagement, fitting well with high effort behaviors such as reducing energy consumption (Osbaldiston and Schott 2012). Therefore, they will be the focus of our future research. We plan to begin with goal setting, as it not only has a strong effect but recent advances in the area (e.g., Gollwitzer and Sheeran 2006; Holland et al. 2006) are very promising.

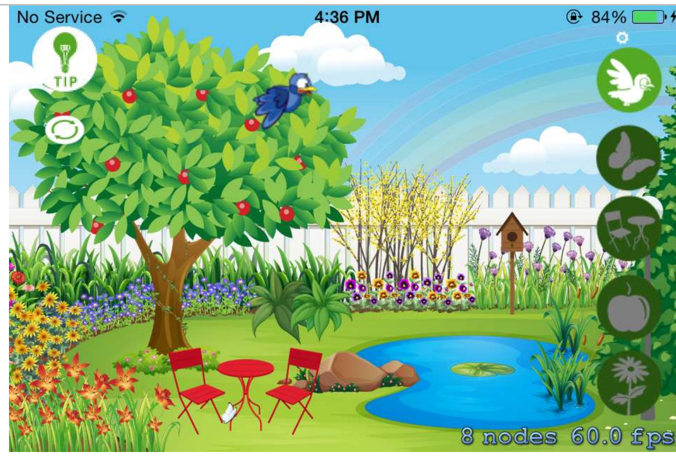
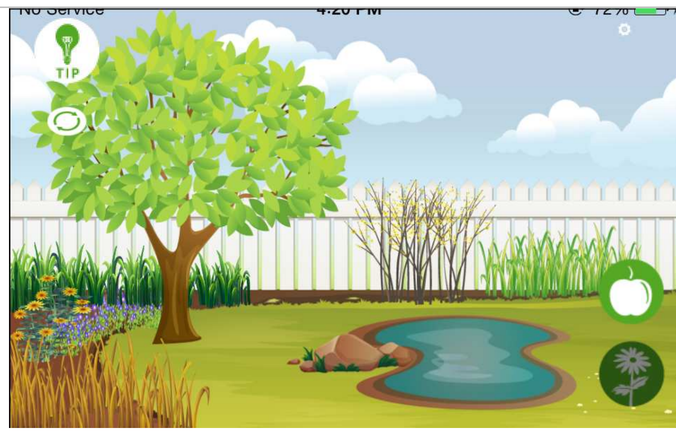
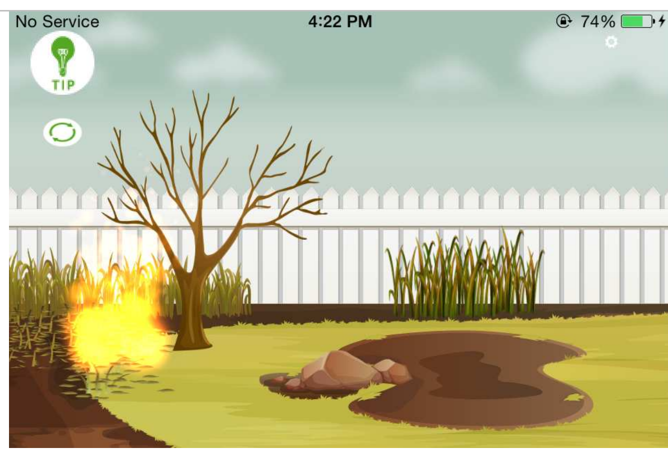
Garden State	Picture
Level 1 Best Garden for excellent energy conservation	
Level 4 Baseline Garden for normal energy consumption	
Level 7 Worst Garden for highest (worst) energy consumption	

Table 2: Three Illustrations of Garden Level Displays

Garden Level	SD Range	Description
7	x ≤ -1.0	Worst Garden
6	-1.0 < x ≤ -0.5	Worse
5	-0.5 < x < -0.1	Bad
4	-0.1 < x ≤ 0.1	Baseline Garden
3	0.1 < x ≤ 0.5	Good
2	0.5 < x ≤ 1.0	Better
1	x > 1.0	Best Garden

Table 3: Standard Deviations used to determine Garden Level Changes

Social-Psychological Processes	Description	Theoretical rationale[1]
Setting goals *(strong effect)*	Ask individuals to aim for a certain goal	• Creates obligation and intention • Use specific, difficult, attainable goals (goal-setting theory) • Self-monitoring and self-regulation important (control theory)
Social Modeling *(strong effect)*	Utilize demonstration or discussion	• We are guided by what others think is correct as well as by their behaviours • Similarity of people strengthens effects • Perceived authority has strong influence
Consistency *(very strong effect)*	Try to make individuals behave in ways consistent with preexisting beliefs	• We desire to be consistent in our values and actions • Cognitive dissonance • Behaving different than social reference group causes guilt
Commitment *(medium effect)*	Ask for verbal or written pledges to do a behaviour	• If we commit to something, then we will be very likely to follow through (respond in a way that justifies our earlier decision to make a commitment) • Effective commitments are active, public, effortful and freely chosen (we take responsibility)

Table 4. Proposed Interventions for Future Research

[1] Sources: Bamberg and Moser (2007), Cialdini (2009), Michie et al. (2009), Osbaldiston and Schott (2012)

In conclusion, as pressure mounts on organizations to be more environmentally sustainable, companies are increasingly incorporating sustainable development strategies to meet legal and corporate social responsibilities. Mobilizing employees will be key to success, as their sustainable practices can translate into meaningful organizational results. The proposed research will make important contributions to this area. Drawing upon persuasive computing and social-psychological theories, our findings will provide a better understanding of how the material properties of information systems can be leveraged to engage employees to perform more pro-environmental behaviors. Our approach will be useful for future theorizing about the role that persuasive information systems can play in generating sustainable behaviours in employees. Most past research has been conducted with citizens. However, organizational factors such as power relations, group influences, reward structures, and corporate norms and values create a different context than private life which may alter the effects of any interventions. Understanding interventions that are most effective in organizations, as well as the theoretical mechanisms behind them, are needed. Business practitioners will benefit from the broader knowledge relating to "green IS" in the link between internal stakeholders' behaviours and responsible corporate practices.

Acknowledgements

The authors thank the study participants who gave so freely of their valuable time as well as Dina Ayad, Tam Hung, and Mariana Osaki. The research was funded by a grant from the Social Sciences and Humanities Research Council of Canada (SSHRC Grant #435-2013-0716).

References

Abrahamse, W., Steg, L., Vlek, C., and Rothengatter, T. 2005. "A Review of Intervention Studies aimed at Household Energy Conservation," *Journal of Environmental Psychology* (25:3), pp. 273-291.

Abrahamse, W., Steg, L., Vlek, C., and Rothengatter, T. 2007. "The Effect of Tailored Information, Goal Setting, and Tailored Feedback on Household Energy Use, Energy-Related Behaviors, and Behavioral Antecedents," *Journal of Environmental Psychology* (27:4), pp. 265–276.

Bamberg, S., and Moser, G. 2007. "Twenty Years After Hines, Hungerford, and Tomera: A New Meta-Analysis of Psycho-Social Determinants of Pro-Environmental Behaviour," *Journal of Environmental Psychology* (27:1), pp. 14-25.

Bolderdijk, J. W., Steg, L., and Postmes, T. 2013. "Fostering Support for Workflow Energy Conservation Policies: Accounting for Privacy Concerns," *Journal of Organizational Behavior (*34), pp. 195-210.

Brynjarsdottir, H., Håkansson, M., Pierce, J., Baumer, E., DiSalvo, C., and Sengers, P. 2012. "Sustainably Unpersuaded: How Persuasion Narrows Our Vision of Sustainability," *Proceedings of the CHI '12 ACM Annual Conference on Human Factors in Computing Systems,* Austin, TX, pp. 947-956.

Cain, M.W., Mann, J., Silver, M.A., Basso, M. Walls, A., and Rozwell, C. 2011. "Predicts 2012: The Rising Force of Social Networking and Collaboration Services," *Gartner Research Report:* G00226087. November 28.

Carrico, A.R., and Riemer, M. 2011. "Motivating Energy Conservation in the Workplace: An Evaluation of the Use of Group-Level Feedback and Peer Education," *Journal of Environmental Psychology,* (31:1), pp. 1-13.

Chen, H.-M., Lin, C.-W., Hsieh, S.-H., Chao, H.-F., Chen, C.-S., Shiu, R.-S., Ye, S.-R. and Deng, Y.-C. 2012. "Persuasive Feedback Model for Inducing Energy Conservation Behaviors of Building Users based on Interaction with a Virtual Object," *Energy and Buildings* (45), pp. 106-115.

Cialdini, R. B. 2009. *Influence: Science and Practice* (Fifth edition), Boston, Pearson Education, Inc.

Cialdini, R. B., and Goldstein, N. J. 2004. "Social influence: Compliance and Conformity," *Annual Review of Psychology* (55), pp. 591-621.

Corbett, J. 2013. "Designing and Using Carbon Management Systems to Promote Ecologically Responsible Behaviors," *Journal of the Association for Information Systems* (14: 7), Article 2.

Elliot, S. 2011. "Transdisciplinary Perspectives on Environmental Sustainability: A Resource Base and Framework for IT-Enabled Business Transformation," *MIS Quarterly* (35:1), pp. 197-236.

Fogg, B. J. 1999. "Persuasive Technologies," *Communications of the ACM* (42:5), pp. 27-29.

Fogg, B.J., and Iizawa, D. 2008. "Online Persuasion in Facebook and Mixi: A Cross-Cultural Comparison," in *Proceedings of the 3rd International Conference on Persuasive Technology,* H. Oinas-Kukkonen, P. Hasle, M. Harjumaa, K. Segerståhl, and P. Øhrstrøm (eds.), Oulu: Springer-Verlag, pp. 35-46.

Fogg, B.J. 2003. *Persuasive Technology: Using Computers to Change What We Think and Do*, Morgan Kaufmann Publishers Inc., San Francisco.

Foster, D., Blythe, M., Cairns, P., and Lawson, S. 2010. "Competitive Carbon Counting: Can Social Networking Sites Make Saving Energy More Enjoyable?," in *Proceedings of the CHI '10 ACM Extended Abstracts on Human Factors in Computing,* Atlanta, GA, pp. 4039-4044.

Froehlich, J., Dillahunt, T., Klasnja, P., Mankoff, J., Consolvo, S., Harrison, B., and Landay, J.A. 2009. "UbiGreen: Investigating a Mobile Tool for Tracking and Supporting Green Transportation Habits." in *Proceedings of the CHI '09 ACM Annual Conference on Human Factors in Computing*, Boston, MA, pp. 1043-1052.

Gardner, G.T., and Stern, P.C. 2002. *Environmental Problems and Human Behavior*. Second Edition. Pearson Custom Publishing, Boston, MA.

Gollwitzer, P. M., and Sheeran, P. 2006. "Implementation Intentions and Goal Achievement: A Meta-Analysis of Effects and Processes," *Advances in Experimental Social Psychology* (38), pp. 69-118.

Gregor, S. 2006. "The Nature of Theory in Information Systems," *MIS Quarterly* (30:3), pp. 611-642.

Gregor, S., and Jones, D. 2007. “The Anatomy of Design Science Theory,” *Journal of the Association of Information Systems,* (8:5), pp. 312-335.

Ham, J., Midden, C., and Beute, F. 2009. “Can Ambient Persuasive Technology Persuade Unconsciously?: Using Subliminal Feedback to Influence Energy Consumption Ratings of Household Appliances,” in *Proceedings of 4th International Conference on Persuasive Technology,* ACM, Claremont, CA, Article 29.

Hevner, A.R., March, S.T., Park, J., and Ram, S. 2004. “Design Science in Information Systems Research,” *MIS Quarterly,* (28:1), pp.75-105.

Hodges, R. and Gaughan, B. 2008. “Information Technology – The New Green Superhero,” Webinar, http://www.itmanagement.com/webcast/green-it-superhero/?gritart, May 8, 2008.

Holland, R. W., Aarts, H., and Langendam, D.2006. “Breaking and Creating Habits on the Working Floor: A Field-Experiment on the Power of Implementation Intentions,” *Journal of Experimental Social Psychology* (42), pp. 776–783.

Jenkin T. A, McShane, L., and Webster, J. 2011. “Green Information Technologies and Systems: Employees’ Perceptions of Organizational Practices,” *Business and Society* (50:2). pp. 266-314.

Kaplan, A. M., and Haenlein, M. 2010. “Users of the World, Unite! The Challenges and Opportunities of Social Media,” *Business Horizons* (53:1), pp. 59-68.

Kappel, K., and Grechenig, T. 2009. "Show-Me: Water Consumption at a Glance to Promote Water Conservation in the Shower,” in *Proceedings of 4th International Conference on Persuasive Technology,* ACM, Claremont, CA, Article 29.

Khaled, R., Barr, P., Noble, J., and Biddle, R. 2006. “Investigating Social Software as Persuasive Technology,” in *Proceedings of the 1st International Conference on Persuasive Technology,* W. IJsselsteijn, Y. de Kort, C. J. H. Midden, B. Eggen, and E. van den Hoven (eds.), Eindhoven: Springer-Verlag, pp. 104-107.

Kim, T., Hong, H., and Magerko, B. 2010. “Design Requirements for Ambient Display that Supports Sustainable Lifestyle,” in *Proceedings of the 8th ACM Conference on Designing Interactive Systems,* Aarhus, Denmark, pp. 103-112.

Kim, T., Hong, H., and Magerko, B. 2009. “Coralog: Useaware Visualization Connecting Human Micro-Activities to Environmental Change,” in *Proceedings of the CHI ‘09 Extended Abstracts on Human Factors in Computing,* ACM, Atlanta, GA, pp. 4303-4308.

Melville, N. 2010. “Information Systems Innovation for Environmental Sustainability,” *MIS Quarterly*, (34:1), pp. 1-21.

Michie, S., Abraham, C., Whittington, C., McAteer, J., and Gupta, S. 2009. “Effective Techniques in Healthy Eating and Physical Activity Interventions: A Meta-Regression,” *Health Psychology*, (28:6), pp. 690-701.

Oinas-Kukkonen, H., and Harjumaa, M. 2009. “Persuasive Systems Design: Key Issues, Process Model, and System Features,” *Communications of the Association for Information Systems* (24), pp. 485-500.

Oinas-Kukkonen, H., and Harjumaa, M. 2008. “A Systematic Framework for Designing and Evaluating Persuasive Systems,” in *Proceedings of the 3rd International Conference on Persuasive Technology,* H. Oinas-Kukkonen, P. Hasle, M. Harjumaa, K. Segerståhl, and P. Øhrstrøm (eds.), Oulu: Springer-Verlag, pp. 164-176.

Osbaldiston, R., and Schott, J. P. 2012. “Environmental Sustainability and Behavioral Science: Meta-Analysis of Pro-Environmental Behavior Experiments,” *Environment and Behavior*, (44:2), pp. 257-299.

Petty, R. E. and Briñol, P. 2012. “The Elaboration Likelihood Model,” in *Handbook of Theories of Social Psychology*, P. A. M. Van Lange, A. Kruglanski, and E. T. Higgins (Eds.), Vol. 1, London, England: Sage. pp. 224-245.

Ramus, C. A., and Steger, U. 2000. “The Roles of Supervisory Support Behaviors and Environmental Policy in Employee ‘Ecoinitiatives’ at Leading-Edge European Companies,” *Academy of Management Journal,* (43), pp. 605-626.

Russell, S. 2007. “Getting to the Heart of Environmental Issues,” Paper presented at the annual *Academy of Management Meeting*, Philadelphia, PA. 2007.

Siedel, S., Recker, J., and vom Brocke, J. 2013. “Sensemaking and Sustainable Practicing: Functional Affordances of Information Systems in Green Transformations,” *MIS Quarterly*, (37:4), pp. 1275-1299.

Siero, F. W., Bakker, A. B., Dekker, G. B., and vandenBurg, M. T. C. 1996. "Changing Organizational Energy Consumption Behaviour through Comparative Feedback," *Journal of Environmental Psychology* (16), pp. 235-246.

Simon, H. 1996. *The sciences of the artificial.* Cambridge: MIT Press.

Smith, A.M., and O'Sullivan, T. 2012. "Environmentally Responsible Behaviour in the Workplace: An Internal Social Marketing Approach," *Journal of Marketing Management*, (28:3-4), pp. 469-493.

Staats, H.J., Wit, A.P., and Midden, C.Y.H. 1996. "Communicating the Greenhouse Effect to the Public: Evaluation of a Mass Media Campaign from a Social Dilemma Perspective," *Journal of Environmental Management* (45), pp. 189-203.

Swim, J. et al., (2010). *Psychology and Global Climate Change. Addressing a Multifaceted Phenomenon and Set of Challenges,* American Psychological Association, http://www.apa.org/science/climate-change (Assessed: 27 April, 2014).

The Climate Group. 2008. "SMART 2020: Enabling the Low Carbon Economy in the Information Age," *The Global Sustainability Initiative*, Brussels, Belgium, 2008.

Vaishnavi, V., and Kuechler, W. 2004. "Design Science Research in Information Systems," January 20, 2004; Last updated: October 23, 2013. URL: http://www.desrist.org/design-research-in-inforamtion-systems/ (Assessed: 27 April, 2014).

Walls, J. G., Widemeyer, G. R., and El Sawy, O. A. 1992. "Building an Information System Design Theory for Vigilant EIS," *Information Systems Research,* (3:1), pp. 36-59.

Watson, R. T., Boudreau, M.-C., and Chen, A. J. 2010. "Information Systems and Environmentally Sustainable Development: Energy Informatics and New Directions for the IS Community," *MIS Quarterly* (34:1), pp. 23-38.

Weiksner, M.G., Fogg, B.J., and Liu, X. 2008. "Six Patterns for Persuasion in Online Social Networks," in *Proceedings of the 3rd International Conference on Persuasive Technology,* H. Oinas-Kukkonen, P. Hasle, M. Harjumaa, K. Segerståhl, and P. Øhrstrøm (eds.), Oulu: Springer-Verlag, pp. 151-163.