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Three Essays on the Role of IT in Environmental Sustainability: Motivating Individuals to Use Green IT, Enhancing Their User Experience, and Promoting Electricity Conservation

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THREE ESSAYS ON THE ROLE OF IT IN ENVIRONMENTAL SUSTAINABILITY: MOTIVATING INDIVIDUALS TO USE GREEN IT, ENHANCING THEIR USER EXPERIENCE, AND PROMOTING ELECTRICITY CONSERVATION

By

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ABSTRACT

THREE ESSAYS ON THE ROLE OF IT IN ENVIRONMENTAL SUSTAINABILITY: MOTIVATING INDIVIDUALS TO USE GREEN IT, ENHANCING THEIR USER EXPERIENCE, AND PROMOTING ELECTRICITY CONSERVATION

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This dissertation focuses on the role of IT in environmental sustainability and electricity conservation through three research essays. The first essay makes a case for behavior research, with the focus on individuals' use of Green IT. Moreover, environmental studies lack a coherent theory that could identify the motivators of Green-IT beliefs. We develop the hedonic motivation theory, which synthesizes theoretical and philosophical thoughts on hedonism with concepts from environmental research. Using this theory, we develop a conceptual model that identifies the motivators of context-specific beliefs, attitudes, and uses of Green IT. We theorize that there are significant generational differences in the process by which hedonic motivators influence Green IT use behaviors. Young adults are more motivated by personal hedonic motivation, and an affective and automatic process, whereas older adults are motivated by a cognitive and attitudinal process. This study was carried out using a structural equation modeling method of analysis based on 702 observations of the survey data. The results support the theorized model, with significant implications.

The second essay examines the design taxonomy of electricity consumption feedback applications, which are considered one of the critical technologies in alleviating the increasing trends of energy consumption and greenhouse gas emissions. We relied on an integrative theoretical framework and literature review to propose a comprehensive taxonomy for salient design elements of electricity consumption feedback applications. Using a survey method, we collected data from general public to evaluate the preference and relative importance of the design elements. We found that there is a preferred set of design elements for the feedback applications. Our results could serve as a basis to evaluate the design of existing electricity consumption feedback applications, and to help in studying the influence of design elements on beliefs and behaviors related to individuals' electricity conservation.

The third essay investigates the role of the salient design elements identified in the second essay, and the processes by which these elements motivate electricity consumers' behaviors towards energy conservation. We developed a conceptual framework by extending the theory of planned behavior to study how salient design elements of feedback applications impact the beliefs and behaviors of individual electricity consumers. To our knowledge, this is the first study aimed at examining the relationship between electricity consumers' beliefs and behaviors and the specific perceived design elements of electricity consumption feedback applications. We empirically evaluated the conceptual model by developing a mobile app and a corresponding website and conducting a controlled longitudinal lab experiment. The results indicate strong support for the premises of the model and support the significant role of personalized design elements in use behaviors and electricity conservation. Our findings show the importance of integrating descriptive social norm, personalized goal setting, and personalized privacy preferences design elements in feedback applications.

This dissertation makes a number of significant contributions to theory and application. First, it develops a new theory that identifies motivators of Green IT use. It shows that the conceptualized motivators impact use behaviors though multiple paths—the cognitive and emotional automatic paths— and are moderated by users' age. Second, this work develops a taxonomy of design elements for electricity consumption feedback applications based on an integrative theoretical framework and extensive review of the existing literature. This taxonomy and the relative importance of elements in the taxonomy could serve as the standard for developing and assessing feedback application tools. Third, this work develops a conceptual model that identifies the processes by which design elements of electricity consumption feedback applications help in the conservation of electricity by individuals. Together, the three essays contribute to the sustainability and Green IT literature by uncovering the significant role of individuals in dealing with environmental threats and energy consumption challenges and by conceptualizing the different antecedents and processes that shape the perceptions and behaviors related to Green IT and electricity consumption. Moreover, the three studies extend user-centric design research by integrating insights from multiple disciplines to explain, design, create, and test innovative tools that could have a pivotal role in dealing with global sustainability challenges. This work also provides a standard for the evaluation of such tools from multiple stakeholder perspectives. Finally, the three essays contribute to practice by proposing guidelines to industry designers and policy makers for promoting sustainability and energy conservation through personalized tools and effective campaigns.

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CHAPTER 1

INTRODUCTION

Environmental issues, existing trends of energy consumption, and carbon emissions are of growing global concern in several fields of inquiry. Green IT is perceived as a major contributor in addressing such issues. IS practitioners have come to recognize the business importance of Green IT. A survey of IS executives reveals that 73 % of companies have implemented Green-IT plans (Gedda 2011). Venture capitalists invested $6.3 billion in green technology deals in 2013 (Makower 2014). Green IT has been called the environmental “hero” (Zuckerman 2010). In IS literature, Green IT agendas have urged IT-focused research on environmental sustainability and have called for the investigation of energy consumers’ information needs for improving energy efficiency (Watson et al. 2010). This three-essay dissertation addresses Green IT agenda by focusing on individuals' use of Green IT, a user-centric design of electricity consumption feedback applications, and the role of personalized feedback applications in energy conservation.

Essay 1: Hedonic Motivation Theory for Using Green IT: Does Generation Matter?

In IS, there have been calls for the examination of factors influencing individual adoption of Green IT (Dedrick 2010). Furthermore, it is essential to understand differences in behavior motivators across different types of populations since environmental issues and Green-IT behaviors could have a generational scope. Therefore, we pose the following research questions: *What are the motivators and beliefs that shape individuals' behaviors with respect to using Green IT? What (if any) are the impacts of generational differences in motivations and beliefs that shape individuals' Green-IT use?*

In answering these questions, we develop an integrative theory—the hedonic motivation theory, based on which we conceptualize the hedonic-motivated model of Green-IT use and generational differences in use antecedents. Using a survey approach, we report on the model estimation by applying the group analysis technique for two generational groups—youths and adults. The results showed that the four identified levels of hedonic motivators contributed significantly to context-specific beliefs indicating that the hedonic motivators operate at the personal, group, humanity, and nature levels. The findings showed a generational effect in the use of Green IT, with Green-IT habit-forming enjoyment motivating the younger generation, whereas for the older generation, Green-IT attitude and its constituent beliefs were more influential in promoting use.

<u>Essay 2:</u> **Theory-Based Taxonomy of Feedback Application Design for Electricity Conservation: A User-Centric Approach.**

Considering the importance of understanding individual's perceptions and motivations regarding green behavior as discussed in Essay 1, Essay 2 examines a user-centric design of feedback applications which helps individuals conserve electricity. Electricity consumption feedback applications are designed to provide feedback on household electricity consumption to promote electricity conservation (Midden et al. 2007). The residential sector accounted for 36% of total electricity consumption in the US in 2012 more than any other sector (U.S. Energy Information Administration 2013). Effective feedback applications can play a critical role by altering individuals' energy consumption behaviors (IEA 2011, Rodden et al. 2013). The design of effective feedback applications requires an in-depth understanding of salient design elements, which is the focus of this work. Hence, we examine the research question: *What are the salient design elements for an electricity consumption feedback application?*

To answer this research question, we developed a comprehensive taxonomy of design elements for electricity consumption feedback applications based on a theoretical framework and extensive literature review. The taxonomy identified the design elements for electricity consumption feedback applications and organized them in a meaningful hierarchy based on a theoretical framework. In order to study the preferences of the design elements, data was collected from general public using a survey method. The results indicated that there were distinct preferences for some design element options, indicating the need for personalization of feedback applications. This work contributes to the effective design of feedback applications and the evaluation of existing feedback applications for changing energy users' consumption behaviors and promoting energy conservation.

<u>Essay 3:</u> A Theory-Based Approach for Electricity Consumption Feedback Application Use and Electricity Conservation.

After examining the salient design elements in Essay 2, Essay 3 investigates the role of the salient design elements and the processes by which these elements promote the use of feedback applications and encourage energy conservation. Findings from pilot projects on feedback mechanisms show that information and feedback have rarely been enough to create permanent behavior change (Staats et al. 2004). In fact, energy consumption and conservation are both behaviors that depend on psychological variables such as attitudes (Abrahamse and Steg 2009). This study attempts to address the following research questions: *Do the design elements of feedback applications impact the use of such tool? Does the use of tool enhance electricity conservation? If so, what is the process by which these impacts take place?*

To answer our questions, we develop a conceptual framework by extending theory of planned behavior to study how salient design elements of feedback applications impact the beliefs and behaviors of individual electricity consumers. We empirically evaluated our model by developing a mobile app and website and controlled longitudinal lab experiment. The results indicate strong support for the premises of the model and support the significance of personalized design elements. Our findings show the importance of integrating descriptive social norm, personalized goal setting, and personalized privacy settings design elements in feedback applications.

Overall, the proposed dissertation makes a number of significant contributions to theory and application. Together, the three essays contribute to the sustainability and Green IT literature by uncovering the significant role of individuals in dealing with environmental threats and energy consumption challenges and by conceptualizing the different antecedents and processes that shape the perceptions and behaviors related to Green IT and electricity consumption. Moreover, the three studies extend user-centric design research by integrating insights from multi-disciplines to explain, design, create, and test innovative tools that could have a pivotal role in dealing with global sustainability challenges. This work also provides a standard for the evaluation of such tools from multiple-stakeholder perspectives. Finally, the three essays contribute to practice by proposing guidelines to industry designers and policy makers for promoting sustainability and energy conservation through personalized tools and effective campaigns.

CHAPTER 2

Essay 1: HEDONIC MOTIVATION THEORY FOR USING GREEN IT: DOES GENERATION MATTER?

2.1. INTRODUCTION

Environmental issues are of growing global concern. Green IT is perceived as a major contributor in addressing such issues. We define Green IT as information technologies that are more environmentally friendly than the "brown" practices that they replace. For example, paying bills online (eBill) replaces the paper-based bill payment that consumes paper and far more energy to accomplish the same task. IS practitioners have come to recognize the business importance of Green IT. A recent survey of IS executives reveals that 73 % of companies have implemented Green-IT plans (Gedda 2011). Venture capitalists invested $4.65 billion in 348 green technology deals in 2011 (PricewaterhouseCoopers 2012). Green IT has been called the environmental "hero" (Zuckerman 2010). Thought leaders in IS research have urged IT-focused research on environmental sustainability (Watson et al. 2010, Melville 2010).

Within IS, Green-IT research is in its infancy. Watson et al. (2010) and Melville (2010) proposed research agenda for Green IT that includes the need for investigating individuals' behaviors. Elliot (2011) reviewed the research in sustainability from multiple disciplines with a focus on organizations and people working in them. However, most published research has focused on organizations. Appendix A provides a summary of published research in the top six IS journals and the two major IS conferences proceedings in the 2009-2013 period. Of 84 published papers, only 13 had individual focus and almost all were conference papers, whereas 47 papers had organizational focus or organizational and societal/community focus, indicating a lack of adequate research about individual actors in IS literature.

In this paper, we argue for the importance of individual actors in Green-IT research by noting the multiple roles individuals play in environmental issues. Organizations adopt pro-environment technologies not only due to local and international regulations (Behtash 2008) or cost reduction benefits (Wilson 2009), but also under pressure from their customers (Bosavage 2010). In a survey conducted in the US, Australia, and New Zealand, 71% percent of IS professionals agreed that social responsibility was their main reason for adopting Green IT, and 48% admitted that clients' pressure was a major motivation to pursue Green-IT plans (Molla et al. 2009). Individuals as voters influence policies; as organizations' members and customers they influence the adoption of Green-IT plans; and as consumers they use Green-IT products and services. Moreover, individuals are adopters of Green-IT practices and followers of Green-IT advocates.

Several disciplines have studied environmental issues—natural environmental sciences, psychology, social psychology, environmental psychology, sociology, economics, law, and philosophy (Uiterkamp and Vlek 2007). In social psychology, human behavior and decision-making processes have been identified as the source of many problems (Worldwatch Institute 2004 and 2005, Vlek and Steg 2007), concluding that psychological and sociological transformations of individuals are critical for the green environment. In environmental psychology, individuals are viewed as the “ultimate key” in dealing with environmental threats— policies, programs, and regulations are not effective until they are “bought into” by individuals (Gifford 2008). In psychology, it is suggested that policy makers should go beyond biology and focus on the social, emotional, and behavioral impacts of environmental problems (Wandersman and Hallman 1993); that new technologies could motivate individuals’ pro-environmental behaviors (Pelletier et al. 2008); and that more research is needed on why individuals take specific pro-environmental decisions and “why, whether, and when” useful technologies are adopted (Gifford 2008).

In IS, there have been calls for the examination of factors influencing individual adoption of Green IT (Dedrick 2010) and for the investigation of beliefs that impact specific IT adoption (Melville 2010), and for the study of employees’ roles in organizations’ pro-environmental stance (Jenkin et al. 2011, Elliot 2011). Although each person’s impact in using Green IT may be insubstantial, individuals’ collective Green-IT behaviors at the global level could constitute a significant contributor to a green environment. However, the published IS research does not adequately focus on individual behaviors. This gap motivates our first research question: What are the motivators and beliefs that shape individuals’ behaviors with respect to using Green IT?

Furthermore, it is essential to understand differences in behavior motivators across different types of populations since environmental issues and Green-IT behaviors could have a generational scope. To our knowledge, there is no published work that studies generation differences in the use of Green IT. This motivates our second research question: What (if any) are the impacts of generational differences in motivations and beliefs that shape individuals' Green-IT use?

In answering these questions, we first review IS and environmental literature. In the subsequent section, we develop an integrative theory—the hedonic motivation (HM) theory, based on which we conceptualize the hedonic-motivated model (HMM) of Green-IT use and generational differences in use antecedents. Using a survey approach, we report on the model estimation by applying the group analysis technique for two generational groups—youths and adults.

This paper makes novel and significant contributions to theory and practice. It is the first to propose an integrative theory to identify motivating beliefs based on the extant literature on hedonism as well as in environmental studies. This theory also proposes the cognitive and affective causes for the emergence of environmental beliefs. In addition, the proposed model of Green-IT use is the first to conceptualize individual motivators of Green-IT use while identifying the distinct paths that youths and adults follow in their behaviors. The results also support the cognitive base of anti-anthropocentrism in environmental hedonism that shows how environmental beliefs arise. Moreover, our results support the resource-based assertion that expanding hedonism from self to others and to nature requires access to resources above individuals' basic needs. Finally, our work contributes to developing differentiated policies for motivating individuals to use pro-environment technologies.

2.2. SIGNIFICANCE OF GREEN IT IN REPLACING PAPER

We define individual Green-IT behavior as the choice of pro-environmental "green" IT alternatives over other non-environmental "brown" options. Practitioner literature indicated interest in various categories of Green IT, including technologies that replace paper, replace transportation, reduce energy consumption, and integrate devices and gadgets. Our research focuses on technologies that replace papers, such as eCard (sending electronic cards for special occasions), eBook (reading books on a device such as a Kindle or online), eNews (reading news online), and eBill payment (paying bills online), which are referred to as Green IT from here onward.

The paper and pulp industry is ranked first in using industrial process water per ton of product, third in industrial energy consumption, and fourth within the manufacturing sector in emitting greenhouse gases (Roberts 2007). The paper industry uses 42% of industrial wood supplies, thus contributing to deforestation that reduces our ability to deal with terrestrial carbon. Methane gas is described as having "23 times the heat-trapping power of carbon dioxide" (Roberts 2007, p. v). Papers in landfills produce 34% of human-based methane gas emissions. Despite the significant environmental impact of using paper, there is little research on why individuals use technologies that replace paper. We investigate this gap by developing an integrated theory and testing it empirically.

2.3. REVIEW OF LITERATURE ON ENVIRONMENTAL RESEARCH AND THEORIES

Different disciplines such as sociology, marketing, and economics have examined environmental attitudes, and pro-environmental behaviors and their antecedents. However, the most pertinent field with individuals as the unit of analysis is environmental psychology, which started in the 1960s (Pol 2006) and is defined as a field that focuses on the psychological relationship between humans and the environment (Craik 1973). By 2005, over 160 empirical studies had been published in just two influential environmental psychology journals—Journal of Environmental Psychology and Environment and Behavior (Giuliani and Scopelliti 2009). Table 2.1 reports a selected set of influential, theory-based papers that focus on individuals' environmental behaviors. However, none of them investigates Green IT as a pro-environmental behavior.

Table 2.1 Selected Research in Environmental Psychology

Author	Description	Theory*	Method
Bamberg and Schmidt 2003	Compared the predictive power of three theories in explaining travel mode, using survey data college students	NAM,TPB and theory of interpersonal	Survey

		behavior	
Bamberg and Moser 2007	Performed meta-analysis on 57 studies to examine the variables predicting general environmental behavior	NAM & TPB	Meta-analysis
Clark et al. 2003	Combined theories from psychology and economics to examine the adoption of green electricity	Neoclassical Economic Theory, NAM, NEP	Survey
Dietz et al. 1998	Compared the predictive power of social structure and psychological variables in explaining willingness to sacrifice, sign petitions, environmental group membership, environmental spending, and consumer behaviors	Stern-Oskamp framework (1987), a precursor of VBN	Secondary data
Guagnano et al. 1995	Examined the influence of external conditions on reported recycling	NAM	Survey
Hopper and Nielsen 1991	Conceptualized the antecedents of recycling behavior as an altruistic behavior, social norm mediated by personal norm	NAM	Survey & experiment
Kaiser et al. 1999	Studied the antecedents of general environment behavior	TPB	Survey
Kals et al. 1999	Introduced “emotional affinity toward nature” as an emotional antecedent of environmental behavior	Biophilia hypothesis (Wilson 1984)	Survey
Karp 1996	Examined the relationship between personal values and environmental behavior, using surveyed data from college students	Value Theory	Survey
Mayer and Frantz 2004	Defined connectedness to nature as a trait, and used it to explain ecological behavior and subjective well being. It involved 5 studies	Leopold’s (1949) sense of belonging to nature	Survey & experiment
Oskamp et al. 1991	Examined the antecedents of curbside recycling behavior as demographic, knowledge, attitude variables	--	Survey
Poortinga et al. 2004	Compared the prediction power of values, attitudes and socio-demographic variables to explain energy use, used data from Netherland households	VBN	Survey
Schultz and Zelezny 1999	Examined the prediction of environmental attitudes across 14 countries using student data	VBN	Survey
Schultz 2001	Studied factors of environmental concerns, and relationship with other environmental attitudes measures, 4 surveys in 10 countries	VBN	Survey
Schultz et al. 2004	Developed a tool to measure the individual’s implicit connectedness to nature, and studied its relation with environmental attitudes	---	Survey & experiment
Scott and Willits 1994	Examined the adoption of NEP beliefs and their relationship with environmental, consumer, and political behaviors	--	Survey
Stern et al. 1993	Developed three models to predict environmental behavior intention across genders, using data from college students	NAM	Survey
Stern et al. 1995	Studied NEP as a measure that can be included in VBN to study various pro-environmental behaviors	NEP, NAM, Value Theory (Schwartz 1992)	Survey
Thompson and Barton 1994	Distinguished ecocentrism and anthropocentrism, conceptualized environmental concern, tests a measurement scale, and examined its relationship with environmental behavior	Stokols’ (1990) people- environment relation, and Stern’s three-level values (Stern et al. 1993)	Survey

***NAM**: Norm Activation Model (Schwartz 1977), **NEP**: New Environmental Paradigm (Dunlap and Van Liere 1978), **TPB**: Theory of Planned Behavior (Ajzen 1991), **VBN**: Value-Belief-Norm (Stern et al. 1999)

Theories for studying pro-environment behaviors can be divided into two categories. The first category includes general behavior theories, an example of which is the theory of planned behavior (TPB) (Ajzen 1991). Another example is moral norm-activation theory (NAM) (Schwartz 1973 and 1977), which proposes that individuals' altruistic behaviors are the consequence of the activation of their moral norms. In the application of NAM, pro-environment behaviors are interpreted as instances of altruism. It is argued that such theories are inadequate and need to be modified in order to include the constructs that are specific to the context of environmental protection (Kals et al. 1999, Valle et al. 2005).

The second category involves theories that are developed for specifically conceptualizing pro-environment behaviors. Dunlap et al. (2000) proposed a set of scales for the new environmental paradigm (NEP) to measure pro-environment orientation, based on scales originally proposed by Dunlap and Van Liere (1978). Arguably the most well-known theory in this category is value-belief-norm (VBN) (Stern et al. 1999, Stern 2000), which is a synthesis of NEP with the norm-activation theory, Schwartz's (1992, 1994) value theory, and other beliefs. This theory has been used to study environmental activism as well as pro-environment behaviors in different settings. VBN consists of a chain of constructs starting with values (such as altruism, egoistic value, traditional value, and openness to change) → ecological world views (measured by NEP) → awareness of adverse consequences → ability to take action → sense of obligation to take actions → pro-environment behaviors. Although VBN contains a rich set of constructs, it does not justify why the values emerge, why they lead to the new ecological paradigm, or why they lead to the subsequent chain of paths. Furthermore, it does not reflect other potentially contributing factors such as habit.

Behavior theories, including the theory of planned behavior (TPB), assume the presence of certain domain-specific salient beliefs that influence attitudes and behaviors. In other words, the behavior theories axiomatically assume the presence of certain beliefs that form attitudes and behaviors. In the environmental literature, however, beliefs have received close scrutiny. It is argued that individuals' value systems lead them to form beliefs and opinions in a given context. In his value theory, Schwartz (1994) defines values as "desirable transsituational goals, varying in importance, that serve as guiding principles in the life of a person or other social entity" (p. 21). Schwartz (1994) has empirically categorized human values into 10 categories—achievement, hedonism, stimulation, self-direction, universalism, benevolence, conformity, tradition, security and power. These values have been further abstracted into two sets of bipolar categories: "openness to change vs. conservatism" and "self-transcendence vs. self-enhancement." The value categories have been influential in the conceptualization of pro-environment behaviors (see, for example, Table 2.1). However, it is not clear whether these values operate at the same level, how they arise, and more importantly whether and how they evolve in individuals' life cycle. There is a need for a stronger theoretical approach to identify salient beliefs. Moreover, environmental literature has reported the impact of affect on pro-environmental behavior (De Young 2000, Pelletier et al. 1998, Steg 2005); still, these studies are few in number (Lindenberg and Steg 2007) and generally not theory-driven (Steg and Vlek 2009). In reviewing the literature of pro-environmental behavior encompassing moral, reasoned, and affective-based studies, Steg and Vlek (2009) concluded that while various theories have showed predictive power, we still need to understand how they act together. Hence, there is a need for an integrative lens to examine the multiple motivators for pro-environmental behaviors. This paper addresses this need by proposing the hedonic motivation theory and applying it to conceptualize the model for Green-IT use.

2.4. HEDONIC MOTIVATION THEORY: AN INTEGRATIVE LENS

In this section, we synthesize the philosophical thoughts and modern research on hedonism with environmental research to propose the hedonic motivation theory. Hedonism in its simplest meaning is defined as the intrinsic motivation of seeking pleasure and avoiding pain, and is argued to be the motivational foundation of all human actions. The hedonism philosophy goes back to Democritus in 460 BC in ancient Greece (Barnes 1982, Taylor 2005). While hedonism was originally based on the experience of pain and pleasure by individual, in modern times its focus has shifted to ethical and social hedonism. John Stewart Mill was the first modern philosopher who advocated utilitarian hedonism or "happiness theory" (Mill 1863, p. 6), and argued for "utility" or the "greatest happiness principle," which covers physical as well as intellectual hedonism. It has an ethical perspective in that utilitarian hedonism emphasizes not only happiness for self, but also happiness for all. Individuals' intrinsic motivation for seeking pleasure and avoiding pain combined with the extrinsic motivations promoted by others move individuals to act in a way that increases happiness for all. The question is, when does self-focused hedonism extend to others?

Schwartz (1994) has argued that "materialism values, presumably grounded in experience of insecurity, emphasize social order and stability and the political and economic arrangements believed to ensure them" (p. 37). "Social expectations are learned in the normal course of socialization" and are respected for fear of "social sanctions" (Schwartz 1977, p. 225). Social norms are defined as "rules and standards that are understood by members of a group, and that guide and/or constrain social behavior without the force of laws" (Cialdini and Trost 1998, p. 152). These norms reflect the dominant values and opinions of the group members. By following tradition and social norms, humans have sought to satisfy their needs for protection and security. This idea relates to the cultural co-evolution theory, which proposes that ecological, environmental, and social processes co-evolve in tandem with physical and psychological evolution (Richardson and Boyd 2005). Avoiding the pain of social ostracism and loss of support is another manifestation of social hedonism. Thus, promoting happiness for one's social group is a motivation for increasing one's nourishment (pleasure) and safety (absence of pain), hence increasing the collective happiness of the entire social group. The stronger the sense of belonging to a social group is, the stronger social hedonism and respect for social norms would be. Hence, we argue that social hedonism is the basis for the saliency of social norms—deriving pleasure from acting in step with one's social group.

Post-materialism motivates individuals to expand their hedonic sphere outward from self. Inglehart (1971, 1999) argues the traditional category of values was formed to satisfy the basic needs of nourishment, shelter, and security for self, family and immediate social group. As these needs are satisfied, "post-materialism" emerges, in that openness to change and orientation to others who are not members of one's social group gain acceptance. Based on Inglehart's post-materialism, Kahneman et al. (1999) has proposed "hedonistic psychology" as a new field of inquiry, which is defined as "what makes life experiences and life pleasant or unpleasant. It is concerned with feelings of pleasure and pain, of interest and boredom, of joy and sorrow, of satisfaction and dissatisfaction. It is also concerned with the whole range of circumstances, from biological to societal, that occasion suffering and enjoyment" (p. ix). Hedonistic psychology posits that quality of life is not limited to experiencing pain and pleasure alone. It embodies "subjective satisfaction" with life within societal and cultural contexts and experiences. The objective qualities of a society or environment—such as poverty, crime rate, and pollution—are major contributors to hedonic experiences and subjective well being.

Synthesizing Mill's hedonic utilitarianism and hedonistic psychology with Inglehart's post-materialism theory, we posit that individuals form their values based on gaining pleasure and avoiding pain (for self and others) and depending on their materialistic and post-materialistic status. At the materialistic stage, traditional values and respect for social norms guarantee the least amount of pain (starvation, insecurity, and social chaos). As individuals move to the post-materialistic stage, openness to change, self-transcendence, and focus on non-member others gain acceptance. This progression increases the pleasure of experiencing novelty, freedom of self- direction, and universalism. A secure group that does not see others as a threat to its existence can afford to be open and move toward universalism. This leads to the argument that there is a hierarchy of hedonism that starts with self, then moves to immediate family and social groups, and finally extends to humanity—all others regardless of their membership in one's social groups—caring about the pain and pleasure of strangers and humanity in general.

The next extension of hedonism is towards non-human nature and the environment. The personal, social, and humanity hedonisms have a human focus. Many religions and philosophical thoughts have viewed humans as superior to other beings and dominant over nature—referred to as "anthropocentrism." In contrast, anti-anthropocentrism rejects humans' supremacy and dominance over nature (Naess 1973) and the belief that "nature exists solely for human use" (Dunlap and Van Liere 1978, p. 11). It expands morality from a purely human-oriented perspective to include nature and the non-human inhabitants of nature. In anti-anthropocentrism, the sphere of concern extends to non-humans. Searles (1960) has observed that nature is critical to humans' psychological well being, a school of thought that has led to "ecopsychology" (Roszak 1992). Wilson (1984), a biologist, proposed the "biophilia hypothesis," arguing that the love of nature is genetically wired into humans as a result of biological evolution and evolutionary psychology (Kellert 1993). Anti-anthropocentrism[1] considers non-human natural entities as "moral subjects" (Taylor 1989), which have moral rights and standing (Clayton 2003). Environmental hedonism emerges as individuals accept and subscribe to the morality of

[1] In his theory of environmental ethics, Taylor (1989) has distinguished between human-focused environmental ethics and life-focused environmental ethics. In the former case, environment preservation is intended to further the survival of humans (present or future generations). In the latter case, environmental entities are moral subjects to which we have moral obligations. The conflict between the well-being of humans and non-humans should be resolved as a moral dilemma, and not by brute force or as a foregone conclusion in favor of humans. We follow Taylor's life-focused environmental ethics in the definition of anti-anthropocentrism in this paper.

anti-anthropocentrism, giving rise to motivating environmental beliefs. Thus, we posit that the four layers of hedonism in Figure 2.1 are the fundamental motivators of human beliefs and actions and call it the Hedonic Motivation (HM) theory. The HM theory posits that context-specific motivators arise from these four types of hedonism.[2]

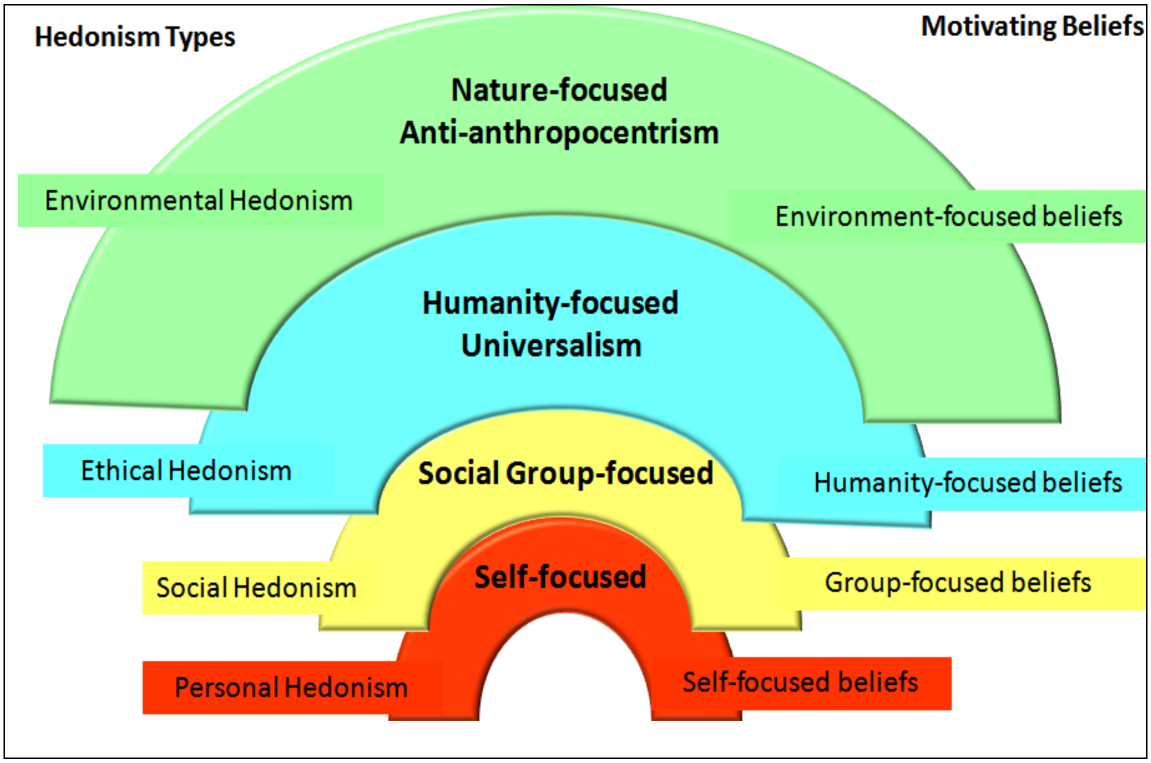


Figure 2.1 Spheres of Hedonism and Hedonic-basis of Motivating Beliefs

Based on the four layers of hedonism, motivating values and underlying beliefs could be categorized based on self, group-, humanity-, and environment-focused beliefs. (1) Self-focused motivating beliefs are based on personal pursuit of pleasure and avoidance of pain. (2) As the sphere of hedonism expands to one's social group, social hedonism

[2] In the value theory, Schwartz (1994) characterizes value as "a (1) belief (2) pertaining to desirable end states or modes of conduct, that (3) transcends specific situations, (4) guides selection of evaluation of behavior, people, and events, and (5) is ordered by importance relative to other values to form a system of value priorities" (p. 20). We use values and motivating fundamental beliefs interchangeably in this paper.

offers pleasure from following norms set by one’s social group. Individuals derive pleasure in the membership to their social groups and avoid the pain of exclusion by following their norms. Group-focused motivating beliefs promote group preservation, harmony and cohesiveness, with emphasis on the pain and pleasure experienced by group members. (3) Humanity-focused motivating beliefs promote universalism, emphasizing the pain and pleasure experienced by humanity. (4) Environment-focused motivating beliefs promote the preservation of non-human nature. Moreover, the cognitive and moral foundation for environmental hedonism is based on anti-anthropocentrism, which rejects human domination of nature and endows nature with moral standing.

The multiple levels of roles and values have precedence in environmental literature. Stern et al. (1993) and Stern (2000) have categorized values as egoistic, altruistic and biospheric. Schultz (2001) has observed the role of self, other people and biosphere in the structure of environmental concern. Egocentric, anthropocentric, and ecocentric (also called biocentric) refer to these three layers of reference. In our argument, personal hedonism has an egocentric reference, whereas social and ethical hedonism have anthropocentric references, and environmental hedonism has an ecocentric reference. While these roles have been observed in the environmental literature, there had been little explanation about how these levels arise and how people adopt such roles.

In the HM theory, hedonism also arises from affective and below conscious sources. Moving to post-materialism requires resources that are more than basic needs to expand the sphere of hedonism beyond self, and has a cognitive and conscious logic. However, specific threatening events or generally unfavorable conditions of threat and insecurity may give rise to environmental awareness and concerns, promoting pro-environment beliefs and behaviors. Health risks associated with polluted air may be one such threat (Homburg and Stolberg 2006). In a multi-study research, Fritsche et al. (2010) reported that conditions of general threat and focus on mortality lead to increased cooperation, environmental awareness and pro-environmental behaviors. These responses are affective and below-conscious reactions that give rise to emotional and automatic forces of hedonism. Under conditions of threat, boundaries between self and others blur, and people tend to behave selflessly and heroically, with increased concerns for other beings. The strength of such responses depends on individuals' life experience, living conditions, and collective history. The HM theory posits that affective and automatic responses to threat and avoidance of pain also give rise to the four levels of hedonism, particularly to environmental hedonism.

2.5. GENERATIONAL EFFECTS

Generational differences play a part in the HM theory as well. Generational differences could be due to the chronological stages of life or to cohort effects. While there has been substantial work on stages of childhood-adolescence and old age, there has not been adequate research in the stages of adult development. Levinson (1986) has argued that there is a "life course" which signifies the evolution of individuals as they age in their adult lives. He has identified the stages for adult development as: transition to early adulthood, early adulthood, transition to middle adulthood, middle adulthood, late adult transition, and late adulthood (above age 65).

As people age, their needs and values change, particularly as related to family/marriage and career (Levinson et al. 1974, Levinson 1986). In young adults, personal hedonic motivators are stronger and motivate affective responses. Young adults have less commitment to the existing social norms, and therefore, are more willing to challenge the existing norms and adopt novel views and beliefs. As individuals move toward middle adulthood, they develop a stronger sense of moral and social obligations (Colby et al.1983, Labouvie-Vief 1992). Their family responsibilities increase and their focus moves toward communal and social groups. This is also supported by studies in criminology, which suggest that decline in crime for older individuals is a result of maturation and is independent from social or personal factors (Gottfredson and Hirschi 1990).

Levinson (1986) equates middle adulthood with the desire for stability, and the acceptance of social responsibilities as individuals take up more roles and responsibilities in their families and careers. By middle adulthood, individuals have had more opportunities to be acculturated with social norms that promote social and ethical hedonism. Their responsibilities grow for caring for the next generation and contributing to their communities and societies. The wisdom of aging allows them to channel their personal, social and ethical motivators in forming their social beliefs. By middle adulthood, individuals have had more opportunities to form their cognitive beliefs through their social communications and interactions, which provide them a foundation for increased cognitive responses to their hedonic motivations. Furthermore, compared to younger adults, the older adults have more access to resources. By middle adulthood, individuals normally have gained more resources through their careers, which provide resources and motivations for social and ethical contributions. As they age, individuals experience a significant change in economic conditions, preferences for the status quo, and avoidance of risk. Established beliefs as well as the desire for stability, familiarity, and social acceptance cause older adults to be less open to unorthodox social and moral views and beliefs, so they need a stronger impetus to alter their beliefs and moral values. Therefore, we argue that hedonic motivators in older adults shape their cognitive beliefs as long, as these beliefs are in line with well-established social norms. Hence, personal, social and moral hedonic motivators drive older adults' socially accepted cognitive beliefs.

Events and historical settings that shape people's life course constitute another aspect of human development. Major environmental disasters or new scientific findings register in the mainstream conscious of the society and create a "cohort effect"— defined as altering values and perspectives of a generation through social interactions and communications (Torgler et al. 2008, Vlosky and Vlosky 1999).

Environmental issues have only recently become mainstream social concerns. Compared to long-standing social and moral hedonic motivators, environmental hedonism reflects a new historical shift. We argue that such effects are stronger in the younger generation since the members of that generation encounter the issues at an earlier age when their emotions, tastes and preferences were being formed. They normally have not had the life experience to form well-defined cognitive beliefs, and are less entrenched in its pre-existing opinions and more willing to give non-human nature the moral right and standing as affective responses. Therefore, the HM theory posits that hedonic motivators lead to more affective direct responses in the younger generation, whereas their influence is mediated by cognitive responses in the older generation. Furthermore, at this point in history, environmental hedonism should exert a stronger influence on youths since environmental issues have more recently become mainstream societal concerns.

2.6. MODEL CONCEPTUALIZATION OF GREEN-IT USE

We rely on the HM theory to conceptualize the Hedonic-Motivated Model (HMM) of Green-IT use. Figure 2.2 presents the conceptual model.

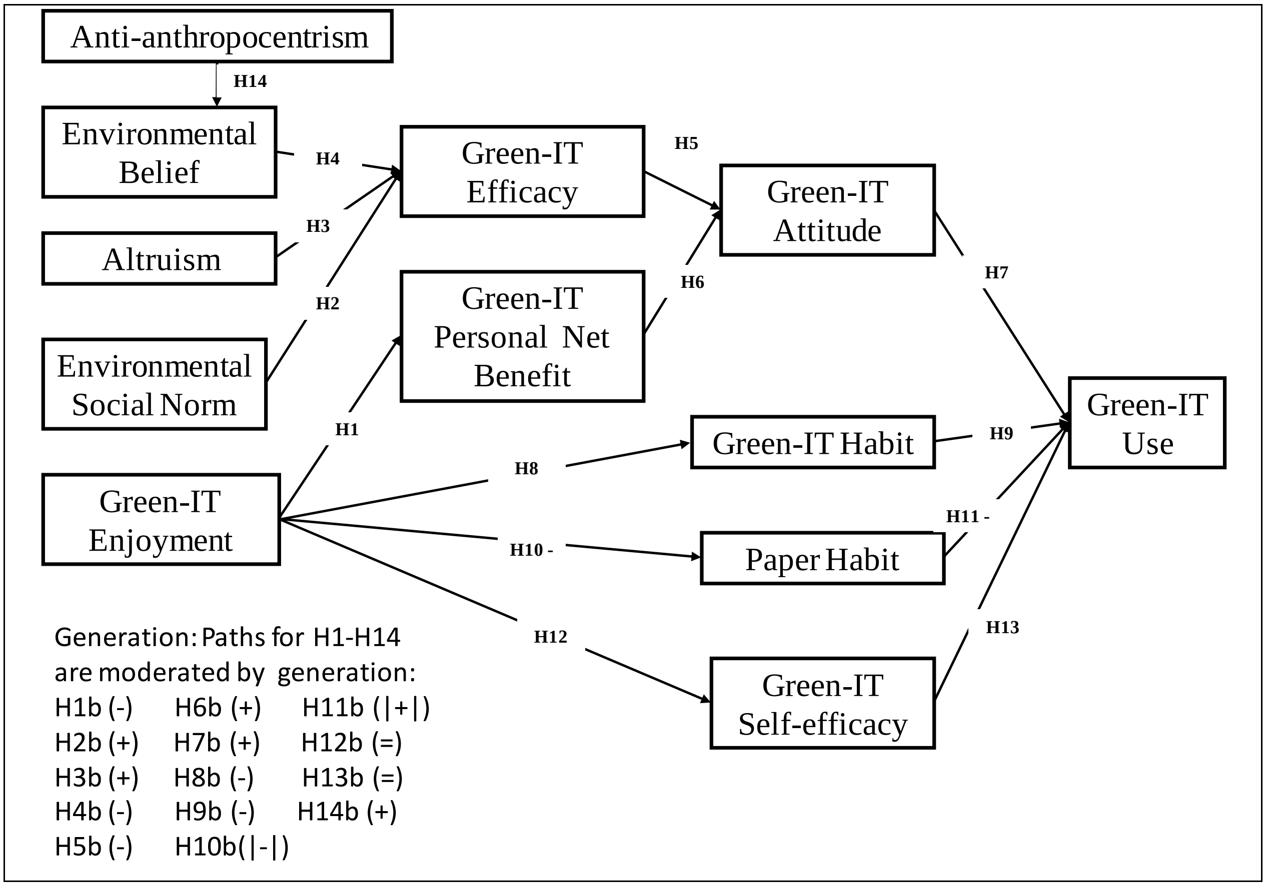


Figure 2.2. Hedonic-Motivated Model (HMM) of Green IT

Inglehart (1999) identifies four underlying factors for the success of modern social movements: "objective problem," "organizational network," "relevant motivating values" and "certain essential skills" (p. 373). Green IT has the four components identified by Inglehart—the objective problem of environmental issues, the global network of people concerned over environmental issues, the relevant motivating values to protect the environment, and adequate skills in using Green IT. The "relevant motivating values" are based on four sources of hedonism in the HM theory. Applied to the context of Green IT, we identify our motivators reflecting four levels of hedonism: Green IT enjoyment (self), social norm (social group), altruism (humanity), and environmental belief (nature).

In his motivational model for online trust, Sun (2010) defines enjoyment as the pleasure of using the technology per se regardless of its perceived usefulness. Although the role of enjoyment has been observed in IS research as an intrinsic motivation (Venkatesh et al. 2002), its source has lacked an overarching theory. We argue that Green-IT enjoyment has its basis in personal hedonism that motivates beliefs about the benefits of Green IT.

The pain of exclusion from the social group motivates individuals to subscribe to their social norm. This is also in line with the norm focus theory (Cialdini et al. 1991). In the context of Green IT, social norms may involve the group's opinions about the environment as well as the use of and opinions about Green-IT by the social group. The first social norm reflects the environmental norm, whereas the second reflects the technology social norm. We focus on the environmental social norm because this study has an environmental focus and the influence of technology social norms has been reported to be relatively small (e.g., Song and Zahedi 2005).

Altruism reflects subscription to the ethics of universalism. Altruism is defined as caring "about the welfare of others as an end in itself. Altruists have irreducible other-oriented ends" (Sober and Wilson 1998, p. 228). Altruism has been studied in various areas, and has a long history in world religions and philosophy as a personal responsibility and a moral obligation. Altruism has been the subject of scientific studies and its role in evolutionary psychology has been vigorously argued, calling it the principle of the "survival of the nicest" that improves the collective fitness of the group (Lewontin 1998). Recent studies in neuroscience indicate that altruism is associated with the zones of social attachment, aversion and pleasure in the brain (Moll et al. 2006), providing support for the concept of ethical hedonism.

Other salient human-related motivator s could include environmental concerns for the preservation of the human race and avoidance of the pain and death that a contaminated environment can cause. In this study, we have selected altruism since it has been significant in environmental studies (Schultz 2001, Stern et al. 1999). For the fourth level of hedonism, we focus on belief in the fragility of nature and the potential for humans to damage it.

We propose that these four motivating beliefs: Green IT personal enjoyment, environmental social norm, altruism, and environmental beliefs are salient motivators that influence beliefs in the benefits of Green-IT. We distinguish two types of Green-IT benefits: (1) Does using Green IT help the environment? (2) Does Green IT have a net benefit for me? [3] The first belief relates to the efficacy of Green IT. It relates to the cognitive evaluation of the net impacts of Green IT on the environment. Its focus is external. The second belief has an internal focus, and results from a rational evaluation of the time, effort and cost needed to use Green IT. Both beliefs involve gains that are cognitively evaluated based on a rational choice (Lindenberg and Steg 2007) that maximizes the intended goals. In the first belief, the goal is to maximize the benefit to

[3] Other salient context-specific beliefs could also be identified, such as the benefit of Green IT for the social group. We have limited benefits to personal and environment for the sake of model parsimony, since Green-IT efficacy would simultaneously benefit humans and the environment.

the environment, whereas the second belief's goal is to maximize one's personal net benefit.

Environmental studies have recognized the importance of cost and convenience as contextual or control variables in forming green behavior (Stern 2000, Valle et al. 2005). We argue that in the case of Green IT, a cost-benefit analysis of the time, effort, and monetary cost of technology inform the individual's belief about the personal net benefit of Green IT. This is consistent with the norm activation model (NAM), which suggests that altruistic behavior passes through a cost balancing step in the assessment, valuation, and reassessment stage (Schwartz 1977). Green-IT efficacy, on the other hand, refers to the perceived ability of Green IT to reduce threats to the environment. This is in line with the value-belief-norm (VBN) theory, which argues that the perceived ability to reduce a threat is a significant antecedent in explaining various pro- environmental behaviors (Stern 2000).

The Cognitive Paths to Green-IT Use. Based on the HM theory, personal hedonism should motivate context-specific personal beliefs. Applied to Green IT, personal enjoyment in Green IT motivates the personal net benefit of Green IT. Here, net benefit is the result of a cognitive evaluation of Green IT in terms of its benefits over the cost and effort involved in its acquisition and use. In contrast, the other-focused motivational beliefs (social norm, altruism, and environmental belief) impact the other-focused belief—Green IT efficacy. Hence, we posit in the (a) sections of H1-H4—the (b) sections hypothesize generation as the moderator and are discussed subsequently.

H1. (a) Individuals' enjoyment of Green IT is positively associated with their perceived personal net benefits of Green IT. (b) This positive association is higher for youths.
H2. (a) Individuals' environmental social norm is positively associated with their perceived efficacy of Green IT. (b) This positive association is higher for adults.
H2. (a) Individuals' altruism value is positively associated with their perceived efficacy of Green IT. (b) This positive association is higher for adults.
H4. (a) Individuals' environmental beliefs are positively associated with their perceived efficacy of Green IT. (b) This positive association is higher for youths.

Generational Influence. We argue that there are generational differences in the use of Green IT. To be specific, we define two generations in this conceptualization: youths and adults. The United Nation defines youths as those between the ages of 15-24 (UN 2011). The 24-year cutoff point has been used in other studies (e.g., Chawla 1999, Howell and Laska 1992). Chawla (1999) argues that leaving home for college at age 18 and leaving college for jobs and career-building at age 24 are two major shifts in people's lives. We define 18-24 years olds as youths and those above 24 as adults.

Using the HM theory, we argue that in the older generation we expect to see stronger impacts of hedonic social and ethical motivators on cognitive beliefs and attitudes. On the other hand, youths' focus on self gives them a stronger personal hedonic motivator, which increases the impact of personal enjoyment on the net benefits of Green IT. Furthermore, per the HM theory, when it comes to emerging motivators, youths are more receptive to new ideas. Compared to other spheres, the environment as a sphere of hedonism has been a more recent phenomenon. Therefore, we expect to see a stronger environmental motivator in youths. This is in line with the findings that openness to change and green beliefs are positively correlated (Schultz et al. 2005).

Furthermore, Nord et al. (1998) have observed significant relationships between age and environmental concern. Torgler et al. (2008) report on a number of studies that have found older individuals are less concerned about the environment and its protection (Whitehead 1991, Howell and Laska 1992, Carlsson and Johansson-Stenman 2000). Other studies also report similar findings (Buttel and Flinn,1978, Buttel 1979, Klineberg 1998). Torgler et al. (2008) argues that one reason for the generational difference is that the older people do not expect to live long enough to enjoy the positive improvements created by environmental preservation (Whitehead 1991, Carlsson and Johansson-Stenman 2000). Another explanation is that the older generation has been habituated to a certain life style. Environmental beliefs may require drastic changes in the habitual life style, hence causing the pain and loss of enjoyment in well-established routines.

Therefore, we expect to see a stronger motivational impact of environmental belief in youths.[4] This leads us to hypothesize in the (b) sections of H1-H4 that hedonic motivator (Green-IT enjoyment) and environmental belief have a greater influence for youths whereas social and human-focused motivators (social norm and altruism) have stronger impacts for adults.

The Belief-Attitude Paths to Green-IS Use. The significant impact of salient beliefs on use behaviors mediated by attitude has been theorized in a number of well-known IS theories, including TAM (Davis et al. 1989), the theory of reasoned action (TRA) (Ajzen and Fishbein 1980) and the theory of planned behavior (TPB) (Ajzen 1991), and has been shown to hold in a variety of contexts (Venkatesh et al. 2003). Therefore, these associations are included for the completeness of the model. However,

[4] An exception could be threat conditions. The experience of threat, such as the pain of a polluted environment, may increase pain to a level that would make adopting a new way of life the lesser of two evils for the older generation.

generational influences need further elaboration.

The environmental-focus of perceived Green-IT efficacy indicates the desire to improve the environment. The role of age has been investigated in supporting various environmental policies (e.g., Dietz et al. 2007). However, there is inadequate investigation of the moderating influence of generational differences in environmental attitudes. We argue that the cognitive process of beliefs→attitude→use emerges more strongly in adult life. Per the HM theory, adults have more time and experience to formulate their beliefs and attitudes and have more maturity to act according to their beliefs and attitudes. Therefore, we expect to see the cognitive path from beliefs→attitude→ use to be more prominent for adults. One exception could be the impact of Green-IT efficacy on attitude. We argue that youths have a more favorable view of how technology can positively influence environment and more awareness of environmental issues (Buttel and Flinn 1978, Buttel 1979, Klineberg et al. 1998). We posit that the positive association between Green-IT efficacy (which is environment-focused) and attitude is stronger for youths.

H5. (a) Individuals' perceived efficacy of Green IT is positively associated with their Green IT attitude. (b) This positive association is higher for youths.
H6. (a) Individuals' perceived net benefit of Green IT is positively associated with their Green IT attitude. (b) This positive association is higher for adults.
H7. (a) Individuals' Green-IT attitude is positively associated with Green-IT use. (b) This positive association is higher for adults.

Impact of Enjoyment on Use Mediated by Habit. While beliefs, attitudes and use form a cognitive path, enjoyment→habit→use form an affective and automatic path. Habit is defined as "learned, goal-directed acts that become automatic responses in specific situations” (Knussen and Yule 2008). Habits are formed through repetitive actions and emotional attachment that make the preference for an action an automatic choice, bypassing cognitive reasoning and processes. The influence of habit on behavior has been recognized in IS literature (Limayem et al. 2007, Limayem and Hirt 2003). Oritz de Guinea and Markus (2009) are critical of IS research for ignoring the role of automatic responses such as habit and emotion in technology adoption. Environment research has shown that the habit of recycling plays a role in behavior intention (Knussen and Yule 2008, Ouellette and Wood 1998). We argue that habit is a manifestation of repeated actions in the past, which also is an indicator of the same choice in the future. The IS research does not identify the forces operating in habit formation. We propose that personal hedonism is a salient motivator in habit formation. Personal enjoyment creates an affective state that motivates individuals to repeatedly prefer a given alternative over others, hence forming habit. In our study, habit is salient since enjoyment motivates habit formation, thus creating an automatic preference for Green IT.

We argue that this affective path is stronger in youths for a number of reasons. As discussed in the HM theory, youths act based on personal hedonism more often since they have fewer resources and less well-paying jobs to go beyond meeting their personal needs (inadequate resources). Compared to adults, they act less often with reason and contemplation (inadequate maturity). Today’s youths have had earlier exposure to technology and have more affinity for technology (abundance of technology enjoyment). Therefore, we posit that the affective-automatic path of Green IT enjoyment→Green-IT habit →Green-IT use should be stronger for youths.

H8. (a) Individuals' Green-IT enjoyment is positively associated with their Green-IT habit. (b) This positive association is stronger for youths.
H9. (a) Individuals' Green-IT habit is positively associated with their use of Green IT. (b) This positive association is stronger for youths.

Negative Impact of Paper Habit. Since Green-IT is an alternative to using paper, Green-IT enjoyment should reduce paper habit. However, those who have formed paper habit are less likely to use Green IT. Since youths are more motivated by Green-IT enjoyment, they are less likely to form paper habit. Once formed, however, paper habit reduces the use of Green-IT. We argue that since adults have had a longer lifetime opportunity to form paper habit, they are less likely to switch to using Green-IT.

H10. (a) Individuals' Green-IT enjoyment is negatively associated with their habit of using paper. (b) This negative association is stronger for youths.
H11. (a) Individuals' habit of using paper is negatively associated with their use of Green IT. (b) This negative association is stronger for adults.

Self-Efficacy. It is argued that self-efficacy is one of the most salient constructs in all behaviors (Bandura 1982, Compeau and Higgins 1995). Self-efficacy has consistently been shown to impact behavior and behavior intentions in numerous contexts, including in environmental contexts such as recycling (Chan 1998) and anti-environment behaviors such as overuse of plastic bags (Lam and Chen 2006). Self-efficacy has been shown to be universal and we expect its impact to be similar across generations.

While the significant role of self-efficacy has been established, there has been inadequate research in identifying the motivators of self-efficacy. Compeau et al. (1999) have identified the external motivators of self-efficacy such as the influence of others, performance, and support. In the voluntary and personal use of IT, intrinsic motivators should play a larger role since major external motivators that are present in organizational contexts are absent in personal use. We argue that personal hedonism is an intrinsic motivator of self-efficacy, similar to that of habit formation. Green-IT enjoyment creates an affective state that motivates individuals to acquire knowledge about the technology and increase their self-efficacy.

H12. (a) Individuals' technology enjoyment is positively associated with their self-efficacy in using Green IT. (b) This positive association is universal.
H13. (a) Individuals' self-efficacy in using Green IT is positively associated with their use of Green IT. (b) This positive association is universal.

Test of Anti-anthropocentrism Assertion. The HM theory asserts that the basis for environmental hedonism is the anti-anthropocentrism morality. To test this fundamental assertion, we posit that the antecedent of environmental beliefs is the fundamental moral value of anti- anthropocentrism. Since this moral value is the result of contemplation, deliberation, and cognitive processes, we expect to see its impact to be stronger for adults.

H14(a). Individuals' anti-anthropocentrism moral value is positively associated with environmental belief. (b) This positive association is higher for adults.

2.7. RESEARCH METHODOLOGY

The research method was survey. For the instrument, scales were developed from the literature and were modified to make them semantic differential, ranging from 1 to 10. Appendix B shows the definition of constructs and sources for scale development. The instrument was pilot tested using 356 respondents, and was modified based on the results

(Appendix C). A web-based survey was developed. The general public and students in a Midwestern state in the US were invited to participate in the survey. Collecting data from the general public involved asking at random for participation in public areas and in offices. A small course credit or gift card was offered as an incentive. The volunteer respondents completed surveys using wireless laptops. A strict count was kept of how many people were approached for participation and how many accepted. A total of 1,363 individuals were invited to participate, and a total of 532 took the survey, resulting in a response rate of 39%. In order to ensure that responses were the result of careful reading of the questions, the data was cleansed to remove incomplete surveys and those who had taken less than 5 minutes to complete the survey. This resulted in 527 usable data. The average age of respondents was 25; 69% were youths and 31% were adults; 60% were male and 40% were female (Appendix D).

2.8. DATA ANALYSIS AND RESULTS

2.8.1. Measurement Model

We first investigated the common method bias (CMB) in the data. We designed the survey data using a semantic differential measure in order to prevent CMB. After data collection, we used the Harman Single Factor test (Podsakoff et al. 2003) to check for the presence of CMB. This test showed that the single factor explained 22% of variance, indicating a slight CMB effect since 20% explained variance is the conventional threshold (Igbaria et al. 1997, Song and Zahedi 2005). To remove any threat of CMB, we purified data using a marker item (Podsakoff et al. 2003). The resulting purified dataset was used in the analysis.

We checked for reliability and validity of constructs in a number of ways. We carried out exploratory factor analysis, which indicated no cross loadings greater than 0.40 (McKnight et al. 2002), and all items were properly loaded on the corresponding construct (Appendix E). Table 2.2 reports additional checks.

Table 2.2 Construct Correlations and Checks for Reliability and Validity*

Construct	1	2	3	4	5	6	7	8	9	10	11	Alpha	CPR	AVE
1. Anti-anthropocentrism	**.81**											.79	.79	.66
2. Altruism	.18	**.78**										.82	.82	.61
3. Social norm	.32	.34	**.78**									.83	.83	.62
4. Environmental belief	.31	.48	.38	**.68**								.72	.72	.47
5. Green-IT enjoyment	.11	.15	.19	.08	**.89**							.91	.92	.79
6. Green-IT efficacy	.18	.41	.35	.41	.44	**.85**						.88	.88	.72
7. Green-IT net benefit	.11	.27	.29	.22	.34	.51	**.75**					.79	.79	.56
8. Green-IT attitude	.09	.23	.24	.35	.36	.48	.47	**.86**				.90	.90	.74
9. Paper habit	.17	.12	.12	.08	-.10	-.01	-.03	-.05	**.84**			.88	.88	.71
10. Green-IT habit	.06	.15	.16	.07	.53	.40	.40	.33	-.09	**.89**		.92	.92	.79
11. Green-IT self-efficacy	.14	.18	.19	.25	.31	.36	.40	.31	-.07	.51	**.91**	.94	.94	.84

*Columns 1-11 show correlation values and the square root of AVE is shown on the boldface diagonal of the matrix.

Per Table 2.2, Cronbach alpha values exceeded the cutoff value of 0.70 (Nunnally 1978), CPR values were above 0.70 cut-off threshold, the AVE values were above 0.50 except for environmental belief, and correlation values of all constructs were below the square root of AVE. We carried out the confirmatory factor by estimating the measurement model. The CFA loadings were above 0.70 cutoff values with highly significant t-values (Appendix F). The measurement model fit indices were all satisfactory (Table 2.3).

To further check the discriminant validity of the environmental-belief construct, we contrasted the originally measurement model with one that combined the environmental belief construct with three other latent variables at the same level (enjoyment, altruism and social norm), one at a time (Gefen et al. 2003, Song and Zahedi 2005). Three new measurement models were estimated. In all three cases, the new measurement model had lower fit values. The Chi-square test comparing the original measurement model with each one of the new measurement models indicated that all three new models were statistically different and inferior to the original model, providing further support for the discriminant validity of environmental belief (Gefen et al. 2003). Together, these results supported the reliability and validity of the constructs.

2.8.2. SEM Estimation

We used group analysis in MPlus (version 6.0) for estimating the HMM model with generation as the moderator. MPlus is one of the few statistical tools that has a well-established procedure for group analysis. Prior to estimating the SEM, we checked for the invariance of the factor structure across the two groups (Qureshi and Compeau 2009) by estimating the measurement model with no equality restriction on factor structure (unconstrained) with the measurement model in which the factor structures set to be the same for all constructs (constrained). The test of the chi-square difference of the two estimated measurement models was insignificant, supporting invariance of the measurement model between the two groups. The estimation of the constrained measurement model indicated satisfactory fit (Table 2.3). Fit indices were favorably above (or below) the threshold values, indicating satisfactory fit for the estimated model (Table 2.3).

Table 2.3 Fit Indices for the Model Estimation using Group Analysis*

	Measurement Model			
Fit index	**Unconstrained**	**Constrained**	**HMM Model**	**Threshold Values**
Normed Chi-square	1.26	1.27	1.65	<3.0 or 5.0
CFI (comparative fit index)	0.97	0.97	0.92	>0.90
TLI (Tucker-Lewis index)	0.97	0.97	0.91	>0.90 or 0.95
RMSEA (root mean square error of approximation)	.032	.032	.050	<0.06

*References for cutoff values include: Krause et al. (2000), Bentler (1989), Hu and Bentler (1999), McKnight et al. (2002), Bentler and Bonnett (1980), Gefen et al. (2000).

Figure 2.3 reports the SEM group analysis of the model. Paths show two coefficients, one for youths (first number) and one for adults (second number). The R^2 values are reported under each construct with the first value representing youths.

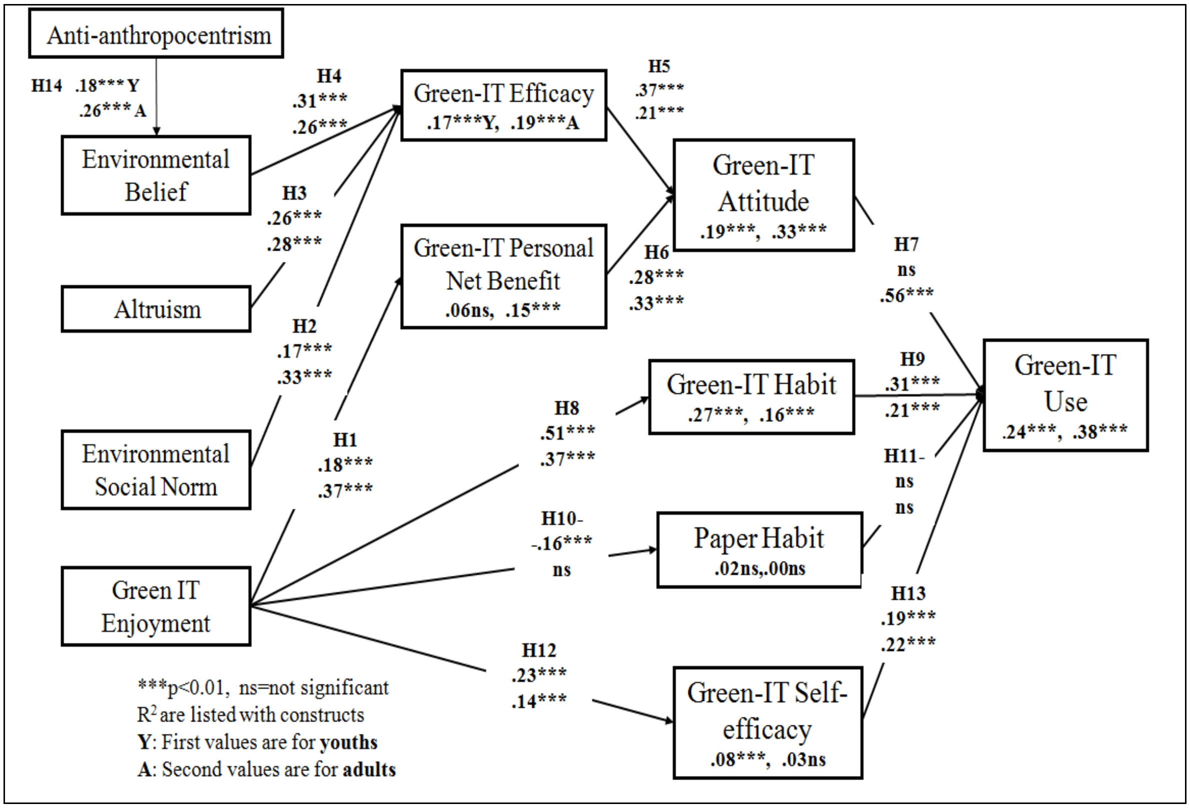


Figure 2.3. Group Analysis of Hedonic-Motivated Model of Green-IT Use

As shown in Figure 2.3, the hypotheses related to the influence of four levels of hedonism (self, social, human ethical, and environmental) and related beliefs (H1a-H4a and H8a, H10a, and H12a) were all strongly supported for both youths and adults, except for H10a for adults. Furthermore, the impact of anti-anthropocentrism on environmental belief (H14a) was significant in both groups. The mediating impacts of Green-IT efficacy, Green-IT personal net benefit and Green-IT attitude on use (H5a-H7a) were also significant in both groups except for H7a for adults. The mediating impacts of Green-IT and self-efficacy (H9a and H13a) on use were also significant for both groups. The mediating role of paper habit (H11) was not significant. For testing H1b-H14b, the differences in path coefficients were tested using the pairwise t-test. Table 2.4 reports the results. Of 14 hypothesized part (b) sections, 10 were supported.

Table 2.4 T-Test for Pairwise Path Coefficient Differences for Youths vs. Adults†

H1b	H2b	H3b	H4b	H5b	H6b	H7b	H8b	H9b	H10b	H11b	H12b	H13b	H14b
Sup ***	**sup** ***	Ns	ns	**sup** **	ns	**sup** **	**sup** ***	**sup** ***	**sup** **	**sup** **	Ns	**sup** =	**sup** **

†(sup) means supported, (sup=) means support for cases in which no generational difference was hypothesized, (ns) means not significant. *** p<0.01,**p<0.05

We also used gender, access to technology and education as control variables. Results showed that altruism was significantly associated with gender, confirming reports that the extent of altruism is higher for women (Gilligan 1982, Stern et al. 1993).

2.9. DISCUSSIONS AND CONTRIBUTIONS

2.9.1. Discussions

Testing the hedonic-motivated model (HMM) of Green-IT use provided strong evidence in support of the hypotheses and the assertions of the hedonic motivation (HM) theory. In H1(a)-H4(b), we tested the impacts of hedonic motivators of Green-IT enjoyment (self-focused), social norm (social group-focused), altruism (humanity-focused) and environmental belief (nature-focused) on the beliefs about personal and environmental benefits of Green-IT. The results strongly supported these hypotheses for youths and adults at a high level of significance (p<0.01). This showed that the four levels of hedonic motivators contributed significantly to context-specific beliefs, supporting the HM theory for both younger and older generations, indicating that the hedonic motivators operate at the personal, group, humanity and nature levels. The strong support for the path between anti-anthropocentrism and environmental belief in both generations reinforced the assertion in the HM theory that environmental beliefs arise from endowing non-human nature with a moral standing—another novel finding in this study.

Furthermore, as hypothesized, the impact of enjoyment, social norms (H1 and H2) (self and social hedonism) were higher on the Green-IT cognitive belief of adults, supporting our argument that adults operate at the cognitive path. Although the impact of altruism on cognitive belief (H3) was higher for adults, the difference was not statistically significant. Globalization and universal awareness caused by regular exposure to global events and human suffering might have increased youths' altruism and universalism. When it comes to the more recent hedonic motivator (environmental belief), the impact of this motivator was higher for youths (0.31 for youths vs. 0.26 for adults). However, the difference was not large enough to pass the pairwise t-test. This could be due to the increased universal awareness caused by environmental disasters such as the 2010 oil spills in the Gulf of Mexico.

Comparing the R^2 values of Green-IT efficacy and Green-IT personal net benefit showed that the model has far more explanatory power for adults—0.17 vs. 0.19 and ns vs. 0.15, respectively. Green-IT attitude also had higher R^2 for adults (0.19 vs. 0.33). This support the assertion that cognitive paths are better formed in adults. This generational difference was more prominent in the attitude→use path, which was highly significant for adults and not at all significant for youths. The findings support our hypotheses of generational paths and constitute a major contribution, uncovering the presence of distinctly different paths for youths and adults. Adults rely more on the cognitive paths for their use behavior. The only cognitive path operating at the higher level for youths was Green-IT efficacy→attitude, which indicated the significant impact of environmental belief on attitude as mediated by Green-IT efficacy. While their attitudes were more affected by environment-focused belief, youths did not seem to be acting based on their cognitive attitude since the path attitude→use was not significant in the youths group.

The youths' paths to Green-IT use were the affective, automatic paths: Green-IT enjoyment→ Green-IT habit→use, which indicated youths were motivated by personal hedonic motivators. Furthermore, this enjoyment has reduced youths' reliance on paper since enjoyment showed a significant negative effect on paper habit for this group. The path from enjoyment→paper habit was negative for youths as hypothesized, indicating that the enjoyment of technology has led to reduced paper habit in youths. However, this path was not significant for adults, indicating that adults' enjoyment of technology was offset by a preference for using paper. Adults have a longer experience with using paper in their daily lives, which is more difficult to overcome by the technology enjoyment.

Furthermore, paper habit did not have any impact on the overall use of Green IT. This could be due to a differential impact of paper habit depending on the specific technology. In a post-hoc analysis, the use of each technology was used as the dependent variable

(Appendix G). The results indicated that paper habit had no influence in youths' use of technology. However, it was significant for adults. Adults' paper habit had a negative association with the use of eBill and eBook, as hypothesized. However, it had no significance in using eCard and had a marginal ($p<0.10$) positive association with eNews, indicating that those who read newspapers may consume more eNews. These findings indicate that paper habits have a more complex influence on the use of Green IT, which requires further investigation.

In sum, our findings about generational differences showed that for the older generation, hedonic motivators operate more on the cognitive beliefs→attitude→use path, whereas for the younger generation, the hedonic motivators operate more on the affective and automatic path of enjoyment→habit→use, providing support Oritz de Guinea and Markus (2009)'s argument that habit and emotions are automatic responses that have been neglected in IT adoption research.

2.9.2. Theoretical Contributions

This work makes major contributions to theory by developing the hedonic motivation (HM) theory, which synthesizes well-established philosophical thoughts on hedonism and utilitarian hedonism with more recent theories and thoughts on hedonistic psychology, ethical hedonism, post-materialism and value theory to argue that the fundamental human motivators of seeking pleasure and avoiding pain expand outward from self to group, humanity and environment as people's basic needs are satisfied and their resources increase in quantity, variety and quality. This theory unifies a diverse and extensive body of literature on environmental studies, each striving to explain the beliefs and values that contribute to adopting various types of environmental behaviors in different contexts. The HM theory not only identifies the structure of motivating beliefs, it also postulates the process by which such beliefs emerge as people's personal and social needs are met and surpassed, their resources expand, and their technologies improve throughout the course of their lives.

Well-known behavior theories, such as the theory of planned behavior (TPB), the theory of reasoned action (TRA), or TAM have been built on a set of salient beliefs. However, these theories do not provide an overall theoretical lens to justify why such beliefs may be motivated in different contexts or how to identify the saliency of such beliefs. The HM theory could be used in a variety of contexts to identify salient beliefs in environmental studies as well as studies of other behaviors. The HM theory could unify theories involving beliefs at different levels of hedonism. For example, TAM has focus on self, whereas TRA and TPB move up to the social group level by incorporating social norms. Theories involving the third and fourth levels of hedonism are scarce in the array of IS theories. The HM theory could be the theoretical framework for studying the higher levels of motivating beliefs in technology adoption within other contexts.

We applied the HM theory in the context of Green-IT use. The conceptual model—the hedonic-motivated model (HMM) of Green-IT use—identified salient motivating beliefs based on the HM theory. Its successful empirical results provided support for the underlying theory. Particularly, it showed that the basic assertion of anti-anthropocentrism morality as the cognitive force for environmental beliefs has universal support across population types. As resources and stability increase, so does subscription to anti-anthropocentrism. This finding not only uncovers that process by which environmental hedonism emerges, it also supports the argument in evolutionary psychology that universalism is a part of the human evolution. Furthermore, the uniformly strong significance of hedonic motivators at four distinct levels indicated the validity of personal, social, humanity and environmental levels of hedonic spheres in the HM theory. Moreover, if used at all, age has normally been used as a control variable in IT adoption studies. The HM theory and its application show that generational paths are motivated by the level of resource and extent of cognitive maturity. This is another major theoretical contribution that sheds light on an aspect of technology use that has not been adequately explored.

The support for the HMM of Green-IT use provides a conceptual framework for studying individual behaviors and uses of various types of IT in different contexts. It could be expanded to include a more extensive set of context-specific salient beliefs.

The HM theory and the hedonic motivated model (HMM) of Green-IT use open a new theoretical stream for debate and integration in the environmental studies and Green IT. The HM theory is general enough to be applied in other Green IT contexts. The HMM can also be expanded to encompass more context-specific beliefs salient in personal and organizational studies. Furthermore, the HM theory could be used to integrate behavioral theories and adoption models.

2.9.3. Empirical Contributions

This research makes major empirical contributions. This work shows that there are generational differences in what contributes to adopting Green IT. The younger generation is motivated by their environmental belief, which impacts their attitude as mediated by the efficacy of such technologies in helping the environment. Their technology habit is a strong antecedent in their use. Therefore, in promoting the use of Green IT in support of the environment, the role of Green IT in helping the environment should be highlighted for youths. In contrast, to motivate an older generation, it is more effective to emphasize their social norm and personal net benefits.

Another empirical contribution of our work is in the recognition that while self-efficacy continues to play a universally significant role in almost all technologies, Green-IT habit in the younger generation and Green-IT attitude for the older generation are the two constructs that divide the two generations. Since the older generation has had a longer time to form a clear attitude with respect to Green IT, promotion of use requires changing attitudes, whereas the younger generation could be motivated more by the joy of using technology to form their Green-IT habit and use.

There have been recommendations for promoting pro-environmental behaviors through educational programs (Hasan 2010). The question of how to educate individuals in order to increase their self-efficacy in technology—especially Green IT—is a universal issue, particularly for poor people and poor countries. Our results provide a clear response—increase and promote technology enjoyment. Investment in making Green IT more enjoyable for all could have a substantial payback in terms of environmental protection.

2.10. LIMITATIONS AND CONCLUSIONS

This paper developed a new theory, called the hedonic motivation (HM) theory, for the investigation of environmental behaviors and their motivating belief structures. This theory is a synthesis of major philosophical thoughts on hedonism, hedonic utilitarianism, post-materialism, and ethical hedonism as well as published environmental scholarship. The HM theory was applied in the conceptualization of the hedonic-motivated model (HMM) of Green-IT use, where Green IT was defined as technologies that replace paper, such as eBill, eBook, eCard, and eNews. The HMM proposed the antecedents of Green-IT use. It also identified the differences between the younger and older generations. A survey method was used to collect data from students and the general public. The results indicated support for the premises of the model. They also supported the assertion of anti-anthropocentrism based on which the HM theory was built. Our findings showed a generational effect in the use of Green IT, with Green-IT habit-forming enjoyment motivating the younger generation, whereas for the older generation, Green-IT attitude and its constituent beliefs were more influential in promoting use.

The study has limitations. The data was collected mostly from one Midwestern state in the US. A more comprehensive set of data at the global level could increase the generalizeability of results. Moreover, generations were identified as two groups. There is a need to further categorize generational groups to shed more light on how life-cycle influences the dynamics of environmental beliefs and behaviors.

This study was among the first to develop a theory and a model for individuals' Green-IT use. As such, it must be considered as a first attempt in investigating the generational influences of IT adoption and use. This work could be extended in a number of ways. There are other types of IT that have environmental impacts, such as eCollaborations, use of virtual worlds, eLearning, and eConferencing. The environmental motivations for adopting these technologies would be an extension of this study. The role of culture at the personal, organizationalو and national levels is another future direction. Such extensions of this work would increase our collective insight about the motivations of environmental behaviors, leading to the adoption of more effective global, national, and educational policies to promote environmentally-friendly IT use.

CHAPTER 3

Essay 2: THEORY-BASED TAXONOMY OF FEEDBACK APPLICATION DESIGN FOR ELECTRICITY CONSERVATION: A USER-CENTRIC APPROACH

3.1. INTRODUCTION

Existing trends of energy consumption and carbon dioxide emissions are of growing global concern in several fields of inquiry. Greenhouse gases are expected to double by 2050 (IEA 2011). Based on G8 countries' recommendations, the International Energy Agency has developed smart-grid technology roadmaps to reduce greenhouse gas emissions globally (IEA 2011). The residential sector accounted for 36% of total electricity consumption in the US in 2012, which is more than any other sector (U.S. Energy Information Administration 2013). Effective feedback applications can play a critical role by altering individuals' energy consumption behaviors (IEA 2011, Rodden et al. 2013). Furthermore, feedback applications for household energy consumptions are considered one of the six trends which will influence the growth of the smart grid (Wheelock et al. 2011). The influence of technologies and feedback mechanisms on consumers' behavior is expected to reduce electricity consumptions by 10 to 30% (Abrahamse et al. 2005, Bertoldi et al. 2000). In IS literature, Green IT agendas have urged the investigation of energy consumers' information needs and levels of detail for improving energy efficiency (Watson et al. 2010).

Industrial researchers have studied electricity-consumption feedback tools and their effects on consumers' electricity consumption. However, since existing feedback and intervention mechanisms imitate designs for industrial sector interventions aimed at cost saving, they may not work well when applied to households (IEA 2011), especially in view of recent research that has suggested that individuals currently lack useful and effective information from their utility companies that would help them save energy (Neustaedter et al. 2013). Academic studies in disciplines such as environmental psychology, ecological sciences, and marketing have examined electricity consumption feedback applications in the wider context of energy conservation mechanisms. Despite the focus on theories explaining behavioral changes, little attention in these behavior-focused fields has been paid to the design of feedback artifacts (Froehlich et al. 2010).

In the IS field, we reviewed the recent literature (2009-2013) and found 84 Green IT papers in the top 6 IS journals and in proceedings from two major IS conferences. Only five papers examine electricity consumption behavior, with focus on the influence of online communities (Baeriswyl et al. 2011b), social competitions (Yim 2011), social norms (Loock et al. 2011), public games (Baeriswyl et al. 2011a), and goal setting (Loock et al. 2013). This clearly shows that the design of IT artifacts for feedback applications in promoting electricity conservation is an area that has not been adequately investigated. This gap has been observed at the international level. "More rigorous and methodical research and evaluation is needed to identify the optimal method to deliver feedback and to understand better the interaction between consumer feedback and pricing or incentives (financial or other) and the effect of enabling technologies (e.g. automation) on results." (IEA 2011, p. 37). Green IT agendas have urged examining the information and levels of detail required by energy consumers to improve their energy efficiency (Watson et al. 2010). Our study addresses this gap by identifying the design elements that motivate electricity consumers' behavior toward energy conservation by asking the following question: *What are the salient design elements for an electricity consumption feedback application?*

3.2. ELECTRICITY CONSERVATION AND FEEDBACK APPLICATIONS

Electricity conservation behaviors refer to the actions exerted to reduce energy consumption and are categorized as efficiency behaviors or curtailment behaviors (Abrahamse et al. 2005, Gardner and Stern 2008). *Efficiency behaviors* refer to one-time actions which reduce electricity consumption such as using energy-efficient light bulbs instead of traditional light bulbs. *Curtailment behaviors* involve actions over time with the aim of decreasing electricity consumption, such as using laptops instead of desktop computers. Although some studies suggested that efficiency behaviors are more effective in terms of savings (Gardner and Stern 2008), other studies showed that efficiency behaviors might lead to increase in consumption due to rebound effect, when users increase their energy demand (Barker et al. 2009, Polimeni et al. 2008). Therefore, both long-term and short-term conservation behaviors should be considered when examining electricity conservation mechanisms.

Electricity consumption feedback applications are designed to provide feedback on household electricity consumption to promote electricity conservation (Midden et al. 2007). Feedback device applications can be categorized into in-home display monitors, website applications, and mobile phone applications. A survey conducted on 1,041 electricity consumers in the US showed that 52% had very strong interest in such devices, and 45% were interested in becoming active users in order to decrease their electricity consumptions (Wheelock 2009). These results show that the general public has significant interest in feedback applications. The design of effective feedback applications requires an in-depth understanding of salient design elements, which is the focus of this work. To this end, we developed a comprehensive taxonomy of design elements for electricity consumption feedback applications based on a theoretical framework and extensive literature review. This taxonomy is used to develop a survey instrument for collecting data about the relative importance of design elements. The analysis of data resulted in the identification of critical design elements for feedback applications.

3.3. THEORETICAL FRAMEWORK

In identifying salient design elements for electricity conversion feedback applications, we examine salient theories and prior research that explored the relationship between feedback interventions and the attitudinal and behavioral processes of electricity consumers. Two theories fall within this framework—the Feedback Intervention Theory (FIT) (Kluger and DeNisi 1996) and the Learning Theory (Kolb 1984).

Feedback Intervention Theory (FIT) (Kluger and DeNisi 1996) examined the influence of feedback interventions on performance. FIT defines feedback interventions as any action performed by an "external agent" to deliver feedback on the performance of the task (Kluger and DeNisi 1996). Integrating several theories such as control theory (Carver and Scheier 1981), goal setting theory (Locke and Latham 1990), and action theory (Frese and Zapf 1994), FIT suggests that individual's performance is positively influenced if feedback is well-timed, directs attention to the details of the task with guiding information, and is coupled with an appropriate goal setting intervention. For example, in our context, a goal is defined as a newly assigned level of electricity consumption relative to an initial (or prior) consumption level. The pertinence of having a goal coupled with feedback was supported by a meta-analysis of 23,663 observations (Kluger and DeNisi 1996). Moreover, FIT argues that goals or levels of control are organized hierarchically—with the lowest level being task-specific, going up to task-motivated, and then to meta-tasks (self-related). Feedback interventions could change behaviors depending on the goal level in the hierarchy. In our context, the task is energy conservation. In this context, if users have a self-related goal such as being pro-environment, they will be less affected by feedback interventions focusing on task-specific goals, such as saving energy when using appliances (McCalley et al. 2011). Also, the feedback will have stronger impact if it is coupled with guiding information. In addition, FIT posits that the feedback is more effective on performance when it is associated with less cognitive effort. Moreover, the medium communicating the feedback, the time of receiving the feedback, and the frequency have an impact on the feedback effectiveness.

Learning Theory (Kolb 1984) posits that feedback information modifies individuals' perceptions and behaviors. Based on learning theory, feedback impacts users' perceptions and abilities related to electricity conservation. The learning process involves electricity usage and receiving feedback. This process helps users better manage their consumption, eventually leading to more sustainable practices (Darby 2010). Therefore, users with different levels of motivation and skill need feedback to guide them in enhancing their electricity conservation behaviors in terms of saving or more efficient usage (Darby 2010).

Our theoretical framework is an integration of FIT and the learning theory. Based on this framework, we propose that residential households will go through a learning process when presented with feedback information (Figure 3.1).

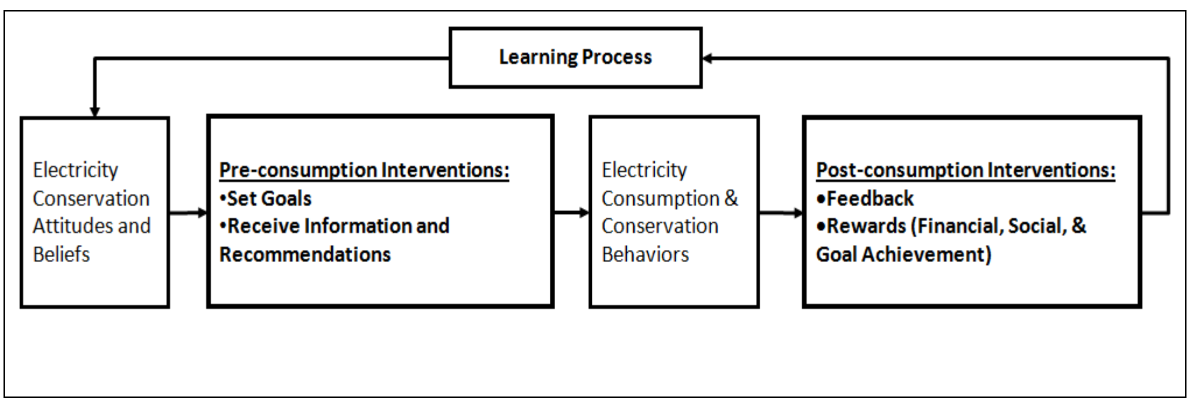


Figure 3.1 Feedback Intervention Process

We posit that users initially have attitudes and beliefs related to electricity conservation. When introduced to a device on which a feedback application resides, users go through the *pre-consumption intervention stage* (or antecedent interventions) whereby they use the feedback application to set their goals and receive information, tips, and recommendations from the feedback application (Figure 3.1). After consuming electricity, users are exposed to the *post-consumption intervention stage* when the feedback application provides users with feedback and rewards in terms of their performance. According to the learning theory (Kolb 1984), the feedback application constitutes a reverse process flow, in which the flow reverses back through learning to dynamically impact users' salient beliefs and attitudes. Our study focuses on developing the taxonomy of design elements feedback applications' pre- and post-consumption interventions.

3.4. TAXONOMY OF DESIGN ELEMENTS

Based on FIT, effective feedback is the one which relates to the goals and enables the elimination of the discrepancy between current and future desired state (Kluger and DeNisi 1996). The effect of the feedback is stronger when it is coupled with guiding information. We posit that feedback applications design elements should enhance the learning process. This requires an investigation of feedback information contents that includes goals, recommendations, assessment of consumption and feedback information. Furthermore, based on FIT, the feedback should be associated with less cognitive effort, well-timed, and suitably mediated; therefore, influencing users' behaviors requires an effective delivery of feedback information through a suitable interface and an appropriate device or medium on which the application works. Hence, design elements could be categorized into feedback information, interface, and media elements (Figure 3.2). Guided by this theoretical framework, we carried out extensive literature review to identify the taxonomy of details within each category. Figures 3.3, 3.4, and 3.5 show the proposed taxonomy and Table 3.1 lists the definitions and sources for concepts used in the taxonomy. The details of each category are discussed below.

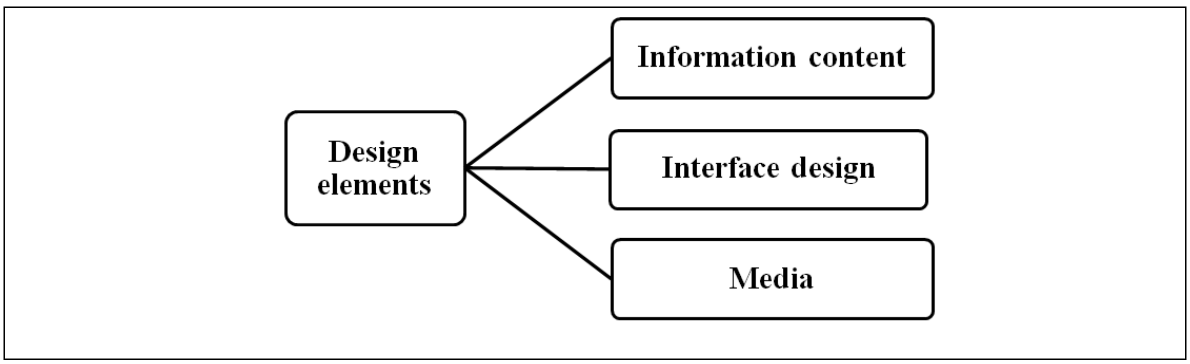


Figure 3.2. Taxonomy for Electricity Consumption Feedback Applications

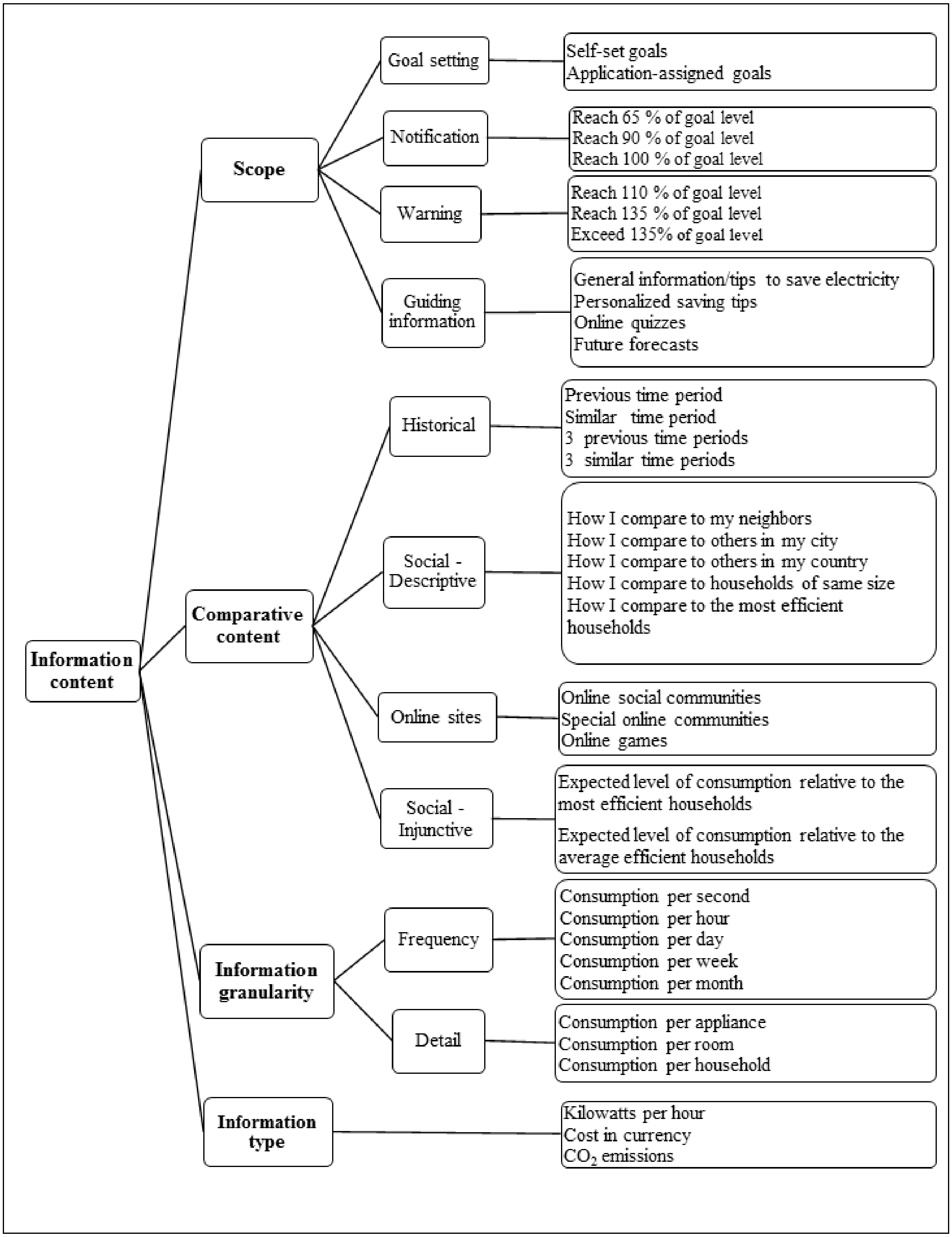


Figure 3.3. Information Content Elements for Electricity Consumption Feedback Applications

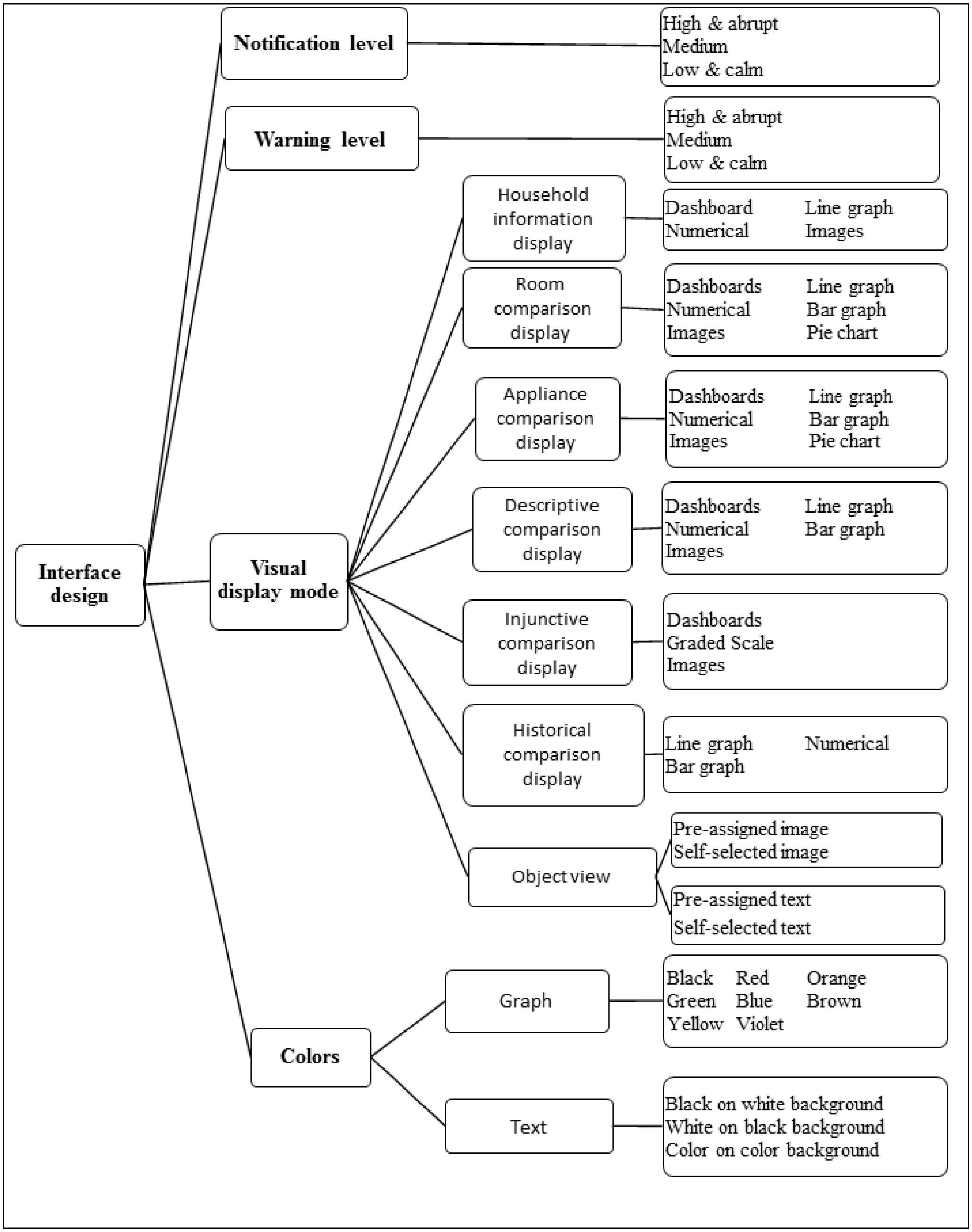


Figure 3.4. Interface Design Elements for Electricity Consumption Feedback Applications

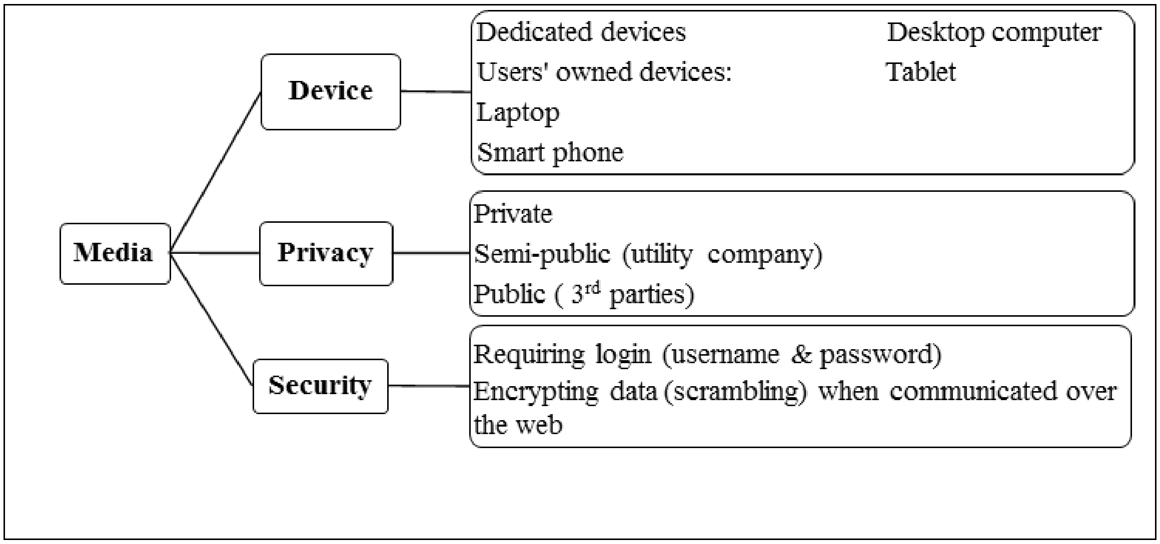


Figure 3.5. Media Elements for Electricity Consumption Feedback Applications

Table 3.1. Concepts, Definitions, and References of Taxonomy

Taxonomy	Definition	References
Information content	Feedback information about electricity consumption displayed on feedback device	Darby 2010, Koehler et al. 2010, Pierce and Paulos 2012, Watson et al. 2010
Scope	Learning through goal-related & tailored information mechanisms	Abrahamse et al. 2005, Darby 2010
Goal setting	Setting target levels of electricity consumption	Abrahamse et al. 2005, Brewer et al. 2011, Crowley et al. 2011, Erickson et al. 2013
Notification	Level of consumption in reference to the target goal	Bartram et al. 2010
Warning	Level of consumption exceeding the target goal	Bartram et al. 2010, Erickson et al. 2013
Guiding information	Tips and information provided as guidelines to reduce electricity consumption.	Abrahamse et al. 2005, Kjeldskov et al. 2012, Koehler et al. 2010
Comparative content	Comparison of electricity consumption with prior or other group’s consumption	Abrahamse et al. 2005, Darby 2010, Kjeldskov et al. 2012, Schwartz et al. 2013
Historical	Refers to displaying current consumption relative to historical consumption	Bonino 2012, Erickson et al. 2013, Loviscach 2011, Riche et al. 2010, Yun 2009

Social - Descriptive	Direct comparison of consumption relative to other household's consumption	Baeriswyl et al. 2011a&b, Chetty et al 2008, Cialdini et al. 1990, Crowley et al. 2011, Fischer 2008, Gamberini 2011, Kjeldskov et al. 2012, Loock et al. 2011
Online sites	Media that provides sharing of social comparisons of the electricity consumption online.	Brewer et al 2011
Social - Injunctive	Comparison based on the expected consumption.	Baeriswyl et al. 2011a&b, Cialdini et al. 1990, Fischer 2008, Kjeldskov et al. 2012, Loock et al. 2011
Information granularity	Refers to both the detail and the frequency of electricity consumption information	Ehrhardt-Martinez et al. 2010, Pierce and Paulos 2012, Schwartz et al. 2013, Watson et al. 2010
Frequency	The information's rate of update in terms of displaying electrical consumption	Chetty et al 2008, Gamberini 2011, Roberts and Baker 2003
Detail	The information's level of specificity in terms of electrical consumption of electrical devices	Chetty et al 2008, Fischer 2008, Gamberini 2011, Riche et al. 2010, Schwartz et al. 2013, Yun 2009
Information type	The measurement unit of for electricity consumption	Bartram et al. 2010, Chetty et al. 2008, Froehlich 2009, Kjeldskov et al. 2012
Interface design	The design features implemented in the feedback device interface	Froehlich et al. 2009, Tomitsch et al. 2007
Notification level	The level of interruption designed to alert the user about the notification message	Bartram et al. 2010, Erickson et al. 2013, Tomitsch et al. 2007
Warning level	The level of interruption designed to alert the user about the warning message	Bartram et al. 2010, Erickson et al. 2013, Tomitsch et al. 2007
Visual display mode	The type of visual display provided by the application	Freundlieb and Teuteberg 2012, Froehlich 2009, Tomitsch et al. 2007
Household info. display	The type of visual display for household consumption information	Crowley et al. 2011, Freundlieb and Teuteberg 2012
Room comp. display	The type of visual display for comparison of consumption in household rooms	Bonino et al 2012, Riche et al. 2010
Appliance comp.	The type of visual display for comparison of consumption by	Bonino et al 2012, Riche et al. 2010

display	household appliances	
Descriptive comp. display	The type of visual display for comparison with similar households, such as neighbors	Loock et al. 2011, Schultz et al. 2007
Injunctive comp. display	The type of visual display for comparison with average consumption of others	Kjeldskov et al. 2012, Loock et al. 2011, Schultz et al. 2007
Historical comparative inf. Display	The type of visual display for comparing current and historical consumptions	Crowley et al. 2011, Froehlich 2009, Loumidi et al 2011
Object view	Images or texts used for displays—could be pre-assigned or selected by the user	Crowley et al. 2011, Froehlich 2009, Loumidi et al 2011
Colors	The colors used in the in the visual interface	Crowley et al. 2011, Freundlieb and Teuteberg 2012, Makonin et al. 2012
Graph	The colors used in graphs	Crowley et al. 2011, Freundlieb and Teuteberg 2012
Text	The colors used in text and its background	Crowley et al. 2011
Media	The device which presents the feedback information and related privacy and security levels.	Bartram et al. 2010, Tomitsch et al. 2007
Device	The device type on which the feedback application runs	Bartram et al. 2010, Ehrhardt-Martinez et al. 2010, Mattern et al. 2010, Pierce and Paulos 2012
Privacy	Levels of information privacy settings for consumption information	Cavoukian et al. 2010, Garcia and Jacobs 2011, Rodden et al. 2013
Security	The security measures implemented to protect electricity consumption data	Cavoukian et al. 2010, Garcia and Jacobs 2011

3.4.1 Information Content Category

The taxonomy for this category is reported in Figure 3.3. This category involves the information contents of feedback applications and has scope, comparative content, information granularity, and information type as subcategories.

Scope. Abrahamse et al. (2005) and Darby (2010) argue that suitable feedback mechanisms should provide information that goes beyond simple reporting of electricity consumption. Guided by our theoretical framework, the scope taxonomy is specific to feedback application. Based on FIT and the learning theory, goal setting, notification, and warning are critical elements in the learning process. They facilitate learning by guiding and motivating users to take concrete electricity conservation actions (Crowley et al. 2011).

It is argued that setting goals for consumers or encouraging them to set goals influences their behavior (Abrahamse et al. 2005, Brewer et al. 2011, Crowley et al. 2011, Erickson et al. 2013). Self-goal setting combined with feedback information is considered to be more successful in changing behaviors than any other type of feedback intervention (McCalley and Midden 2002). Yun (2009) argued that goal-setting raises consumer's interest and motivation by creating an attractive self-competitive context. The process of using the feedback application is that the feedback device first notifies users about their current consumptions before reaching the preset goal. When a consumption level exceeds the preset goal, a warning is issued (Bartram et al. 2010).

Moreover, based on FIT, the effect of the feedback is stronger when it is coupled with guiding information. Also, some aspects of information need to be tailored to specific needs of users in order to increase the relevance of information for them. Guiding information could involve providing customers with personalized tips about their household consumption (Kjeldskov et al. 2012, Koehler et al. 2010, Midden et al. 2007).

Other guiding information could include online quizzes and future forecasts tailored to specific users.

Comparative Content. In line with FIT, which suggests that detailed information helps performance, Kempton and Layne (1994) argued that disaggregated data is a requirement to compare electricity consumption behaviors. Comparison could be with the household's historical consumption or with the consumption of salient other people. Historical information displayed by a feedback application provides individuals with comparisons between their previous and current consumptions. This type of feedback positively influences the electricity conservation (Darby 2006, Kjeldskov et al. 2012, Schultz et al. 2007). Users primarily react to historical information (Roberts and Baker 2003). It is further reported that historical information is more attractive than consumption reported in kWh or cost (Karjalainen 2011).

Social comparisons reflect the comparison of a household's consumption with that of salient others. Based on the focus theory of normative conduct (Cialdini et al. 1990), providing descriptive normative information—comparing with social benchmarks—leads to an undesirable boomerang effect. Boomerang effect is created when providing information to individuals with higher performance relative to the others (descriptive *normative feedback*) causes them to reduce their performance level (Schultz et al. 2007). In order to prevent the boomerang effect, Cialdini et al. (1990) suggested that two kinds of normative information should be provided. The first type is the *descriptive normative feedback*, which involves direct comparison with other households. The second type is *injunctive normative feedback*, which reflects the community's approval or disapproval of the user's performance. Providing multiple types of normative feedback via web portal improves users' energy conservation (Loock et al. 2011). To this end, two elements reflect these two categories of comparison. The first category is social descriptive *normative feedback* which covers the direct comparisons with different frames of reference: neighbors, city residents, country residents, residents of households of same size, and residents of households which are characterized as most efficient. The second category includes evaluation relative to the consumption of most efficient households and evaluation relative to average of other people. Both types are included in the taxonomy. New technologies offer social interaction in forms of competition and encouragement. We define online sites as the media that provide sharing of social comparisons online. Recent IS literature indicates that online communities, and online games influence electricity consumption (Baeriswyl et al. 2011a, b Erickson et al. 2013, Kjeldskov et al. 2012). Baeriswyl et al. (2011a, b) argued that online games and online communities have influence on users' energy consumption.

Information Granularity. *S*ome FIT studies showed that feedback information should match users' preferences in order to be noticed (McCalley and Midden 2002). In the energy consumption context, this means that feedback granularity in terms of frequency and detail should fit users' preferences in order to impact their behavior (Schwartz et al. 2013, Watson et al. 2010).

Literature on feedback information categorizes the temporal relationship between users' actions and feedback as direct or indirect (Abrahamse et al. 2007, Darby 2000). In our context, the indirect feedback gives users information with a time delay, such as end of month, whereas direct feedback provides real time information (Darby 2006, Ehrhardt-Martinez et al. 2010). Darby (2006) reported that indirect feedback resulted in savings between 0 and 10% while direct feedback resulted in savings between 5% and 15%. The feedback information could be updated at different frequencies. While there are reports that consumers prefer to receive real-time information that would allow them to take proper decisions and respond to them more effectively (Chetty et al. 2008) and Roberts and Baker 2003), others have argued that more frequent information raises cost (Fischer 2008). Bonino et al. (2012) noted that participants preferred having weekly and monthly goals over daily goals. Therefore, the frequency element and its settings are salient elements in the taxonomy.

The detail subcategory identifies the levels at which the data should be collected. Electricity conservation research has suggested that specific information reduces uncertainty, which in turn facilitates specific actions (Van Houwelingen and van Raaij 1989). Moreover, based on a qualitative survey, Bonino et al. (2012) reported that participants wanted detailed information per room. In the same vein, Yun (2009) also observed that experienced individuals were unsatisfied by general information and requested details about their consumption. This led to the specification of detail as appliance-based, room-based, or household-based.

Information Type. Existing literature suggests that feedback applications should show direct relationship between consumers' actions and their effects and offer diverse motivating reasons to fit most of the population (i.e. money saving, environmental contribution, or social desirability) (Fischer, 2008). Similarly, some energy conservation studies have argued that the use of measurement units such as money or carbon emissions, instead of electricity consumption (kilowatts per hour—kWh), can compensate for the limited electricity-related scientific knowledge of the user (Bartram et al. 2010). This way, the information will be easier to conceptualize and interpret. In fact, based on a qualitative survey, Chetty et al. (2008) reported that individuals find the kilowatt per hour unit to be abstract and meaningless. Furthermore, other studies suggested that the unit of measurement used may function as a financial or environmental motivating factor, depending on the user's beliefs regarding environment or saving costs (Yun 2009). Frey (1999), however, argued that putting an exclusive emphasis on economical motivation may override the ethical motivations of saving energy. Hence, the taxonomy includes kWh, cost and Co_2 emissions as information types.

3.4.2. Interface Design Category

The taxonomy for this category is reported in Figure 3.4. Recent studies argue that interface design should be attractive for users (Fischer 2008). A suitable interface reduces the cognitive efforts needed to process feedback information (Chen et al. 2011). Moreover, the levels of notification and warning should not create negative feelings of stress and anxiety. Furthermore, design and display elements should sustain users' interest and involvement since users are not energy specialists and their usage is voluntary. Such designs are in contrast with the requirements of technical users and engineers who have expertise in the field and normally use feedback applications in mandatory settings.

Notification Level. Notification level is the degree by which the system attracts the user's attention about their consumption. Although useful, Isaacson et al. (2006) suggest that some consumers feel notifications are disruptive. The categories of the notification level are "high and abrupt" demanding the user's attention, "medium" and "low and calm."

Warning Level. Similarly, different degrees of warning can be used to point out an excess in consumption relative to a pre-set goal (Bartram et al. 2010, Tomitsch et al. 2007).

Visual Display Mode. Different display options are available to communicate information in feedback applications. Users can see their consumption information not only in numbers—kWh, money, or carbon emission—but also in various graphical displays, dashboards, or even pictograms. Dashboards and graphs allow easier comparisons than those of numbers. For example, a histogram (bar graph) can show clearly the amount of consumption and its variation during different times of the day. A pie chart can help the user compare electricity consumption per room. Some research suggested displaying information using pictograms instead of numerical values

(Loviscach 2011). Users can, for example, see the equivalent of how many trees or flowers they have planted, which represent the level of their energy conservation. While quantitative and numerical values are more precise, the user needs more time to learn how to read and interpret them (Kjeldskov et al. 2012). On the other hand, more artistic representations such as pictograms may lead to loss in information precision but they increase users' attention and involvement (Froehlich 2009).

Loumidi et al. (2011) studied the optimal visualization of driving-efficiency information in cars and found that gauge dials, horizontal bars, and interestingly textual information were preferred over other visualizations such as vertical bars, diagrams, mini icons on maps, single score number, graphs, images other than leaves and trees, bubble diagram with leaves, leaf graphics, tree graphics. Furthermore, they noted that there is a relationship between income level and the preference for graphs or pictures (Loumidi et al. 2011). Different objects-view options have been suggested for presenting information. Users can be given a choice of images and text related to each room or appliance. Users can upload self-selected images and enter their own text, or use pre-assigned text and images (Mattern et al. 2010). Our taxonomy includes these display modalities for various categories of information content based on the existing literature.

Colors. For the display mode, using various colors when displaying graphs is also an advantage offered by new display technologies. Colored display attracts user's attention easily and communicates information more clearly, especially when using common color codes like green and red (Chen et al. 2011, Crowley et al. 2011). Freundlieb and

Teuteberg (2012) suggest the use of intuitive and eye-friendly colors with a reference legend. This allows the application to get user's attention with minimum analytical effort (Midden et al. 2007). Yet, some studies recommend the use of both numerical values and colors because some users may experience difficulty discriminating colors and thus reading numerical values would be a useful complement (Bonino et al. 2012). As for the text, contrast between its color and the background can affect clarity and the ease of reading (Crowley et al., 2011). Hence, the colors category in the taxonomy provides color options for both graphs and text.

3.4.3. Media Category

The taxonomy for this category is reported in Figure 3.5. This category refers to the elements related to devices or media on which the feedback application runs, as well as their privacy and security features.

Device. Existing literature suggests that feedback applications should offer comfort (Bartram et al. 2010). Devices that run feedback applications can be grouped in two major categories: devices dedicated to feedback applications and users' own electronic devices on which the feedback application is downloaded or accessed from the Internet. Since comfort is an important factor in using a feedback application, it must be easily accessible (Bartram et al. 2010, Pierce and Paulos 2012). The device's display configuration should be reader-friendly and easy to access in order to make it part of users' current "information ecosystem" (Bartram et al 2010). A small, handy, and mobile tool is easier to carry around the house, and the user will be able to refer to it more often. Yun (2009) made similar observation and suggested the use of mobile phones or wristwatches. Our taxonomy includes dedicated devices as well as various user-owned devices.

Privacy. Privacy and security concerns have been investigated regarding feedback applications (Cavoukian et al. 2010, Rodden et al. 2013). "Frequently measuring electricity consumption is privacy sensitive, because it reveals behavioral patterns that can be abused in various ways" (Garcia and Jacobs 2011, p. 4). Thus, it is important to determine desired level of privacy—private, semi-public (available to the utility company or its direct partner who manages the electricity feedback application), or available to 3rd parties and marketing companies—as reflected in our taxonomy.

Security. Since personal consumption information revealing habits and routines (such as going for vacation) is communicated through the feedback application, security measures should be taken into consideration. Recent literature reports on the various identification mechanisms for avoiding information theft in the various smart grid technologies (Cavoukian et al. 2010, Strueker and Kerschbaum 2012). It is also suggested that restricting household information from being sent outside would enhance protection of user's information (Kleiminger et al. 2011). Our taxonomy includes mechanisms such as login and encryption for protecting consumption information.

3.5. METHODOLOGY

The proposed taxonomy presents a guideline for designing feedback applications. We developed a survey instrument (appendix B) to collect data for the different importance ratings of design elements and the preferences for the different design options using an11-point scale. We provided examples of the design elements to simplify the questions asked. We began with the specific and concrete elements and then moved to general and abstract elements to make sure that our participants understood the higher level categories. The survey results allowed us to investigate whether there are certain design elements which were significantly preferred and whether there are major differences in the preferences signifying the need for personalization of feedback applications based on users' profiles. A web-based survey was used for data collection from the public. Students in a Midwestern state in the US were asked to recruit three persons from their acquaintances, neighbors, or relatives by providing their names and email addresses. A small extra credit was offered as an incentive to the students for recruiting the three persons. Invitations were sent by email containing a customized link that could only be used once. In total, 505 participants were invited to participate and 370 took the survey, resulting in a response rate of 73%. The data was cleansed to remove those who had taken less than 7 minutes and 30 seconds to complete the survey—the minimum time deemed needed to take the survey with care— to ensure that responses were the result of careful reading. This resulted in 366 responses. The descriptive statistics are reported are Table 3.2.

Table 3.2 Descriptive Statistics

Variable	Mean or %	Std. Deviation
Age	35.62	13.99
Education*	4.10	1.44
Experience with feedback applications**	5.15	3.04
Internet access using desktop or laptop at home**	9.30	2.35
Internet access using smartphone**	8.13	3.44
Internet access using tablet**	6.54	4.01
Environmental belief ***	9.126	2.14
Male	44%	
Female	56%	

* 1:Some school, non degree 2:High school graduate 3:Some college, non degree/college students, 4: Professional deg./2-year associate deg.5:Bachelor's deg .6:Master's deg. 7:Doctorate, ** Measured on a continuous scale 1(very low)-11(very high)
*** "Item: Focusing on environmental beliefs, for me-In general, protecting environment is" 1(very low)-11(very high).

3.6. ANALYSIS AND RESULTS

In order to study the preferences of the design elements by our respondents, we calculated the mean and standard deviation for each element in our taxonomy and performed t-tests to study the elements that were significantly preferred over others within each category. A statistically significant result implies that at least one element in the last level was preferred over all other options in the taxonomy. Figures 3.6, 3.7, and 3.8 show the preferences of the design elements in the taxonomy.

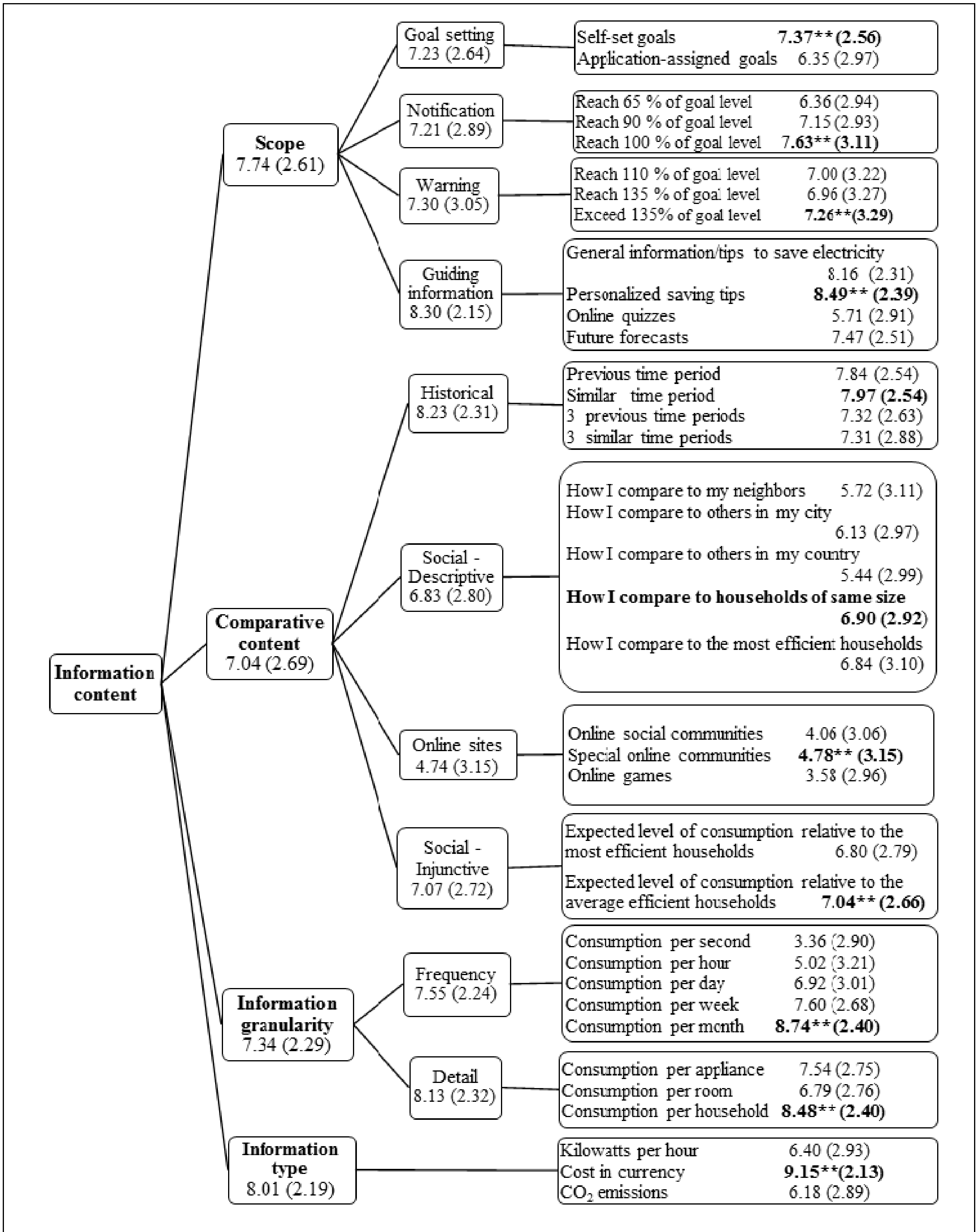
Information content (Figure 3.6). For the scope, goal setting in the scope subcategory is often described as a crucial method of inducing electricity conservation. Results indicated respondents preferred to set their own goals. Users mostly prefer to get notified when their consumption reaches 100% of their pre-set goal and to be warned when they exceed their goal by 135%. Although these findings do not provide a high range of detail to the user, they reinforce literature findings suggesting that some users find notification disruptive (Isaacson et al. 2006).

Supporting this finding was the fact that participants preferred notification and warning levels should both be low. Personalized saving tips design element was the most preferred guiding information. These indicated the need for personalized guidelines in helping users conserve electricity based on their habits and lifestyle.

Regarding information comparisons, historical comparison to the similar period and comparison to social injunctive norm were preferred. Regarding the descriptive comparisons, the surveyed participants preferred household of same size as the frame of reference. Regarding the injunctive norm display, they preferred to be evaluated relative to the average efficient households. Surveyed participants were interested in having social interaction with special online communities, affirming today's social trends of online socialization.

For information granularity, there was a clear preference for consumption information at the household level over room and appliance details. Furthermore, there was a preference for information delivered monthly, which was an unexpected result. It seems that respondents preferred getting feedback in the style of monthly electricity bills to which they were accustomed. This could also be due to the lack of strong motivations such as achieving a pre-set goal.

For information type, our results showed that the currency unit seemed to be the most important information type unit, indicating preference for financial reward by reducing cost. This is in line with existing literature (Bartram et al. 2010, Chetty et al. 2008, Kjeldskov et al. 2012) which suggests that kWh and carbon emissions are abstract for individuals who are not electrical engineers.



Means are inserted outside parentheses, and standard deviations in parentheses, **=p<0.01, *=p<0.05

Figure 3.6. User Preferences for Information Content Elements in Feedback Applications

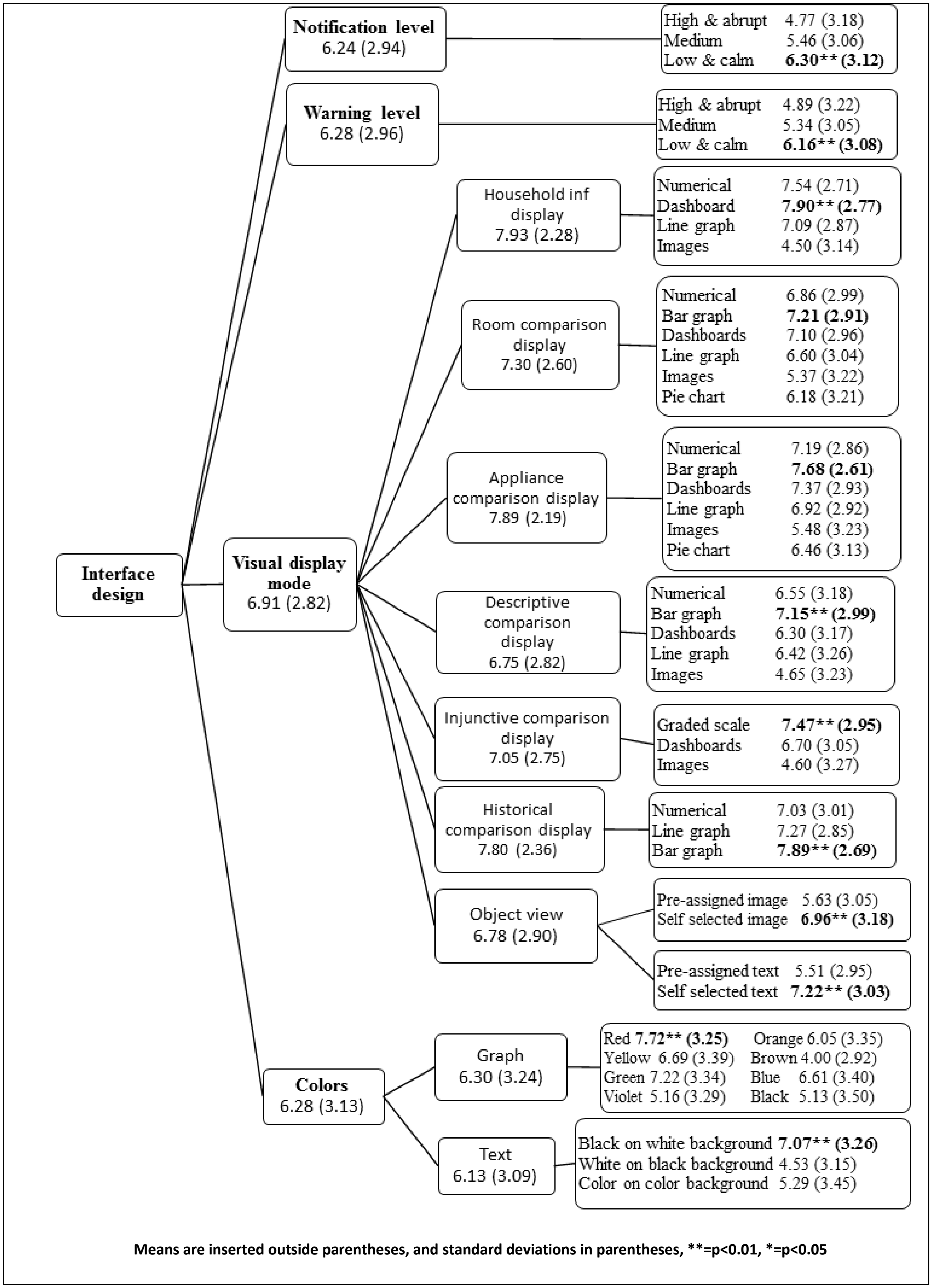


Figure 3.7 User Preferences for Interface Design Elements in Feedback Applications

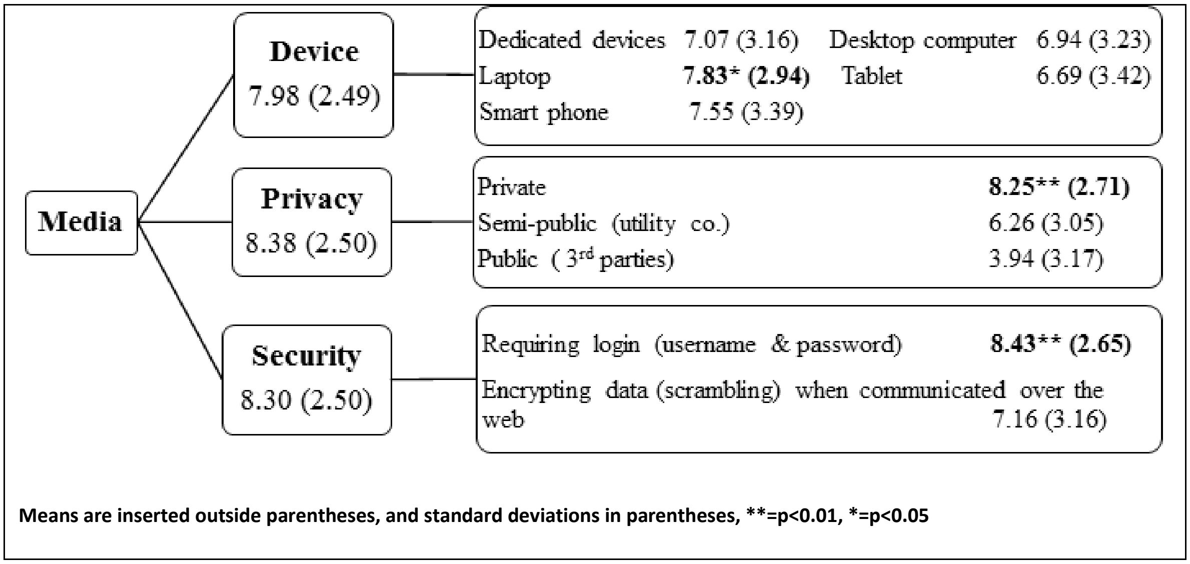


Figure 3.8 User Preferences for Medium Elements in Feedback Applications

Visual display modes (Figure 3.7). The results indicated preference for dashboards to display household consumption. For comparisons' display (room, appliance, social descriptive and historical), bar graphs seemed to be the favorite mode. The only exception lies in the injunctive social comparison where there is a preference for a grading scale that shows how well they are doing compared to others. These results are in line with the idea that graphical representations are easier to interpret than numbers. Participants also showed interest in the display option where they can personalize their text and images for rooms and appliances. When required to choose display colors, there was a clear preference for the use of red. Interestingly, the second most popular choice was green. There could be two interpretations that support this preference. First the use of symbolic and familiar colors like red and green that have well known meanings (as on traffic lights) facilitates user's interpretation of information. Second, studies in neurobiology of human vision show that the color red is perceived at a faster rate than other colors, attracting one's attention (Chen et al. 2011, Roorda and Williams 1999).

Participants show a preference for the most common style of text display—black type on a white background.

Media (Figure 3.8). Most participants preferred laptops as the device. This choice confirms the importance of mobile devices (Bartram et al. 2010). We note that the majority of our participants had access to the Internet and laptops. In line with recent literature (Rodden et al. 2013), privacy and security issues received high ratings since most users preferred to preserve private access to their consumption information and requiring logging in.

3.7. CONTRIBUTIONS AND IMPLICATIONS

This paper makes a number of contributions to the energy conservation and Green IT research in general and the electricity consumption feedback applications research specifically. This study identified the design elements for electricity consumption feedback applications and organized the elements in a meaningful hierarchy based on a theoretical framework. Moreover, our work also attempts to bridge the research gap proposed by Green IT agendas relating to the information and level of detail required by individuals to save electricity. Furthermore, this study highlights the significance of theory-based user centric design for electricity consumption feedback application. The findings reveal the importance of integrating theories and literature from several fields of study to improve the design of electricity consumption feedback applications.

The results revealed the important role of personalization in the design of feedback applications. The participants preferred to use a feedback application that allowed them to set their personal target goals, to receive personalized saving tips, and to select the images and text they preferred in the interface design. Also, the results confirmed that users preferred design elements to which they are accustomed. This finding highlights that in order to motivate users to accept pro-environmentally important design elements, such as carbon emissions for information type, further research is needed on the incentives and motivators required. Together, the findings uncover the significance of designing feedback applications that require less cognitive effort, are well-timed, and are suitably mediated and that, in parallel, integrate goals, saving tips, and feedback information. Furthermore, this study provides a rigorous empirical validation to evaluate the preferences and importance of design elements of feedback applications. Combined with the theory-based approach, this could lead to a new avenue of research on design elements that would enhance users' perceptions towards use of electricity consumption feedback applications and electricity conservation.

This study makes a number of practical contributions and policy implications as well. This work provides a guideline for user-centric design of electricity consumption feedback applications. The findings would help in designing effective tools to improve electricity conservation in the residential sector. In addition, the results form a basis for evaluating current electricity consumption feedback applications and improving their effectiveness. In addition, this study uncovered the significance of considering individual consumers' privacy and security concerns related to electricity consumption information delivered over new smart grid technologies. Policy makers who are responsible for the laws regulating the work of utility companies and other market stakeholders should try to reduce such threats in order to motivate users to adopt electricity consumption feedback applications and other smart grid technologies, thus improving electricity conservation. Furthermore, the findings suggest that the delivery device of the feedback should not be limited to one type of device. Although the use of mobile smartphones is increasing, the results show that users still prefer laptops more than smartphones. Providers of electricity consumption feedback applications to real electricity consumers should design applications for multiple devices and should consider the privacy and security concerns in their design.

3. 8. LIMITATIONS AND FUTURE WORK

This paper developed a taxonomy of design elements for electricity consumption feedback applications based on an integrative theoretical framework and extensive review of the existing literature. In order to study the preferences of the design elements, data was collected using a survey method. The results indicated that there were distinct preferences for some design element options, indicating the need for personalization of feedback applications. This work contributes to the effective design of feedback applications and the evaluation of existing feedback applications for changing energy users' consumption behaviors and promoting energy conservation. Moreover, it serves to inform energy conservation policy makers on the laws regulating the work of utility companies and other market stakeholders. Our data were collected from a segment of the population in the United States. This work could be extended by collecting data from other cultures. This work could also be extended to evaluate the impact of various salient design elements, such as goal setting and social normative elements, in promoting energy conservation.

CHAPTER 4

Essay 3: A THEORY-BASED APPROACH FOR ELECTRICITY CONSUMPTION FEEDBACK APPLICATION USE AND ELECTRICITY CONSERVATION

4.1. INTRODUCTION

Interest in residential energy consumption trends and potential energy saving opportunities is growing significantly among researchers. Although accounting for only 17% of energy consumption in the world, electricity consumption produces 40% of global carbon dioxide emissions (IEA 2013). The electricity consumption for the residential sector in the U.S. has increased by 23% over the last 10 years, reaching 36% of total electricity consumption in the U.S. in 2012 (U.S. Energy Information Administration 2013). This number exceeds the industrial sector and is expected to increase by 24% by 2040 (U.S. Energy Information Administration 2013).

With the proliferation of personal electronics and sophisticated gadgets, reducing residential electricity consumption is gaining more prominence (Ehrhardt-Martinez et al. 2010). Expected rates for electricity conservation caused by the influence of technologies and feedback mechanisms on consumer behavior are estimated to be between 10% and 30% (Abrahamse et al. 2005, Bertoldi et al. 2000). Electricity conservation refers to the actions taken to reduce energy consumption and are of two types: efficiency behaviors and curtailment behaviors (Abrahamse et al. 2005; Gardener and Stern 2008). Efficiency behaviors refer to one-time actions that reduce electricity required for electricity services, such as using energy-efficient bulbs instead of traditional bulbs. On the other hand, curtailment behaviors are dynamic actions aimed at decreasing electricity consumption, such as using laptops instead of desktop computers. The electricity consumption feedback application is an application that provides feedback on household electricity consumption in order to enhance electricity conservation (Midden et al. 2007).

Findings from pilot projects on feedback mechanisms have shown that information and feedback have rarely been enough to create continuing behavior change (Staats et al. 2004). These results bring forth the question: What makes individuals change their behavior? In fact, energy consumption and conservation are both behaviors that depend on psychological variables such as attitudes (Abrahamse and Steg 2009). As such, De Vries et al. (2011) assert that although technological improvements are estimated to bring 30% energy savings (Bertoldi et al. 2000), greater interest and inquiry should be directed towards individuals' behavioral change.

Academic research in several disciplines such as environmental psychology, ecological sciences, and marketing has examined electricity consumption feedback applications in the wider context of energy conservation mechanisms. In environmental psychology, feedback mechanisms are categorized as consequence interventions along with rewards versus antecedent interventions such as personal commitment, goal setting, energy-saving and environmental information, and behavior modeling (Abrahamse et al. 2005). In ecological sciences, feedback applications are considered one of the feedback mechanisms (in addition to accuracy and frequency of billing) along with knowledge mechanism and motivation mechanism (Darby 2010). Empirical results from these disciplines all agree on the need for examining the integration of multiple mechanisms, rather than focusing solely on feedback mechanisms, when designing energy efficiency interventions (Abrahamse et al. 2005, Darby 2010).

In the IS field, we reviewed the recent literature (2009-2013) and found 84 papers in the top six IS journals and in proceedings from two major IS conferences (Table A.1 in Appendix A). Only five papers examine electricity consumption behavior, with a focus on the influence of online communities (Baeriswyl et al. 2011b), social competitions (Yim 2011), social norms (Loock et al. 2011), public games (Baeriswyl et al. 2011a), and goal setting (Loock et al. 2013). However, the role of IT artifacts, especially energy consumption feedback applications, in promoting electricity conservation has not been adequately explored, thus leading to the call for studies that "outline technologies proven to mobilise sustainable changes in energy consumer behavior" (IEA 2011, p. 37). After identifying feedback applications' design elements (discussed in chapter 3), this study addresses this gap in IS literature by describing the role of the design elements and the mechanisms and processes by which these elements will motivate electricity consumers' behavior towards energy conservation by asking the following questions: *Do the design elements of feedback applications impact the use of such tool? Does the use of such tool* *enhance electricity conservation? If so, what is the process by which these impacts take place?*

We have developed a conceptual framework to investigate the impact of feedback application design elements on the beliefs and behaviors of individual electricity consumers by developing a mobile app and website and by conducting a controlled longitudinal lab experiment. To our knowledge this is the first study aimed at examining the relationship between electricity consumers' beliefs and behaviors and the specific perceived design elements of the electricity consumption feedback application. We aim to understand how different features of the feedback application contribute to consumers' beliefs on energy consumption. The main contribution of this paper is to identify the processes by which electricity consumption feedback applications help in decreasing electricity consumption by individuals in households.

4.2. REVIEW OF EXISTING STUDIES

Feedback applications and their consequences on consumers' electricity consumption have been examined by different industrial and academic researchers in an attempt to suggest effective tools to reduce energy consumption.

We have summarized in two categories the studies that particularly examine the effectiveness of the feedback applications in terms of reduction of energy consumption. The first category consists of academic studies in IS literature, and the second category includes pilot projects studies reported by practitioners. Table 4.1 reports the results of these studies relevant to our study.

Table 4.1. Feedback Application Studies

Author	**Tool**	**Features**	**Sample & Duration**	**Results**
Studies in IS discipline (More information is included in Table A.1 In Appendix A)				
Baeriswyl et al. 2011a	Web-based energy information tool	Weekly Data, Saving Tips, Normative feedback, Public Game Feature	Austria, 1,000 households, still in progress	N/A
Baeriswyl et al. 2011b	Web-based energy information tool	Weekly Data, Saving Tips, Normative feedback, Social Sanction Feedback	Austria, 1,400 households, still in progress	N/A
Loock et al. 2011	Web-based energy information tool	Multiple types of normative feedback via web portal to improve individual's energy conservation	Austria, 220 households, six weeks	Users saved around 7 % of electricity consumption when presented with combined descriptive and injunctive feedback
Loock et al. 2013	Web-based energy information tool	Goal setting functionality via web portal to improve individual's energy conservation	Austria, 1,791 households, six weeks	2.3% average electricity saving for the users who had goal setting functionality

Yim 2011	Data displayed on websites or social networks	Weekly energy consumption, normative feedback, rewards (financial and social)	Maryland (USA), 9 weeks and 3 weeks, 2 dorms	14.3% increase in Year-over-Year energy use in residential halls compared to over 6% Year-over-Year reduction in fraternity houses.
Pilot studies in other disciplines/ by practitioners				
Benders et al. (2006)	Web-based energy information tool	N/A	Netherlands: 300 households over 5 months	Energy reduction of 4.3% adjusted for controls
Karbo and Larsen (2005)	Internet based service	Pieces of advice based on household's reported appliances	Denmark: 2500 households over 1 year	Expected annual savings around 10%
Mountain 2006	Real-time monitoring device	N/A	Canada: 505 households over 2.5 years	6.5% adjusted for controls
PA consulting 2010	Internet-based 'dashboard' displaying real-time usage	kWh, USD and CO_2 emissions	USA: 66 households 5-8 months	Average savings over the year were 9.3% against controls
Black et al. 2009	in-home display device connected to smart meter	Electricity consumption in real time, 24 hours, week or month. "Traffic lights" used to show peak price times and cost of unit.	Australia: 48 student cottages 6 months	20% electricity Saving Conflicting results (10 % increase in gas consumption, 24% decrease in electricity consumption)

Ueno et al. 2005	Display on PCs and TVs	historic consumption, daily and 10-daily costs, living room temperatures and comparisons with other homes	Japan: 10 households 9 months	12% energy savings compared to controls
UC Partners, 2009	Real-time monitoring device	real time electricity consumption, historic and real time feedback, daily progress to a self-set target	Netherlands: 18 housholds 3 winter months	4% for electricity saving against baseline consumption

While most of the studies in the IS discipline are conference papers and no results have yet been reported, the studies focused on investigating specific features such as the combination of descriptive and injunctive information (Loock et al. 2011), online communities (Yim 2011), games (Baeriswyl et al. 2011a, Brewer et al. 2013), and goal setting (Loock et al. 2013). None of these studies focused on the behavioral processes that conceptualize the beliefs that lead to the use of feedback applications and electricity conservation. Therefore, there is a need to explore and evaluate the impact of the different design elements and the process by which those design elements influence the use of feedback applications and electricity conservation.

The influence of feedback applications and mechanisms on consumers' energy saving is expected by academic researchers in engineering and environmental psychology to reach 30 % (Abrahamse et al. 2005, Bertoldi et al. 2000). However, as shown in the pilot studies, most of the studies have produced results that are below those expected by academic researchers. This is in line with findings of a meta-analysis of 64 pilot projects on existing feedback mechanisms (Mattern et al. 2010) that asserted that pilot projects have shown saving results limited to 4 % in terms of energy consumption. This confirms that there is a need to investigate the processes that shape actual energy conservation instead of relying on studies that focus mainly on surveying intentions to save electricity by individuals. Also, the pilot studies have shown that energy savings vary from 2% to 12% and that persistence of energy savings decreased as the study duration increased. This underlines the need to examine the interaction of the feedback application's design elements with the salient beliefs related to energy conservation. Therefore, we examined how salient design elements of a feedback application impact the feedback application’s use and conceptualized how the feedback application’s use contributed to consumers’ electricity conservation.

4.3. THEORETICAL BACKGROUND

In order to conceptualize the mechanisms that explain individuals’ use of electricity feedback applications, we relied on theories and relevant literature. We used the Theory of Planned Behavior (TPB) (Ajzen 1991), a recognized theory rooted in social psychology literature, as an overarching theory to guide our theoretical framework synthesis. TPB, developed as an extension to the Theory of Reasoned Action (Ajzen and Fishbein 1980), has been proved to predict behavior in diverse fields of research

(Sheppard et al.1988) and in different contexts of various technologies in the IS field (Song and Zahedi 2005, Venkatesh et al. 2003). Moreover, TPB has an established significance in explaining individual behavior in environmental psychology (Bamberg and Schmidt 2003, Steg and Vlek 2009). There is a strong rationale for relying on TPB in that it encompasses three categories of factors that influence individuals' behaviors: personal dispositions, social behaviors, and contextual factors in term of salient beliefs. In environmental psychology, it is asserted that, in addition to being impacted by personal dispositions, pro-environmental behaviors depict social behaviors (Bamberg and Schmidt 2003) where expectations to adopt pro-environmental behavior are present. Also, environmental behavior is influenced by contextual factors that might facilitate or hinder such behaviors (Steg and Vlek 2009). Hence, the ability of TPB to address these three factors makes it a suitable overarching theory in our model conceptualization.

TPB posits the presence of certain domain-specific salient beliefs that shape attitudes and behaviors. According to TPB, these salient beliefs are classified into three categories: behavioral beliefs, normative beliefs, and control beliefs. Behavioral beliefs are the individual's evaluation of the probable consequences of the behavior. Normative beliefs refer to the personal evaluation of the expectations of the important others towards the behavior. Control beliefs are the evaluation of the existence of facilitating factors that help or deter the examined behavior. Each category of the salient beliefs--behavioral, normative, and control--shape one of the determinants of behavioral intention–attitude, subjective norm, and perceived behavioral control, and behavioral intention in turn determines behavior. Attitude refers to the individual's positive or negative feelings towards performing a specific behavior. Subjective norm is the perceived social rewards or sanctions towards carrying out a certain behavior. Perceived behavioral control captures the perception of the ease or difficulty of performing a certain behavior.

4.4. SALIENCY OF PERCEPTIONS AND BELIEFS REGARDING FEEDBACK APPLICATION

Prior studies using TPB as an overarching theory have posited the importance of examining and investigating the saliency of multiple behavior-specific beliefs that form the studied behavior (Song and Zahedi 2005, Taylor and Todd 1995). Therefore, we relied on existing literature on electricity consumption feedback applications and energy conservation mechanisms to identify the salient beliefs. Prior research on energy consumption feedback applications has investigated the benefits of certain elements considering the criticality of effective use of the feedback (Mattern et al 2010). Ehrhardt-Martinez et al. (2010) argued that in addition to individuals' need for motivation to conserve energy and compensate for the time and inconvenience of such actions; they need to have in the feedback intervention different kinds of features, tools, and guidelines that allow them to conserve energy.

In addition, prior IS literature has found that the "perceived usefulness of IT artifact" construct is a significant antecedent that impacts the attitude towards an IT artifact in studies that used TPB as an overarching theory (Pavlou and Fygenson 2006). We define perceived usefulness of feedback applications as referring to the electricity consumers' belief about the usefulness of the feedback applications as a tool to help save electricity. Thus, we also examine and identify the perceptions and salient beliefs that constitute the antecedents of perceived usefulness of feedback applications.

To satisfy these needs, we discuss the following perceptions that correspond to the useful features provided by feedback applications: perceived usefulness of consumption information, perceived quality of saving advice, perceived usefulness of social comparative information, privacy concern, perceived commitment to feedback application goal, and feedback application descriptive normative belief.

4.4.1. Perceived Usefulness of Consumption Information

Electricity consumption is characterized as a traceless invisible product (Erdhart-Martinez et al. 2010); it is mainly quantified solely by a monthly bill. Therefore, the ability of feedback applications to provide rich descriptive content of feedback information is highly critical in the context of electricity consumption. Moreover, due to their lack of technical knowledge, individuals seem to rely on inaccurate heuristics to assess how their diverse energy consumption behaviors impact their overall consumption (Steg 2008). It is true that existing literature on feedback mechanisms (discussed above in section 4.1 and chapter 3) focuses on the influence of different contents of feedback information on individuals' perceptions related to energy consumption (Abrahamse et al. 2005). However, studies have found that users assess the same feedback information differently (Hutton et al. 1986); hence, examining the personal evaluation of feedback is more salient than just focusing on the design element's information as a sole antecedent to other energy feedback-related behaviors. Therefore, when individuals are assessing a feedback application, they tend to evaluate its usefulness on their understanding of their electricity consumption.

HCI researchers have examined different feedback applications that can increase individuals' assessment of their electricity consumption (Riche et al. 2010, Willis et al. 2010). Perceived usefulness is the degree to which an individual believes that using a specific system can enhance his/her performance (Davis 1989). The perceived usefulness of consumption information describes the electricity consumer's belief about the usefulness of the information related to his/her historical consumption information and performance. Therefore, perceived usefulness of consumption information should be among the salient beliefs influencing individuals' perceptions regarding feedback application.

4.4.2. Perceived Commitment to Feedback Application Goal

One of the main features provided by feedback applications is setting a goal of reduced consumption. The perceived commitment to feedback application goal refers to the electricity consumer's commitment to attain the target level of reduced consumption that is set on the feedback application. Prior studies show that goal-setting mechanisms combined with feedback information is one of the most effective strategies in reducing electricity consumption (McCalley and Midden 2002, Yun 2009). "Goals provide both motivation and a form of information to the user" (McCalley 2006, p.1154). Also, previous research findings have shown that when users set a goal for themselves, they are more motivated to use the feedback information in order to attain the set goals (McCalley 2006). In the case of feedback applications, assessing the feature of setting target goals will help in providing users with a sense of achievement by attaining the target goals, and thus will influence perceptions regarding the feedback application. This is in line with existing literature findings on the significance of designing goal-setting interfaces in feedback applications (Bonino et al. 2012). Therefore, perceived commitment to the feedback application goal is among the salient beliefs impacting individuals' perceptions regarding the feedback application.

4.4.3. Perceived Quality of Saving Advice

In IS literature, studies have demonstrated that personalized recommendations have a positive influence on consumers' technology adoption behavior, such as in the e-commerce domain (Sheng et al. 2008, Tam and Ho 2005). In addition, existing environmental psychology literature has shown that tailored advice on saving recommendations provided to individuals impacts energy consumption behaviors (Abrahamse et al. 2005, McMakin et al. 2002). The perceived quality of saving advice refers to electricity consumers' belief about the relevance of the application's information on saving recommendations. Hence, the perceived quality of saving advice is another salient belief impacting individuals' perceptions regarding the electricity consumption feedback application.

4.4.4. Feedback Application Descriptive Normative Belief

Feedback application descriptive normative belief is a belief associated with impacts from social referents. In surveying the previous studies examining the influence of normative comparisons on perceptions related to electricity conservation and feedback applications, we categorized normative influences using the following conceptualization. We differentiated between descriptive norms and injunctive norms as recommended in the perceived social pressure formulation in revised TPB by Fishbein and Ajzen (2010). In the prior TPB formulation, social pressure was represented by injunctive norm referring to an individual's perception of important others' expectation about what should be done; therefore it was called *subjective* norm. On the other hand, descriptive norm refers to the perceived normative influence due to what an individual believes important referents are doing. The distinction between the two types is supported theoretically and empirically in different fields (Cialdini et al. 1990, Deutsch and Gerard 1955, Grube et al. 1986, Larimer and Neighbours 2003, Manning 2009). The significant impact of descriptive norm on intention was suggested by a meta-analysis of 18 TPB studies (Rivis and Sheeran 2003). The predictive power of injunctive norm in TPB was questioned in social psychology literature (Conner and Armitage 1998, Manning 2009) and also in IS literature (Bhattacherjee and Sanford 2006, Malhotra et al. 2008). An explanation of this finding is that injunctive norm exists when there is an established community norm (Bhattacherjee and Sanford 2006). In the feedback applications context, studies that proposed and experimented with creating an energy conservation online community of family members and other personal referents and the integration of social networks with feedback applications are still experimental in terms of design architecture (Weiss et al.

2010) and lack empirical validation (Baeriswyl et al. 2011b). However, the current limited use of feedback applications in households suggests that individuals could have perceptions regarding the use of feedback applications by others. In the absence of an established community norm with respect to electricity consumption feedback applications, we posit that the feedback application subjective norm is derived from descriptive normative beliefs. We define descriptive normative belief as electricity consumers' belief about the behavior of their referents in terms of feedback application use. We argue that descriptive norm is a salient belief in the context of users' perceptions regarding the electricity consumption feedback application.

4.4.5. Perceived Usefulness of Social Comparative Information

Perceived usefulness of social comparative information is defined as electricity consumers' belief about the usefulness of the social comparative information. Social comparative information reflects the comparison of a household's consumption with other households at different levels, such as neighbors, friends, city residents, or at the country level. Social comparative information is suggested to enhance electricity conservation since it might develop a sense of competition (Abrahamse et al. 2005). The social comparative information is effective when the reference group is relevant (Loock et al. 2012). Therefore, we posit that perceived usefulness of social comparative information should be among the salient beliefs influencing individuals' perceptions regarding the feedback application.

4.4.6. Privacy Concern

Privacy concern has been suggested to have a significant impact on perceptions regarding use of IT artifacts and applications in different contexts (Bansal et al. 2010, Pavlou et al. 2007). Privacy concern has also emerged as a significant factor in the context of digital household information related to electricity consumption (Cavoukian et al. 2010, Garcia and Jacobs 2010). We define privacy concern as the feedback application user's degree of worry about privacy invasion of consumption information. Signifying the importance of privacy concern on the adoption of feedback applications and the advanced metering infrastructure, governments have passed new legislations (John 2011); scientists and engineers are investigating enhanced design requirements, data types, and architectures (Jawurek and Freiling 2011, Strueker and Kerschbaum 2012); and social psychologists are calling for collaborative research with technologists (Midden et al. 2007). In evaluating the feedback applications, users will assess their willingness to use feedback applications based on their degree of worry about the privacy invasions associated with the use of such tools. Thus, privacy concern is another salient belief impacting individuals' perceptions regarding the feedback application.

4.5. MODEL AND HYPOTHESES DEVELOPMENT

In order to examine the influence of feedback application design elements, we conceptualized the mechanisms that could change the electricity conservation behavior, and we proposed the feedback application impact (FAI) model. Based on TPB and environmental psychology literature, we identified five sets of constructs in our model: (1) beliefs regarding the feedback application, (2) beliefs regarding environment, (3) TPB constructs, (4) use of the feedback application, and (5) electricity conservation behavior.

(1) Beliefs regarding feedback application: This set of constructs comprises the constructs of perceived usefulness of consumption information, perceived quality of saving advice, perceived usefulness of social comparative information, privacy concern, perceived commitment to feedback application goal, and feedback application descriptive normative belief. We argue that these evaluations represent the set of salient beliefs perceived by individuals when presented with feedback applications and will influence the perceived usefulness of feedback applications and the TPB attitudinal constructs regarding using the feedback application. Also, we include in this set the perceived usefulness of feedback applications due to the significance in IS literature as an antecedent to TPB attitudinal constructs (Pavlou and Fygenson 2006).

(2) Belief regarding environment: Environmental concern refers to electricity consumers" concern about the fragility of nature and the role of humans in damaging it. Based on environmental psychology literature, we posit that environmental concern perception is a salient belief in relation to electricity conservation behavior.

(3) TPB attitudinal constructs: This set of constructs consists of the TPB suggested antecedents to behavior that in our case are represented by the feedback application

attitude, feedback application subjective norm, and feedback application self-efficacy. Although TPB introduced perceived behavioral control as the construct impacted by control beliefs, self-efficacy which is rooted in social cognitive theory (Bandura 1986) is defined as the individual's perception to control and execute the steps needed to perform the targeted behavior. It is considered the same construct as perceived behavioral control (Ajzen 2002, Fishbein and Cappella 2006).

(4) Use of feedback application: This construct refers to electricity consumers' extent of use of feedback application.

(5) Electricity conservation behavior: This is the dependent variable that refers to the consumers' reduction of electricity consumption. Using these five sets, we discuss our model shown in Figure 4.1. Table B.1 in the appendix summarizes the constructs used in our model.

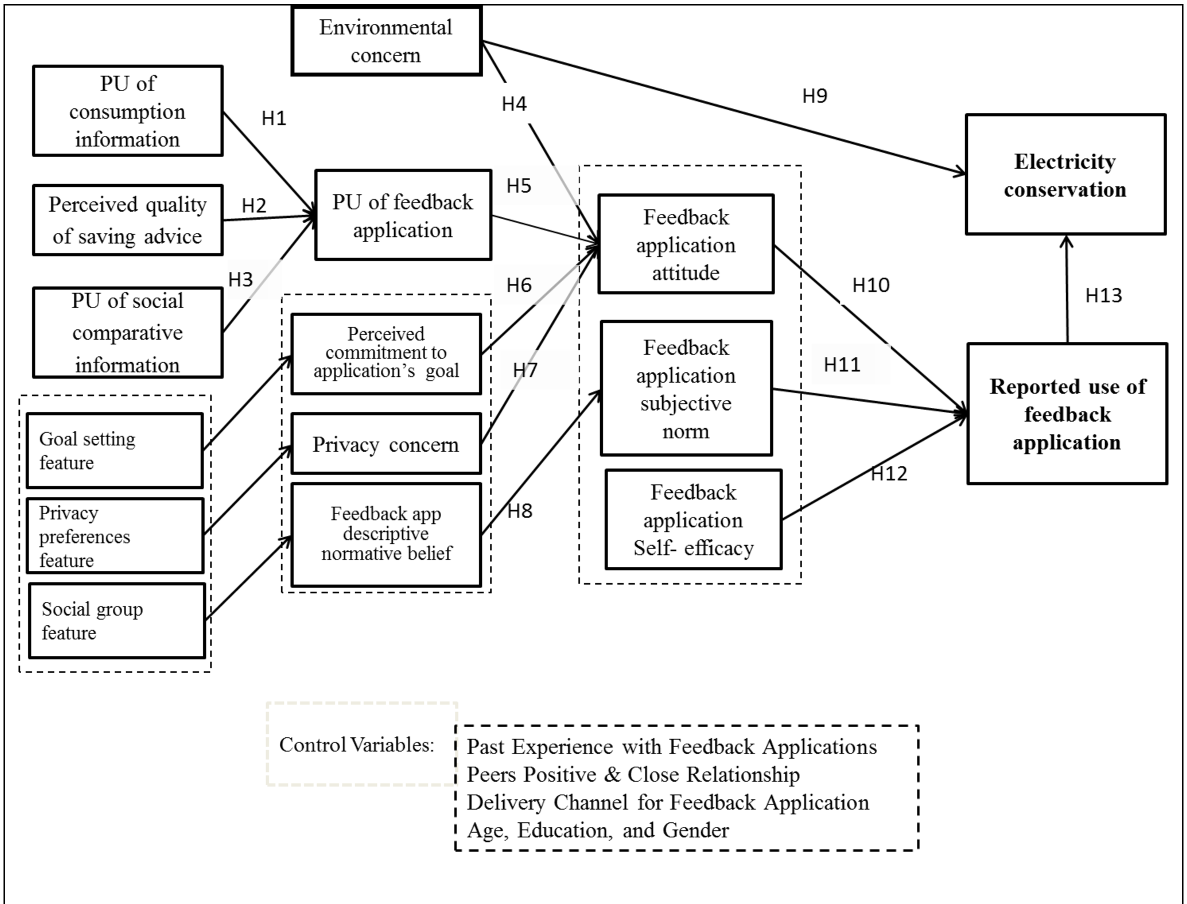


Figure 4.1. Feedback Application Impact (FAI) Model

4.5.1. Impact of Feedback Application Beliefs on PU and TPB Constructs

Feedback applications present information to households regarding their electricity consumption. In evaluating the usefulness of using feedback applications, electricity consumers assess feedback applications' impact on their understanding of their personal consumption behaviors and habits. Studies on feedback applications have suggested that there is a direct relationship between the individual's level of consumption assessment, the preference for higher levels of instantaneous and historical comparative feedback information, and the evaluation of the usefulness of the feedback application (Bonino et al. 2012, Darby 2006, Yun 2009). As applications enhance understanding regarding electricity consumption in terms of historical consumption information and performance relative to other individuals, electricity consumers will tend to interact with feedback applications features and will find such tools useful. (Riche et al 2010). Therefore, we posit that the perceived usefulness of consumption information by users regarding their consumption level affects their belief about the usefulness of the feedback application as a tool to help save electricity and thus affects their perceived usefulness of the feedback application.

H1. Users' perceived usefulness of consumption information is positively associated with their perceived usefulness of the feedback application.

IS literature has suggested that personalized recommendations in the context of e-commerce have a positive influence on individuals' perceptions towards e-commerce adoption and business intentions (Sheng et al. 2008, Tam and Ho 2005). The feedback application has the ability to analyze the consumption information and provide recommendations aimed at conserving electricity (Loviscach 2011). An individual's perception that the application would provide multiple effective personalized electricity saving recommendations targeted to a specific household enhances the user's feeling of self-control, raises intrinsic motivation, and decreases the concern of failing to produce positive results (He et al. 2010). Thus, we posit that the ability of feedback applications to interact with the individual's electricity consumption behaviors increases the quality and relevance of the feedback application's recommendations, which in turn positively impacts the perceptions regarding use of the feedback application.

IS literature on perceived usefulness has shown that information quality impacts perceived usefulness of the IT artifact (Seddon 1997). Hence, we argue that perceived belief about the quality of the feedback application's information on saving recommendations will positively impact perceived usefulness of the feedback application.

H2. Users' perceived quality of saving advice is positively associated with their perceived usefulness of the feedback application.

In recent Green IT literature, the display of social comparison features that enable individuals to compare their electricity consumption to other similar households or to a social network group has been examined in feedback applications in several contexts such as online communities (Baeriswyl et al. 2011 b), social competitions (Yim 2011), social norms (Loock et al. 2011), and public games (Baeriswyl et al. 2011 a). Social comparisons displayed on online applications increase the appeal of feedback programs (Baeriswyl et al. 2011 a). Based on Social Presence Theory (Short et al. 1976), Loock et al. (2011) suggests that providing users with social comparisons would create a feeling of social presence impacting users' perceptions. Users of electricity consumption feedback application are interested in the display of social comparisons on feedback applications (Froehlich et al. 2010). Hence, we argue that perceived usefulness of social comparative information belief will impact individuals' perceived usefulness of the feedback application.

H3. Users' perceived usefulness of social comparative information is positively associated with their perceived usefulness of the feedback application.

Perceived usefulness is the degree to which an individual believes that using a specific system can enhance his/her performance (Davis et al. 1989). In the feedback application context, perceived usefulness refers to electricity consumers' belief about the usefulness of the feedback application as a tool to help save electricity. In IS literature, the perceived usefulness of a system that improves the user's performance has been established to have a significant impact on attitude towards that system (Pavlou and Fygenson 2006, Taylor and Todd 1995b, Venkatesh et al. 2003). Therefore, we posit that perceived usefulness of the feedback application is positively associated with users' feedback application attitude.

H5. Users' perceived usefulness of the feedback application is positively associated with their feedback application attitude.

According to motivational psychology literature (Karoly 1993), goals drive mental and sensory perceptions regarding perceived information. Hence, users who target a certain goal will possess a sense of involvement with the feedback application, which in turn will positively influence their favorable perceptions towards using information provided by the feedback application. Integrating target goals in the design of feedback applications is suggested in recent feedback application design studies (Erickson et al. 2013, He et al. 2010, Koehler et al. 2010, Loock et al. 2013). Furthermore, targeting goals is identified by individuals as one of the most important features in feedback applications (Bonino et al. 2012). In addition, feedback applications implemented with goal-setting mechanisms have significant impact on users' behaviors (Yun 2009). Therefore, we postulate that users' commitment to attain the target level of reduced consumption, which is set on the feedback application, will positively impact the attitude towards the feedback application.

H6. Users' perceived commitment to the feedback application goal is positively associated with their feedback application attitude.

Privacy concerns have been investigated regarding feedback applications (Cavoukian et al. 2010, Kleiminger et al. 2011). With the proliferation of feedback applications, privacy concerns have become an important issue for HCI researchers (Froehlich et al. 2010). "Frequently measuring electricity consumption is privacy sensitive, because it reveals behavioral patterns that can be abused in various ways" (Garcia and Jacobs 2010, p. 4). Household individuals are careful in sharing their consumption data and concerned that other individuals can infer their daily habits (Chetty et al. 2008, Riche et al. 2010). Users should have ability to customize privacy settings to ensure long-term use of feedback applications (Riche et al. 2010). Since personal consumption information related to habits and routines, such as going on vacation, are communicated through the application, worry about privacy invasion of consumption information triggered by the feedback application use can deter individuals from having favorable views of feedback applications. Hence, we argue that privacy concerns will negatively impact individuals' attitude towards the feedback application.

H7. Users' privacy concerns regarding the feedback application are negatively associated with their feedback application attitude.

In our model, we argue that subjective norm is impacted by descriptive norm. This is in line with IS literature that has tried examining new factors other than the injunctive norms among family members and neighbors to explain the weakness of subjective norm (Davis et al. 1989, Song and Zahedi 2005). Since the significant impact of descriptive norm on intention in TPB models was suggested (Fishbein and Ajzen 2010, Rivis and Sheeran 2003), we focus on examining the descriptive norm impact. We define subjective norm as electricity consumers' perceptions of behavior of normative referents in terms of use of the feedback application. Because of the lack of a recognized social norm with respect to electricity consumption feedback applications, we posit that the feedback application subjective norm is impacted by descriptive normative beliefs. In addition, based on the information needs of individuals' in the decision-making process and not the social rewards, this relationship guides decisions and decreases uncertainty based on the interpersonal influence approach (Bearden et al. 1989, Song and Zahedi 2005). Therefore, we argue that descriptive norm will positively impact the subjective norm.

H8. Users' feedback application descriptive normative belief is positively associated with their feedback application subjective norm.

4.5.2. Impact of Environmental Concern on Feedback Application Attitude and Electricity Conservation

Concerns about environmental threats and their impacts have been studied in IS literature (Bansal 2010). We define environmental concern as individuals' concern about the fragility of nature and the role of humans in damaging it (Kim and Choi 2005). With concerns about the carbon footprint generated by energy consumption, consumers are becoming increasingly motivated and positive about taking protective steps, which include using tools that help in conserving electricity. The electricity consumption feedback application is such a tool that manifests the ability to reduce environmental threat. Hence, we argue that the user's attitude towards the feedback application is positively influenced by the cognitive evaluation of its role in facilitating energy consumption reduction and reducing environmental threats. This is in line with the value-belief-norm (VBN) theory, which posits that the perceived ability to reduce a threat and perceptions towards taking pro-environmental actions are significant consequences of environmental beliefs and concerns (Stern 2000).

H4. Users' environmental concern is positively associated with their feedback application attitude.

From an environmental psychology perspective, Abrahmase and Steg (2009) observed that conservation behaviors are determined by psychological factors. They justify this relationship by using Schwartz's (1977) norm activation model (NAM). The NAM "considers pro-environmental behavior as a form of altruistic behavior, insofar as individuals have to give up personal benefits for the sake of collective interests" (Abrahmase and Steg 2009, p.712). The significant impacts of environmental concern has been suggested in numerous environmental studies (Grob 1995, Valle et al. 2005), and has been shown to hold across several types of pro-environmental behaviors (Stern 2000) such as energy consumption saving (Abrahamse and Steg 2009). Therefore, we included this association for the completeness of our model in explaining electricity conservation.

H9. Users' environmental concern is positively associated with their electricity conservation.

4.5.3. Impact of TPB Constructs on Feedback Application Use

Although behavioral intention has been extensively used as a dependent variable in IS studies, we posit that in the context of energy consumption, actual use is more significant. In environmental-related behavior cases, " repeatedly performing a particular behavior, for example, taking the car to go to work each day, may actually overrule someone's intention to deviate from this behavior, such as not using the car but the bicycle instead" (de Vries et al. 2011). "One could hence conclude that while many people claim that saving energy is important, the willingness to act accordingly is rather limited" (Mattern et al. 2010, p. 3). Therefore, use of a feedback application is the dependent variable in our model. This construct refers to the electricity consumers' extent of use of the feedback application.

The significant impact of salient beliefs on use behaviors mediated by attitude, subjective norm, and self-efficacy has been theorized by the theory of planned behavior (TPB) (Ajzen, 1991), and has been shown to hold in IS literature in a variety of contexts (e.g., Song and Zahedi 2005, Venkatesh et al. 2003) and in environmental psychology literature (Bamberg and Schmidt 2003, Steg and Vlek 2009). Therefore, these associations are included for the completeness of the model in explaining the use of feedback applications.

H10. Users' attitude towards the feedback application is positively associated with their use of the feedback application.

H11. Users' subjective norm related to using the feedback application is positively associated with their use of the feedback application.

H12. Users' self-efficacy of using the feedback application is positively associated with their use of the feedback application.

4.5.4. Impact of Use of Feedback Application on Electricity Conservation

Reviews on various feedback mechanisms implemented on household energy consumption have shown that computerized feedback mechanisms such as feedback applications are most effective in terms of electricity conservation results (Fischer 2008, Froehlich et al. 2010). Feedback applications' interactive features raise their users' attention and incite their curiosity about conducting experiments related to electricity conservation (Fischer 2008, Schwartz et al. 2013). Feedback applications that integrate additional behavioral mechanisms, such as goal setting and social norms, in their design will have effective results on electricity conservation (Ehrhardt-Martinez et al. 2010). The greater the user will use the feedback application, the greater he/she will receive specific and accurate information, saving advice, and goal-setting mechanisms, the greater the user will conserve electricity. This is consistent with VBN theory, which argues that the ability to alleviate environmental concerns is a significant antecedent in explaining various pro-environmental behaviors such as electricity conservation (Stern 2000). Also, a feedback application is a facilitator for electricity conservation (Jacucci et al. 2009, Schwartz et al. 2013). In line with the theory of mere-exposure (Zajonc 1968), the more one is exposed to a stimuli or a facilitator, the more one prefers the facilitated behavior.

H13. Users' use of the feedback application is positively associated with their electricity conservation.

4.5.5. Design Elements

Based on the theoretical underpinnings related to electricity consumption feedback applications discussed in Chapter 3, we identify in this section the salient design elements that impact the salient beliefs examined in our conceptual model. We also integrate the findings from our survey study in Chapter 3 with existing literature to identify three salient designs that should be examined: goal setting, privacy preferences, and social group.

Goal Setting. In the context of electricity conservation, goal setting has a strong influence on consumers' behavior (Abrahamse et al. 2005). Moreover, one of the most critical features in an electricity consumption feedback application that impacts users' behavior is goal setting (Crowley et al. 2011, Loock et al. 2013). Following a target goal is considered a motivational factor (Yun 2009), and recent literature has reported that individuals identified it as being the most important feature of an electricity consumption feedback application (Bonino et al. 2012). Moreover, allowing users to set their own goal of maximum consumption while receiving feedback information was found to be most effective in terms of conservation results (McCalley and Midden 2002). This is in line with our theoretical framework in Chapter 3, which posited that feedback is effective when it is coupled with an appropriate goal setting mechanism. Therefore, goal setting feature is a salient design element that should be among the identified design elements in our model.

Privacy Preferences. Privacy concerns have been suggested to have an influence on the adoption and use of smart grid technologies such as electricity consumption feedback applications (Rodden et al. 2013). Feedback applications can collect and share information about a household's electricity consumption reflecting household habits and thus represent a safety issue (Erickson et al. 2013). Therefore, researchers have sought new perspectives regarding the design features of feedback applications that affect users' concerns regarding their privacy and the safety of their information (Cavoukian 2009). While experimental studies have tried to propose different methods to reduce the privacy concerns, the methods proposed were perceived as inconvenient by users and might even negatively impact the use of the feedback application (Erickson et al. 2013) or require a great amount of new regulations and collaboration among the different stakeholders (Jawurek and Freiling 2011). However, some researchers have suggested that users should have the ability to modify the privacy preferences of the feedback applications (Riche et al. 2010). Consequently, we should examine the impact of privacy preference features and their implication for users' privacy concerns. In line with the results of Chapter 3, the findings indicate that users consider privacy as a highly important element in the design of the user-centric feedback applications. Therefore, privacy preference should be examined as a salient design in our conceptual model.

Social Group. To impact behaviors related to electricity consumption feedback applications, prior studies on feedback applications have suggested that community involvement should be included as a motivational factor (Bartram et al 2010). Based on the "social diffusion" concept, users who perceive others' behavior in using feedback applications will likely consider and act according to this modeled behavior (He et al. 2010). In addition, an electricity consumption feedback application is a tool that is not associated with a well-established social norm. To motivate users to use the feedback application, electricity consumption feedback applications designers should help to create the feeling of community by integrating into the design social cues, such as highlighting that their peers are using the feedback application. The impact of such a design element is dependent on the depth of the relationship between the user and his/her peers. Therefore, social group feature is another salient design element that should be included in the set of design elements in our model.

4.5.6. Control Variables

We controlled for peers' positive and close relationships, which refer to an individual's perception of the quality and depth of his/her relationship with peers (Carmeli et al. 2009). The rationale for measuring and controlling for peers' positive and close relationships is that we included in this model the descriptive normative belief based on the premise that the impact of this belief is dependent on the strength of the relationship between the individual and his/her peers. Furthermore, findings in Chapter 3 reveal that users have different preferences for smartphones vis-à-vis websites as a type of delivery channel; therefore, we controlled for the type of delivery channel used for the feedback application: smartphone app or website. Moreover, we controlled for past experience with feedback applications and with the following demographics: age, education, and gender (Bansal et al. 2010, Venkatesh et al. 2003).

4.6 METHODOLOGY

In order to test the conceptual model, we used an experiment as the research methodology to examine users' perceptions towards feedback applications' salient features and their impact on users' behaviors,. The rationale for choosing an experiment methodology stems from the need to investigate the influence of design elements on the real use of feedback applications and on electricity conservation in the real-time non-mandatory setting. Literature reviewing feedback application pilot studies suggest that experiments are more suitable to evaluate behavioral changes (Froehlich et al. 2010). In the context of electricity conservation, experiments are more insightful in examining the impact of IS applications on individuals' voluntary daily electricity use (Loock et al. 2012). Based on the suggestions of prior literature (He et al. 2010) and the results of our investigation in Chapter 3, the design elements are manipulated by personalizing the examined elements in the treatment groups.

As the stimulus of the experiment, an electricity consumption feedback application, iSaveElec, was specially designed, developed, and tested. The tool was used in the data collection protocol.

4.6.1. iSaveElec

A mobile app and corresponding website were designed to include all the salient design elements discussed above. Specifically, iSaveElec had the following screens: a screen for the users to enter their monthly electricity bill information, a screen for a target goal for reducing their electricity consumption, a screen to notify the users about their performance related to the target goal, a screen that provided them with the historical comparison and their saving performance, a screen that provided the users with social comparison and the social group using iSaveElec, a screen for the privacy statement of iSaveElec, and a screen that provided users with saving tips and advice on reducing their electricity consumption.

The mobile app was developed for smartphones that run the open source operating system platform; therefore, the app was developed using JAVA and the Android Software Development Kit. The mobile app was published on Google Play Store for free. Finally, iSaveElec was tested by an MIS professor and 16 undergraduate students.

A corresponding website was also created containing the same features and corresponding pages as the Android application. This allowed participants to choose their mode of delivery, especially in the case where they did not have access to an Android smartphone.

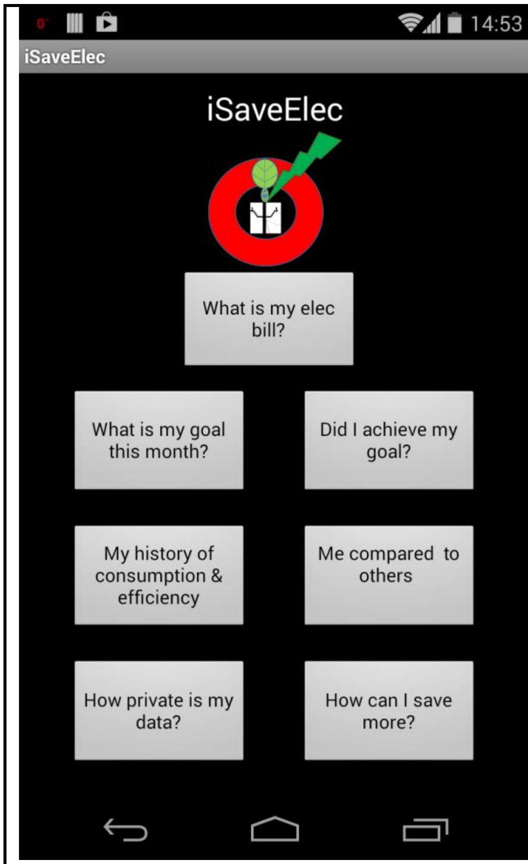


Figure 4.2. The main screen in iSaveElec

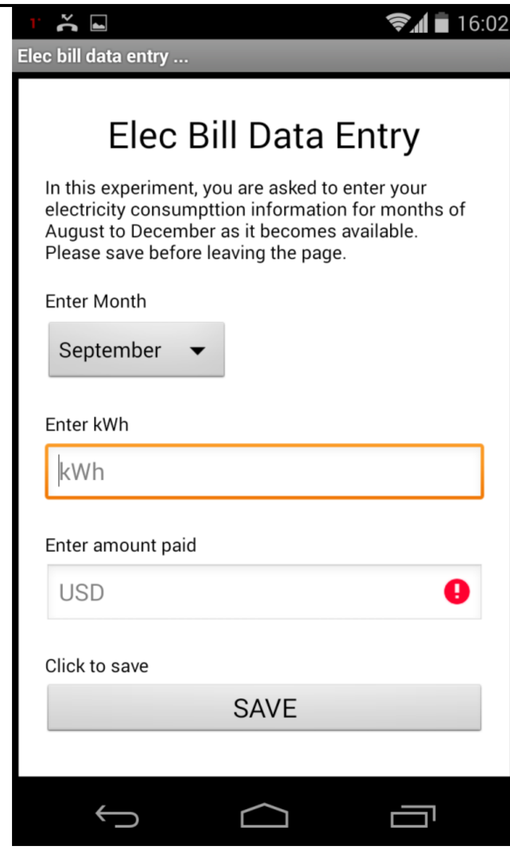


Figure 4.3. The electricity bill data entry screen in iSaveElec

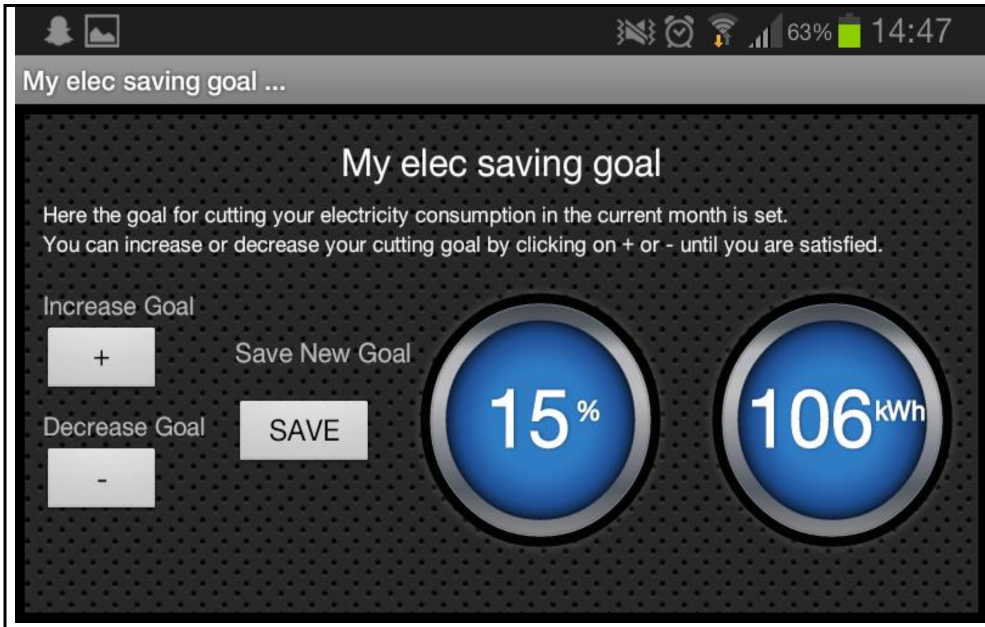


Figure 4.4. The target goal screen in iSaveElec

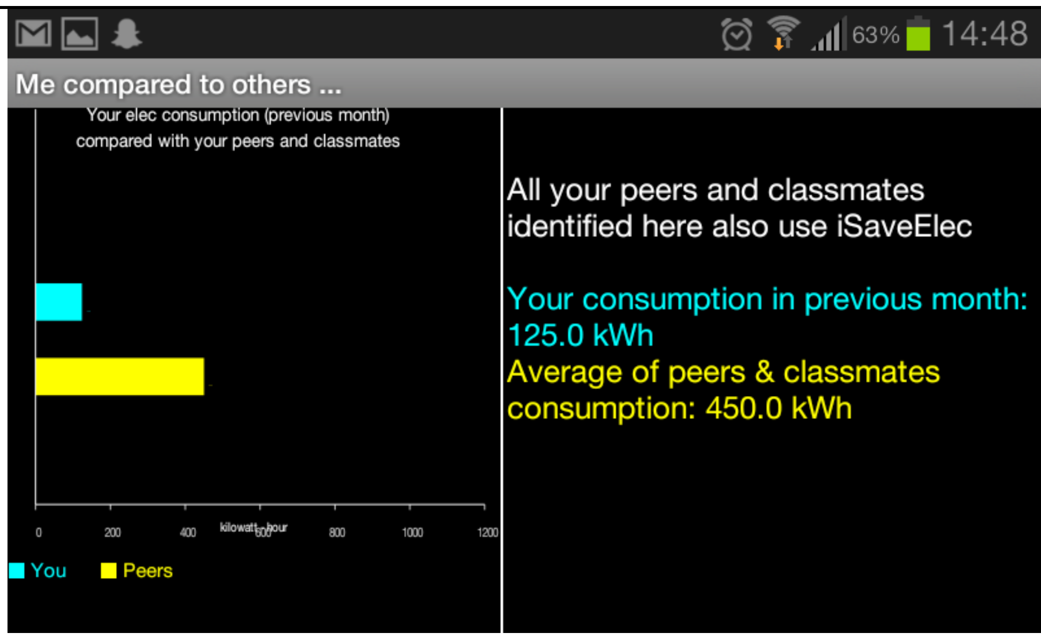


Figure 4.5. The social comparison screen in iSaveElec

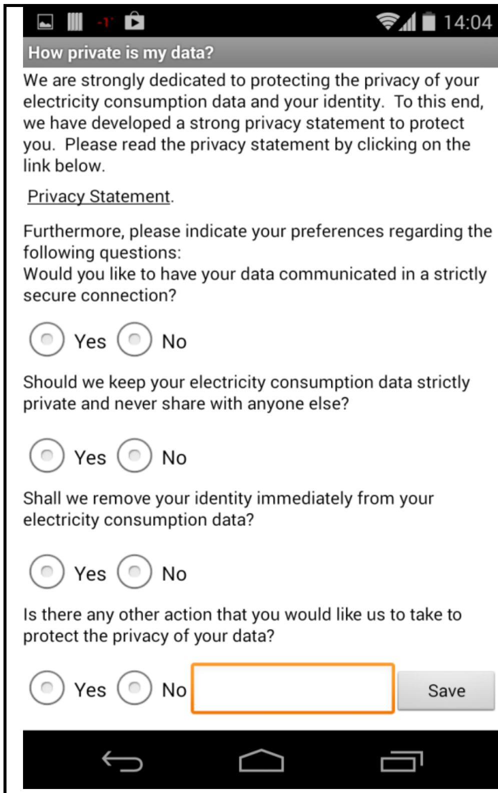


Figure 4.6. The privacy preferences screen in iSaveElec

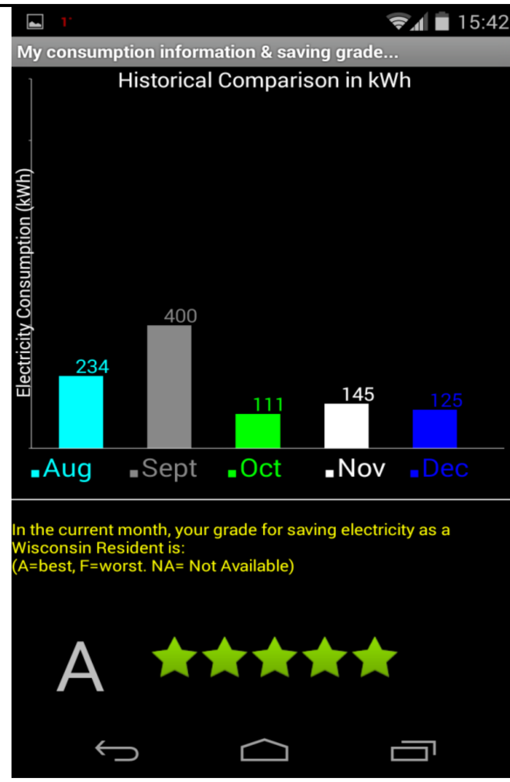


Figure 4.7. The consumption information and saving performance screen in iSaveElec

4.6.2. Experimental Design and Protocol

The experimental design consisted of a 2 x 2 x 2 =8 full-factorial design: personalized assignment of target goal versus application assignment of target goal, personalized preferences for privacy setting versus defined settings in privacy statement, and the use of peers and classmates versus the use of city household residents as a frame of reference in terms of the use of iSaveElec and social comparison. The first feedback application included all three personalized design elements. The other seven feedback applications had one or more of the non-personalized design elements. The participants were randomly assigned to one of the eight groups. Thus, iSaveElec was provided to the participants with the view of one of the eight versions of the feedback application.

The protocol consisted of three stages in a three-month period. Participants at the first stage were introduced to the experiment tasks in a face-to-face session. The participant took an online pre-experiment survey. They downloaded the iSaveElec app or visited the iSaveElec website. They were asked to enter their previous monthly electricity bill information in our mobile app/website. Each participant had a confidential, unique ID password, which they created at the time of registration. During the second stage, participants interacted with the features of the feedback application for the next two months and entered their electricity bills pertaining to the consumption during those two months. Participants were asked to take a short online survey. During stage three and after entering the second electricity bill, participants were asked to take an online post-experiment survey.

4.6.3 Instrument Development, Pilot Test, and Data Collection

After reviewing the literature, scales were developed and adapted to make them 10-point semantic differential, from 1 to 10. Table B.1 in the appendix presents the sources for scale development. The constructs were pilot-tested using 16 undergraduate students. The instrument is shown in Table B.2.

We invited undergraduate and graduate students in a Midwestern state in the U.S. to participate in the experiment. A small course credit was offered as an incentive. To increase the number of participants, participation in a drawing for 10 gift cards was offered to participants. One hundred sixty participants completed the experiment. In discussing the external validity of using students as participants, previous feedback application research has employed students as participants (Bonino et al. 2012, Yim 2011). Table 4.2 reports the descriptive statistics.

Table 4.2. Descriptive Statistics

Variable	**Mean**	**SD**
Age	24.44	6.18
Education*	3.59	1.03
Experience with Feedback Applications**	5.04	2.79
Male	53.75%	
Female	46.25%	

* 1:Some school, non degree 2:High school graduate 3:Some college, non degree/college students, 4: Professional deg./2-year associate deg.5:Bachelor’s deg .6:Master’s deg. 7:Doctorate
** Measured on a continuous scale 1(very low)-10(very high)

4.7. DATA ANALYSIS

4.7.1. Manipulation Check

We asked participants to evaluate the presence of the manipulated design elements in the experiment. We performed the ANOVA tests as reported in Table 4.3. The results indicated that we successfully manipulated the design elements.

Table 4.3. Manipulation Checks				
	Means (STD)		F-value	Sig. diff.
Manipulation	Level 1	Level 2		
Social group[a]	1.08 (0.27)	1.96 (0.19)	**584.96*** **	Yes
Goal Setting[b]	1.21 (0.41)	1.83 (0.37)	**96.35*** **	Yes
Privacy Preferences Settings[c]	1.10 (0.30)	1.92 (0.27)	**273.96*** **	Yes

The introductory part of the manipulation questions: “For each screen of iSaveElec you used in this session, please identify which of the following features were available on your website/app:”
[a] In the “Me compared to others” screen: your electricity consumption was compared with Milwaukee's average /peers and classmates’
[b] In the “What is my goal this month” screen, your target cutting goal for electricity consumption was set by iSaveElec/you
[c] Protection of your information privacy was / described in: “How private is my data?” page which contained a link to a privacy statement page./ page which contained 4 questions related to your preferences plus a link to a privacy statement page
*** p< 0.001

4.7.2. Measurement Model

To test for construct reliability, we computed the reliability checks. Cronbach alpha values exceeded the threshold of 0.70 (Nunnally 1978); the composite factor reliability values exceeded the cutoff value of 0.70 (Segars 1997); and the average variance extracted values exceeded the cutoff point of 0.50 (Segars 1997). Table 4.4 reports the results of the reliability checks, which indicate a high level of construct reliability.

Table 4.4. Checks for Reliability and Validity			
Construct	**Alpha**	**CPR**	**AVE**
Environmental Concern	.93	.93	.83
Perceived Quality of Saving Advice	.93	.93	.80
Perceived Commitment to Feedback Application (FA) Goal	.90	.90	.76
FA Descriptive Normative Belief	.92	.93	.81

Perceived Usefulness of Social Comparative Information	.96	.96	.90
Perceived Usefulness of Consumption Information	.96	.96	.89
Privacy Concern	.86	.86	.67
Perceived Usefulness of FA	.98	.98	.95
FA Attitude	.94	.94	.84
FA Subjective Norm	.98	.98	.95
FA Self-Efficacy	.93	.93	.81
Reported Use of FA	.93	.93	.82
Electricity Conservation	.96	.96	.89
Peers Positive & Close Relationship	.86	.86	.68

We also performed exploratory factor analyses to show discriminant validity. The cross loadings were less than 0.40 (McKnight et al. 2002), and all items appropriately loaded on the related latent variables, as reported in Table B.4 in the appendix. We also evaluated the average variance extracted values with the square root of construct correlation values, which ensured that discriminant validity was supported, as shown in Table 4.5.

Table 4.5. Construct Correlations and Comparison with AVE*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Environmental Concern	**0.97**													
2. Perceived Quality of Saving Advice	0.50	**0.96**												
3. Perceived Commitment to FA Goal**	0.41	0.68	**0.95**											
4. FA Descriptive Normative Belief	0.29	0.33	0.44	**0.96**										
5. Perceived Usefulness of Social Comparative Information	0.37	0.52	0.49	0.63	**0.98**									

6. Perceived Usefulness of Consumption Information	0.47	0.52	0.49	0.54	0.74	**0.98**								
7. Privacy Concern	-0.31	-0.06	0.01	0.08	-0.02	-0.19	**0.93**							
8. Perceived Usefulness of FA	0.39	0.67	0.72	0.45	0.61	0.66	-0.02	**0.99**						
9. FA Attitude	0.51	0.68	0.71	0.45	0.57	0.66	-0.14	0.82	**0.97**					
10. FA Subjective Norm	0.36	0.51	0.70	0.46	0.55	0.54	0.15	0.73	0.70	**0.99**				
11. FA Self-Efficacy	0.51	0.47	0.46	0.45	0.56	0.58	-0.27	0.42	0.52	0.41	**0.96**			
12. Reported Use of FA	0.21	0.40	0.54	0.40	0.43	0.42	0.17	0.57	0.49	0.51	0.30	**0.97**		
13. Electricity Conservation	0.24	0.29	0.41	0.34	0.36	0.46	0.06	0.46	0.37	0.46	0.39	0.42	**0.98**	
14. Peers Positive & Close Relationship	0.25	0.29	0.32	0.35	0.55	0.40	-0.01	0.32	0.38	0.37	0.41	0.26	0.24	**0.93**

*Columns 1-14 show correlation values and the square root of AVE is shown on the boldface diagonal of the matrix.
** FA: Feedback application

In addition, to ensure convergent validity, we carried out a confirmatory factor analysis on the measurement model, and the factor loadings all exceeded the 0.70 threshold values, as reported in Table B.4 in the appendix. The fit indices of the measurement model exceeded the recommended thresholds, as shown in Table 4.6.

Table 4.6 Fit Indices for the Model Estimation

Fit index	Measurement Model	SEM Model	Threshold Values
Normed Chi-square	1.24	1.69	<3.0 or 5.0
CFI (comparative fit index)	0.98	0.91	>0.90
TLI (Tucker-Lewis index)	0.97	0.91	>0.90 or 0.95
RMSEA (root mean square error of approximation)	.04	.06	<0.06

Before estimating the model, we considered common method variance in the data. Using semantic differential measures in our instrument design was to decrease common method bias. Also, we collected data in multiple stages to decrease the threat of common method variance. The data collection for this experiment involved three time periods and multiple stages, reducing the threat of common method variance (Podsakoff et al. 2003). However, to remove any threat of common method variance, we purified data using a marker item (Podsakoff et al. 2003). The resulting purified dataset was also used in the analysis.

4.7.3 Model Estimation

We estimated the model using structural equational modeling (SEM). Fit indices were favorably above (or below) the threshold values, indicating satisfactory fit for the estimated model, as indicated in Table 4.6. Figure 4.2 presents the SEM estimation results, which provided the path coefficients, and the corresponding t-values, which enabled us to validate the hypotheses. The R^2 values are reported under each construct. Of the 16 hypotheses in our model, 15 were statistically significant in the estimation model.

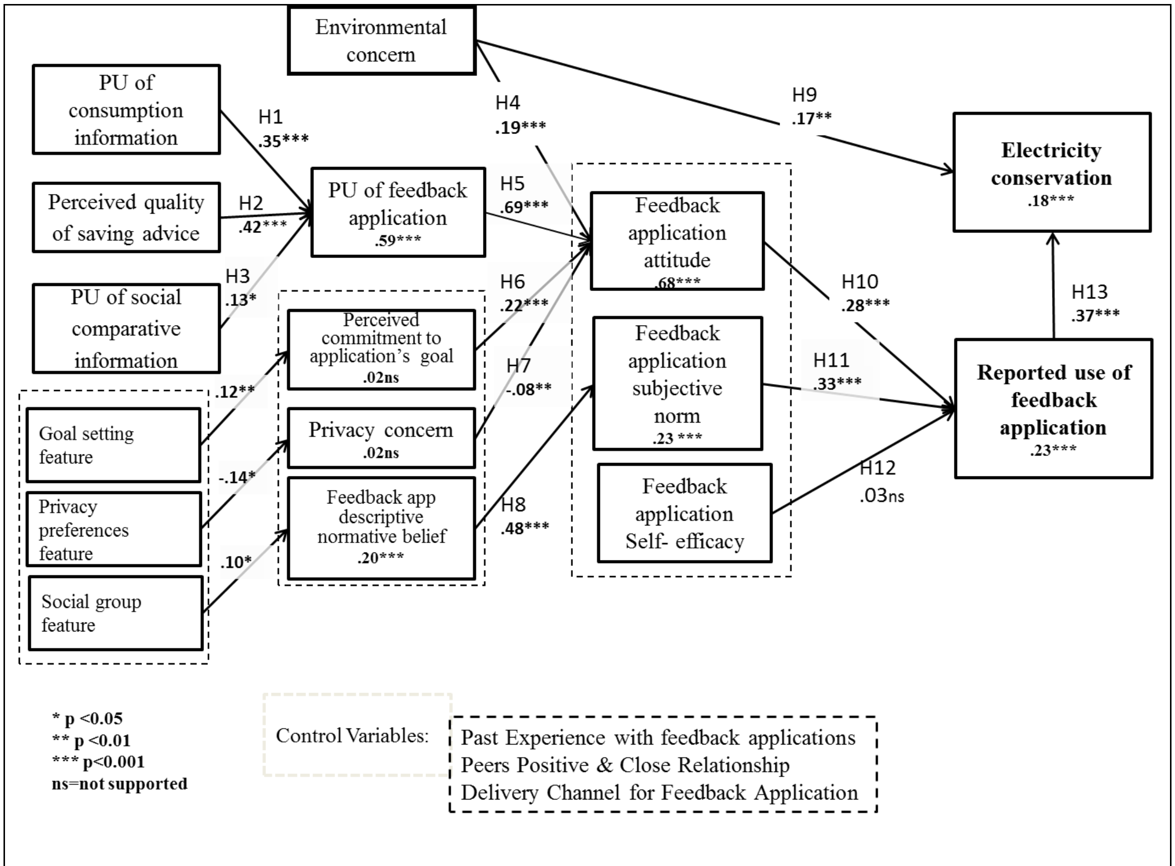


Figure 4.6. Results of Feedback Application Impact (FAI) Model

As shown in Figure 4.6, the hypotheses describing the influence of the three design elements features–goal setting, privacy preferences, and social group–on the corresponding beliefs were supported. Specifically, the goal setting feature showed a strong significant effect (p<0.01) on the perceived commitment to set goals, while the social group feature and the privacy setting preferences had an effect of significance (p<0.05) on descriptive norm and privacy concern beliefs, respectively.

Hypotheses H1, H2, H3, H5, H6, H7, and H8, which pertained to the impact of the salient beliefs of feedback on TPB constructs, were strongly supported. Specifically, the perceived usefulness of the feedback application depends to a certain extent on the perceived usefulness of consumption information (H1), perceived quality of saving advice (H2) as well as the perceived usefulness of social comparative information (H3). As for the attitude towards the feedback application, the influence of the perceived usefulness of the application (H5) and the perceived commitment to the application's goal (H6) are highly significant ($p<0.001$), and the privacy concerns (H7) effect is also significant ($p<0.01$). The impact of the descriptive normative belief on the feedback application's subjective norm is also supported (H8). The influence of TPB constructs on use of feedback applications (H10 and H11) was supported except for the impact of self-efficacy (H12). Most notably, the effect of the use of a feedback application on electricity conservation (H13) was strongly supported. Furthermore, the impact of environmental concern was significant on both feedback application attitude (H4) and electricity conservation (H9). We controlled for type of delivery channel--iSaveElec Android smartphone app or iSaveElec website, and notably the use of feedback application and delivery device relationship was significant. The website version of iSaveElec had a positive association with the use of iSaveElec. We also used past experience with feedback applications, and peers' positive and close relationship as control variables; meanwhile, the demographic variables--education, gender, and age--were not significant control variables.

4.8. DISCUSSION

In this paper, we described the role of the design elements and the mechanisms and processes by which these elements will motivate electricity consumers' behavior towards energy conservation. Testing the FAI model provided strong evidence in support of the hypotheses. The identified salient beliefs related to feedback application were all supported by the results to have impact on the antecedent of feedback application use.

The personalized goal setting feature emerged as a highly significant design element that impacts perceived commitment to the application's goal. This shows that feedback applications should allow the users to set their target goal; this will improve the user's commitment to the target goal, which in turn will positively impact their feedback application use and electricity conservation. This is an interesting finding because it supports recent literature (Erickson et al. 2013, Loock et al. 2013) on the importance of the goal setting feature on electricity conservation. This finding becomes even more interesting when it uncovers the importance of the goal setting feature on the use of feedback applications and, most notably, when it explains the process by which the goal setting feature impacts the beliefs and behaviors related to feedback applications and electricity conservation.

The personalized privacy preferences feature had negative impact on privacy concerns and thus reduced the negative influence of privacy concerns on feedback application attitude. Accordingly, the privacy settings design element emerged as an important factor to reduce the threat posed by privacy concerns on the use of feedback applications and other important smart grid technologies. This is a novel finding because, to the best of our knowledge, this is the first study to test and evaluate the impact of privacy preferences on privacy concerns belief, use of feedback applications, and electricity conservation. This is in line with privacy literature (Brandimarte et al. 2013) that posits that by providing options to users in setting up their privacy preferences, they feel more in control and therefore more confident about the protection of their information.

The social group feature positively influenced the feedback application descriptive normative belief, which in turn positively influenced the subjective norm and the dependent variables. The is a significant finding because the positive significant impact of the design element empirically supported the literature that suggested that creating the sense of community would be a motivational factor in driving behavior (Bartram et al 2010, He et al. 2010).

Together, the personalized design elements emerged as influential in impacting the manipulated salient beliefs, which in turn had significant impact on TPB constructs, the antecedents of feedback application use.

In terms of the salient beliefs influencing the perceived usefulness of feedback applications, perceived usefulness of consumption information and perceived quality of electricity saving advice emerged as the strongest antecedents to perceived usefulness of feedback applications. Perceived usefulness of feedback applications, perceived commitment to the applications' goal, and environmental concern had strong impact on feedback application attitude. As hypothesized, privacy concern had a negative impact on feedback application attitude. This is in line with literature emphasizing the significant role of privacy concern on use of IT artifacts in different contexts (Bansal et al. 2010, Pavlou and Fygenson 2006) and on use of smart grid technologies (Cavoukian et al. 2010, Garcia and Jacobs 2010).

The feedback application descriptive norm had a strong impact on feedback application subjective norm, which in turn has a strong influence on use of feedback applications, highlighting the significance of descriptive norm beliefs in voluntary settings. This is a significant finding because the role of the descriptive norm belief needed more adequate investigation (Rivis and Sheeran 2003). Studies on TPB (Fishbein and Ajzen 2010) have suggested the inclusion of descriptive norm beliefs; this study supports and empirically validates the significance of descriptive norm beliefs. Prior IS literature has suggested that the influence of subjective norm in driving behavior is salient in mandatory settings for women and elder workers with limited experience (Venkatesh et al. 2003); however, prior IS literature has limited subjective norm to the injunctive norm social beliefs and excludes descriptive norm social beliefs. Our study uncovers the important role of descriptive norms for the young generation in voluntary settings, and thus our findings contribute to the explanation of weak support for the impact of subjective norm in driving behavior in voluntary settings, as posited in prior IS literature.

Together, these findings, which are related to the identified salient beliefs and the process by which those beliefs impact use of feedback applications and electricity conservation, provide a novel and significant contribution to the literature on feedback applications because prior literature had lacked any conceptualization of the salient beliefs related to electricity consumption feedback applications and the empirical investigation of the influence of the design elements on such beliefs. Therefore, designers of electricity consumption feedback applications must consider the identified salient beliefs of users and must emphasize the personalization of the design elements related to the salient beliefs.

Feedback application self-efficacy influence on use of feedback applications was not significant. This is in line with some findings in IS literature (Venkatesh et al. 2003) reporting that the influence of self-efficacy is more salient in the elderly and those with insufficient IS experience. In line with prior literature, environmental concern had a positive impact on electricity conservation.

The most important and interesting finding is that results supported the impact of the use of feedback applications on electricity conservation. This finding provides strong evidence that the use of suitably designed electricity consumption feedback applications can contribute to electricity conservation.

Interestingly, use of feedback applications was positively impacted by use of the website version (coef= -0.14; $p<0.05$). This result reveals that individuals are still interested in using websites vis-à-vis mobile apps in our context. Knowing that our sample consists of a relatively young generation, this finding indicates the necessity of providing multiple platforms for feedback applications to allow for a personalized choice of device. This result is in line with our Chapter 3 findings, which indicated a higher preference for website as a delivery channel for feedback applications.

4.9. IMPLICATIONS OF THE STUDY

4.9.1 Theoretical Implications

This study makes major and novel contributions to theory. First, to the best of our knowledge, this is the first work to identify and conceptualize the salient beliefs that shape behavior related to electricity consumption feedback applications. The conceptual model not only identifies the different salient beliefs, it also proposes the process by which such beliefs interplay and influence antecedents of feedback applications and, finally, electricity conservation. Highlighting the salient beliefs, this study demonstrated that future research on energy conservation should not be limited to investigating the direct impact of new design elements without considering the salient beliefs and the processes by which design elements impact both feedback application use and electricity conservation.

Second, this work unifies and synthesizes a diverse body of literature that focused on the different design elements of feedback applications and the design elements' impact on electricity conservation. Hence, this study highlights the importance of integrating literature and insights from multiple disciplines to explain, conceptualize, design, create, and test innovative tools such as electricity consumption feedback applications that have a pivotal role in dealing with global challenges, and to evaluate users' experiences with such tools. Furthermore, this study uses a theory-based framework to examine design elements of feedback applications, use of such applications, and their impact on electricity conservation. Together, this work extends user-centric IS design research to the context of sustainability and energy conservation by focusing on the design of innovative tools that promote electricity conservation.

Third, and most notably, this research shows that the use of electricity consumption feedback applications can promote electricity conservation behavior. This is a significant contribution due to the scientific evidence on the rising trends of global greenhouse gases, which is impacted significantly by the increasing amounts of residential electricity consumption. And it is the importance of investigating feedback applications designed specifically for residential electricity consumers that our study highlights. In addition, our findings uncovered the pivotal role of personalized electricity consumption feedback applications in positively influencing users' electricity conservation. Hence, in addition to conceptualizing the processes and perceptions related to the use of feedback applications, this study also contributed to the design and impact of electricity consumption feedback applications on a global and threatening challenge, which is the rising trend of residential electricity consumption.

Fourth, the FAI model proposes a systemic approach explaining the relationships between design, beliefs, perception, and attitude and how these finally lead to behavioral impact. This finding is an important contribution to research because it highlights the importance of extending studies on the design of feedback applications to include the impact on electricity conservation behavior, thus bridging the gap between studies on design elements of feedback applications and studies focusing on electricity conservation. This contribution could motivate research related to feedback applications and other important pro-environmental behaviors, such as investigating the use of feedback applications related to water consumption behavior and water conservation.

Fifth, this work also responds to the call for research on the information needs of electricity consumers to decrease electricity consumption. This study provides a rigorous empirical validation to evaluate the impact of design elements of feedback applications. Combined with the theory-based approach, this could lead to a new avenue of research on design elements that would enhance electricity conservation and other pro-environmental behaviors. Finally, this research has contributed to IS literature by emphasizing the role of descriptive subjective norm in the context of non-voluntary use of feedback applications.

4.9.2 Practical Implications

This research has practical contributions. First, it contributes to the effective design of feedback applications by laying the foundation to examine the impact of their design elements. The goal of feedback application designers should be to promote users' positive attitudes toward feedback applications in order to increase their electricity conservation. Second, this work could form a basis for the evaluation of existing feedback applications for changing energy users' consumption behaviors and promoting energy conservation. Designers can use the findings to focus on the design elements that would positively impact the salient beliefs that lead to feedback application use and electricity conservation. Third, the findings highlight the importance of personalized design elements. Designers should focus on personalized goal-setting features in enabling feedback application users setting their electricity conservation goals. Personalized features enhance a higher level of commitment among users. Fourth, privacy concern should be addressed in a profound manner. Users should be able to set their privacy preferences to decrease their privacy concern towards use of feedback applications. Furthermore, feedback application designers should pay attention to impact of subjective norm by promoting the sharing of feedback application use among peers and by highlighting the extent of use of users to other users.

Fifth, this study could play a role in advising energy conservation policy makers on new policies that promote electricity conservation. With the increasing levels of greenhouse gases, policy makers should work on laws that require utility companies to partner with third party companies to provide electricity consumers with feedback applications in order to improve electricity conservation. The policy makers should ensure that electricity consumption feedback applications providers are following clear pro-environmental and user-centric guidelines and policies, and that the feedback applications do not pose any threat to the privacy of electricity consumers.

4.10. LIMITATIONS, FUTURE WORK, AND CONCLUSIONS

This study is not without limitations. The data were collected mostly from undergraduate and graduate students in a Midwestern state in the U.S. A more comprehensive set of data at the global level could increase the generalizability of the results. Also, the experiment's duration was for three months, whereas the impact of feedback applications should be examined over a longer period of time to assess the long-term impact of design elements of feedback applications on electricity conservation. A long-term longitudinal study would be an interesting future extension to our work. The iSaveElec mobile app was developed for smartphones that run Android, the open source operating system platform. Future extensions of this work should include other versions of iSaveElec developed for smartphones running other platforms such as Apple iOS and Microsoft Windows Phone.

This work could be extended in a number of ways. We manipulated only three design elements; other design elements could also be investigated. Designers of energy consumption feedback applications are interested in making their tools as user-friendly as possible so as to reach the largest population (Froehlich et al. 2010), keeping in mind that the majority of population are not engineers and are not interested in analyzing raw scientific data (Bartram et al. 2010, Chetty et al. 2008). Therefore, investigating the impact of manipulating the interface design of feedback applications would be a useful extension to examining the process by which electricity consumers are influenced by the visual design of feedback applications. Also, integrating games in feedback applications and examining the impact of such integration would be an interesting extension. Furthermore, future research can extensively examine the design of feedback applications in different contexts and the salient external factors that could impact the relationship between use of feedback applications and electricity conservation. Specifically, another direction for future research is collecting data from other cultures to examine the impact of cultural differences on the perception of feedback application design elements, salient beliefs related to feedback applications, use of feedback applications, and electricity conservation.

The world is experiencing a vast proliferation in the use of electronic gadgets, while at the same time reducing residential electricity consumption is gaining more prominence. This paper described the role of design elements of feedback applications and the mechanisms and processes by which these elements motivate electricity consumers' behavior towards energy conservation. This conceptual model is developed using a theoretical framework and a synthesis of extensive literature review from several disciplines. An experiment method was used to collect data from undergraduate and graduate students. The results indicate strong support for the premises of the model. The results also support the significance of personalized design elements. Our findings show the importance of integrating descriptive social norm, personalized goal setting, and personalized privacy settings design elements in feedback applications.

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APPENDIX A

Table A.1. Recent Studies in Green IT 8 IS Journals and 2 IS Conferences

Authors	**Framework/ Theory used**	**Proposed Framework/ Findings**	**Method**
Level of Analysis: Individual			
Baeriswyl et al. 2011a	Game theory	Design of online game that induces energy sustainability	Conceptual
Baeriswyl et al. 2011b	Pro-social behavior theory	Identity disclosure and online social comparisons impact electricity consumption	Conceptual
Bansal 2010	TAM	Environmental beliefs negatively impact perceptions regarding traditional books	Survey
Busse et al. 2013	Decomposed theory of planned behavior, belief norm theory	There are cultural factors that influence the intentions to adopt electric vehicles	Survey
Corley et al. 2012	Value congruence	Consumer's purchase intention and loyalty is influenced by sustainability attitude	Lab experiment
Hasan 2010	Socio-technical systems theory	IS professionals have conflicting views on how to address environmental problems	Q-method and survey
Kranz and Picot 2012	TPB	Smart metering technologies adoption model	Survey
Loock et al. 2011	Belief-action-outcome framework	Multiple types of normative feedback via web portal improve individual's energy conservation	Field experiment
Loock et al. 2012	Theory of social impact	Descriptive normative feedback impact is moderated by proximity of reference groups	Field experiment
Loock et al. 2013	Goal setting theory	Default goals have significant impact on energy conservation	Field experiment
Winkler and Klapper 2012	--	Mobile product information is a tool to positively impact brand perception of green products	Field experiment
Wunderlich et al. 2012	Organismic integration theory	Smart meter technology adoption model	Survey
Wunderlich et al. 2013	Organismic integration theory	The endogenous motivations for adopting Smart meter technology behavioral intentions are different	Survey

		for users and non-users.	
Level of Analysis: Individual, Organization & Society			
Califf et al. 2012	Fit as gestalts perspective	Categorizes energy informatics literature & highlights the dimensions of energy informatics	Conceptual
Hovorka and Corbett 2012	--	Proposes a trans-disciplinary framework for IS sustainability research and a research agenda	Conceptual
Dedrick 2010	--	IT and carbon productivity & research agenda	Conceptual
Loeser 2013	--	A clear definition of green IT and green IS	Conceptual
Melville 2010	Model of Micro–macro relation	Belief–action–outcome framework & IS research agenda	Conceptual
Strüker and van Dinther 2012	--	Research agenda for IS research on demand response and smart grid	Conceptual
Watson et al. 2010	--	Energy informatics framework/ research agenda	Conceptual
Level of Analysis: Organization			
Bengtsson and Ågerfalk 2011	Actor network theory	IS initiatives (DSS) positively influences organization's sustainability performance	Case study
Benitez-Amado et al.2013	--Theory of Operational and Dynamic Capabilities	Operational sustainability improves firm perrformance	Secondary data
Bose and Luo 2011	Diffusion of innovation theory	Proposes a framework for Green IT initiative implementation via process virtualization	Conceptual
Butler 2011	--	Mechanisms involved in the implementation of IT-based environmental compliance applications	Case study
Chen et al. 2009	Institutional theory, RBV	Outcome-based mimetic pressure and imposition--based coercive pressure impact Green-IT adoption	Survey
Corbett et al. 2010	--	Improvement process of IT/IS curriculum & IS-based energy conservation measures tool	Action research
Corbett 2013	Persuasive systems design theory	Investigates the perceptions/actions of electricity sector players regarding smart grid technologies	Case study
Dao et al. 2011	Triple bottom line of sustainability	IS role in developing firms' sustainability values and competitive advantage	Conceptual
Fradley et al. 2012	Organizing vision of ICT innovations	Examine Green IS development through institutional arrangements by heterogeneous actors	Case study
Friedemann et al. 2011	--	IS applications adoption does not necessarily reduce perceptions of enterprises regarding their supply of renewable resources	Survey and case study
Hedman et al. 2012	Competing values framework	Green IS initiatives form an incremental process associated with the other sustainable initiatives	Case study
Ijab et al. 2012	Theory of practice	Factors that shape Green IS practice	Case study
Iacobelli et al. 2010	Practitioner perspective	Green IS initiatives' solutions enabling organizations gain strategic advantages	Case study
Jeffers and Joseph 2009	RBV	Green IS outcomes model & mediating role of operations and marketing variables	Survey
Kim and Ko 2010	RBV, Stakeholder theory	Classification of Green IT leaders & followers	Data mining
Kuo 2010	Institutional theory	Green IS adoption and influence of management, bottom line, and normative pressures	Survey
Lei and Ngai 2012	Institutional theory/ Org. information processing	Theoretical model for the assimilation of Green IS	Conceptual
Loeser et al. 2011	RBV, Strategic alignment model	Strategic Green IT alignment framework	Conceptual
Loeser et al. 2012	--	Proposes a typology of 4 Green IS strategies	Case study
Mann et al. 2009	Continuous improvement	Strategic framework for Green IT	Conceptual
Marett et al. 2013	Institutional theory	Financial benefits and institutional pressures are the drivers for use of sustainable information systems	Survey
McLaren et al. 2010	Linguistic centering theory	Classification of Green IT initiatives	Text mining
Mithas et al. 2010	Belief-action-outcome model	Green IT adoption & outcomes, positive impacts on profit	secondary data
Molla et al. 2009	Eco-sustainability, RBV	G-readiness model to measure Green IT capabilities	Survey
Nanath and Pillai 2012	--	Sustainable culture promotion & business process	Secondary

		factors help in sustaining green IT initiatives	data
Nedbal et al. 2011	Diffusion of innovation theory	Implementing Green IT initiative through outsourcing enhances sustainability performance	Case study
Nishant et al. 2012	RBV	Environmental performance positively influences organizational performance of green IT orgs.	Secondary data
Pitt et al. 2011	Leavitt's diamond framework	Smartphone as an environmental friendly technology; proposes a Green IS research agenda	Conceptual
Ryoo et al. 2011	Ecological modernization & complementarity	Green-practices positively impact environmental performance and economic performance	Survey
Sayeed and Gill 2009	RBV	Green IS adoption antecedents; slowness of changes for green IT, need for support & resource	Case study
Schiller and Merhout 2011	Sustainable SDLC	Benefits of IT asset disposition solutions	Conceptual
Schmidt et al. 2010	Principal-agent	Green IS adoption model and guidelines for the integration of Green IT in business strategies	Survey
Seidel et al. 2010	Extrinsic and intrinsic motivation	Green IS adoption model; barriers and facilitators of sustainable practices	Case study
Seidel et al. 2013	Socio-technical systems theory	Functional affordances model that leads to sustainable organizations	Case study
Simmonds and Bhattacherjee 2012	Tech-Org-Env (TOE) Framework & 6-stage IT implementation model	IT initial role was used to report sustainability, the resulting information guided the organization to greater levels of sustainability	Case study
Stolze et al. 2012	Literature review	Research agenda for green business process mgmt	Conceptual
Thies and Stanoevska - Slabeva 2012	--	Develops a ranked list of critical success factors in the context of environmental product compliance	Case study
Van Osch and Avital 2010	--	A sustainable innovation approach in Green IT/IS that involves all aspects of sustainability	Longitudin al case study
Hedwig et al. 2009	--	Reducing energy costs of large enterprise systems through a new provisioning model.	Design science
Vazquez et al. 2011	Literature review	Shows that there is an increased awareness of Green IT by organizations	Meta-analysis
Level of Analysis: Organizational and Society/Community			
Corbett 2010	Environmental embeddedness, RBV	Research agenda and natural resource-based view of the firm and environmental embeddedness	Conceptual
Corbett 2011	Organization information processing theory	Investigates the design and use of carbon management systems to promote pro-environmental behavior	Conceptual
Corbett 2012	Institutional theory	Investigates the perceptions/actions of electricity sector players regarding smart grid technologies	Case study
Strüker et al. 2013	Principal agent theory	Proposing an IS monitoring solution to address threat of opportunistic behavior in smart grid markets	Case study
Watson et al. 2011	Four information drives framework	Enhancing sustainability behavior via innovating system designs that address customers needs	Case study
Watson et al. 2012	Constructal theory	Discussing impacts of the growing environmental concerns to current dominant logic & IS research, education, and practice.	Conceptual
Yim 2011	FIT and pro-social behavior	Impact of community culture on energy conservation information usage	Field experiment
Level of Analysis: Product/Technical/Other			
Brandt 2013	--	Use of IT in managing information about automobile uses	Optimization
Brandt et al. 2013	--	IS artifact for providing synergies between electric vehicles and photovoltaic panels	Simulation
Brooks et al. 2010	Literature review	Develops a research agenda for IS academics in Green IT	Conceptual
DesAutels and Berthon 2011	Signaling theory	The cost effectiveness of producing sustainable products	Secondary data
Dorsch and Häckel 2012	--	Optimization solution for an excess capacity problem in a cloud service environment	Design science
Eickenjäger and Breitner	Renewable-Fuels-Scenario-	A simulation tool for substitution of fossil fuels that	Simulation

2013	Analyses	guides political decisions	
Erskine et al.2013	--	Study Dthe impacts of desktop virtualization.	Case study
Flath et al. 2012	--	Optimization approaches to solve electric vehicles charging problems	Design science
Goetzinger et al. 2012	--	Optimization solutions for facility location problem	Design science
Grimm et al. 2013	Life cycle assessment (LCA)	A methodological framework to monitor IT services' carbon footprint.	Case study
Krogstie et al. 2013	Living Lab methodology	Design of a cross-country prototype aimed at energy saving for residential users	Case study
Moeller et al. 2013	--	COBIT 5 process reference model lacks sustainability characteristics	Survey
Opitz et al. 2012	--	Proposes modeling languages and business processes for environmentally sustainable process management	Design science
Reiter et al. 2013	IT Infrastructure Library Reference Modeling	A new process category called Ecology Management was added to IT Service Management framework	Conceptual
Schmidt and Busse 2013	--	Measuring the cost and energy saving advantages of electric vehicles	Simulation
Schödwell et al. 2013	--	A measuring system that analyses data centers green performance.	Survey
Zhang et al. 2011	Goal-oriented requirements modeling	A decision-makng tool that includes the environmental impact factors	Conceptual

Table A.2 Scale Development

Construct	Operational Definition	Sources
Anti-Anthropocentrism	Individual's belief in extent of the human domination over nature.	Cordano et al. 2003, Dunlap and Van Liere 1978, Dunlap et al. 2000
Environmental Belief	Individual's belief in fragility of nature and humans' role in damaging it.	Cordano et al. 2003
Altruism	Individual's perception of altruism as a guiding value.	Milfont et al. 2010, Schultz 2001
Social Norm	Individual's belief in social rewards/sanctions towards pro-environmental behaviors.	Heath and Gifford 2002, Knussen and Yule 2008
Green-IT Enjoyment	Individuals' feelings on the enjoyment of paperless technologies in comparison to paper alternatives.	Limayem and Hirt 2003
Perceived Green-IT Efficacy	Individual's perception of the efficacy of using paperless technologies in dealing with environmental issues.	Lam and Chen 2006
Green-IT Personal Net Benefit	Individual's evaluation of benefit and cost analysis in comparing paperless technologies.	Taylor and Todd 1995
Green-IT Attitude	Individual's cognitive attitude towards paperless technologies.	Pavlou and Fygenson 2006, Taylor and Todd 1995
Paper Habit	Individual's tendency to consider paper alternatives as habits.	Limayem et al. 2007, Pavlou and Fygenson 2006
Green-IT Habit	Individual's tendency to consider paperless technologies as habits.	Limayem et al. 2003, Pavlou and Fygenson 2006
Green-IT Self-efficacy	Individual's perception about his/her self-efficacy in using paperless technologies.	Dinev and Hu 2007, Pavlou and Fygenson 2006, Taylor and Todd 1995
Green-IT Use	Using pro-environmental "green" IT as opposed to non-environmental "brown" practices.	Specific to this study
Green IT	eCards for special occasions eBook (digital books)	

	eNews (news online or other devices) eBill payment (paying your bills online)

Table A.3 Survey Instrument

All items were measured on a continuous 10-point semantic differential scale from 1 to 10.

Construct	Item	Measures
Anti-anthropo-centrism	ANT1	The extent of humans' rights to modify the natural environment to suit their needs is (very high/very low)
	ANT2	The extent of humans' rights to rule over the rest of nature is (very high/very low)
Environ-mental belief	ENV1	When humans interfere with nature, the consequences are (not disastrous at all/very disastrous)
	ENV2	The balance of nature is (not delicate and cannot easily be upset/delicate and can be easily be upset)
	ENV3	The treatment of environment by humans is (not abusive at all/very abusive)
Altruism		How important is each statement as a guiding principle in your own life?
	ALT1	A world at peace, free of war and conflict: (not important at all/very important)
	ALT2	Equality, equal opportunity for all (not important at all/ very important)
	ALT3	Social justice, correcting injustice, care for the weak (not important at all/very important)
Social norm		When it comes to opinions of people most important to me:
	SOC1	If I take actions to protect the environment, they will (not approve for sure/approve for sure)
	SOC2	They think that taking actions to protect the environment is (not desirable at all/very desirable for sure)
	SOC3	If I take actions to protect the environment, they will: (not praise me for my actions at all/ praise me
Green-IT enjoyment		In comparing paperless technologies with using papers,
	ENJ1	I believe that paperless technologies are: (not as enjoyable as using paper at all/ as enjoyable as using
	ENJ2	In comparing paperless technologies with using papers, I believe that paperless technologies are (not as pleasurable as using paper at all/as pleasurable as using paper for sure)
	ENJ3	In comparing paperless technologies with using papers, I believe that paperless technologies are (not as exciting as using paper at all/are as exciting as using paper for sure)
Green-IT efficacy		My opinion about the impact of using paperless technologies on the environment,
	GEF1	I believe that the impact is (very low/very high)
	GEF2	I believe that the impact is (not significant at all/very significant)
	GEF3	I believe that the impact is (will not make any difference in the future/ will make a difference in the future)
Green-IT personal net benefit		In comparing costs and benefits of paperless technologies, for me they:
	BEN1	Require at a lot of effort/ do not require a lot of effort at all
	BEN2	Are too time consuming/ are not time consuming at all
	BEN3	Are very costly/ are not costly at all
Green-IT attitude		I think that using paperless technologies is:
	ATT1	a bad idea for sure/a very good idea
	ATT2	very foolish/very wise
	ATT3	a very unpleasant idea/a very pleasant idea
Paper habit		Using paper (one or more of the following: paper cards, paper bills, paper books, newspapers) is:
	PHB1	not a habit for me at all/a habit for me for sure
	PHB2	not natural to me at all/natural to me for sure
	PHB3	not an automatic choice for me at all/an automatic choice for me for sure
Green-IT habit		Using paperless technologies (one or more of eCard, eBill, eBook, or eNews) is:
	GHB1	not a habit for me at all/a habit for me for sure
	GHB2	not natural to me at all/natural to me for sure
	GHB3	not an automatic choice for me at all/an automatic choice for me for sure
Green-IT		When it comes to using paperless technologies:

self-efficacy	SEF1	The level of my skills is (very low/very high)
	SEF2	The level of my knowledge is (very low/very high)
	SEF3	The level of my confidence is (very low/very high)
Green-IT use	eCard	Do you use eCards for special occasions in place of paper cards? (never/ very often)
	eBoo	Do you use eBook in place of paper books? (never/ very often)
	eNew	Do you read news on the Web in place of newspapers? (never/ very often)
	eBill	Do you pay your bills online in place of paper bills? (never/ very often)

Table A.4 Descriptive Statistics

Variable	**Mean**	**SD**	**Range**
Age	25.17	10.55	18-73
Education*	3.51	1.28	1-7
Access Green-IT**	6.16	2.44	1-10
Experience with nature**	6.95	2.22	1-10

* 1:Some school, non degree 2:High school graduate 3:Some college, non degree/college students, 4: Professional deg./2-year associate deg.5:Bachelor's deg .6:Master's deg. 7:Doctorate
** Measured on a continuous scale 1(very low)-10(very high)

Table A.5 Exploratory Factor Analysis												
Constructs	**Items**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Factor 7**	**Factor 8**	**Factor 9**	**Factor 10**	**Factor 11**
Anti-anthropo-centrism	ANT1	0.08	-0.07	-0.03	-0.03	0.10	-0.04	0.14	0.05	0.02	-0.10	**0.88**
	ANT2	0.01	0.00	0.04	0.02	0.04	-0.06	0.09	0.05	0.04	-0.10	**0.90**
Environmental belief	ENV1	0.02	-0.01	-0.01	-0.16	0.01	-0.08	0.06	0.22	-0.06	**-0.75**	0.06
	ENV2	0.07	-0.07	-0.04	-0.08	0.04	-0.03	0.18	0.07	0.08	**-0.78**	0.13
	ENV3	0.11	0.07	0.02	-0.06	0.02	-0.19	0.06	0.14	0.07	**-0.76**	0.03
Altruism	ALT1	0.01	0.01	0.05	-0.04	0.04	-0.12	0.14	**0.77**	0.00	-0.16	0.06
	ALT2	0.06	-0.04	0.00	-0.01	0.04	-0.11	0.11	**0.85**	0.08	-0.10	0.02
	ALT3	0.02	-0.03	0.02	-0.09	0.04	-0.11	0.04	**0.84**	0.07	-0.15	0.03
Social norm	SOC1	0.05	-0.04	0.03	-0.07	0.04	-0.12	**0.82**	0.11	0.10	-0.09	0.08
	SOC2	0.00	-0.02	0.03	-0.05	0.08	-0.11	**0.84**	0.08	0.04	-0.12	0.06
	SOC3	0.06	-0.08	0.01	-0.03	0.01	-0.04	**0.83**	0.11	0.05	-0.08	0.10
Green-IT enjoyment	ENJ1	0.08	**-0.89**	0.19	-0.14	-0.04	-0.11	0.04	0.04	0.07	-0.01	0.02
	ENJ2	0.08	**-0.89**	0.20	-0.10	-0.08	-0.12	0.03	0.03	0.10	0.02	0.04
	ENJ3	0.07	**-0.83**	0.16	-0.07	-0.02	-0.18	0.07	0.00	0.05	-0.02	0.03
Green-IT Efficacy	GEF1	0.10	-0.21	0.09	-0.14	-0.01	**-0.79**	0.08	0.16	0.15	-0.08	0.08
	GEF2	0.11	-0.15	0.12	-0.18	-0.03	**-0.84**	0.06	0.11	0.12	-0.11	0.03
	GEF3	0.05	-0.10	0.09	-0.12	0.01	**-0.82**	0.17	0.14	0.15	-0.15	0.02
Green-IT personal net benefit	BEN1	0.10	-0.04	0.07	-0.15	-0.07	-0.18	0.07	0.07	**0.81**	-0.03	0.01
	BEN2	0.12	-0.05	0.11	-0.05	0.04	-0.11	0.04	0.06	**0.80**	-0.08	0.06
	BEN3	0.06	-0.09	0.06	-0.19	-0.02	-0.07	0.07	0.02	**0.75**	0.02	-0.01
Green-IT attitude	ATT1	0.07	-0.10	0.11	**-0.85**	-0.01	-0.17	0.07	0.04	0.14	-0.13	0.00
	ATT2	0.07	-0.06	0.02	**-0.88**	-0.02	-0.11	0.06	0.04	0.14	-0.09	-0.01
	ATT3	0.09	-0.15	0.11	**-0.86**	-0.05	-0.12	0.03	0.07	0.15	-0.09	0.03
Paper habit	PHB1	-0.04	0.04	-0.08	0.03	**0.92**	0.00	0.03	0.06	0.00	-0.02	0.09
	PHB2	-0.01	0.06	0.01	-0.04	**0.88**	0.02	0.01	0.05	0.02	-0.11	-0.03
	PHB3	-0.05	0.02	-0.02	0.08	**0.88**	0.01	0.08	0.00	-0.06	0.06	0.08
Green-IT habit	GHB1	0.18	-0.15	**0.88**	-0.06	-0.02	-0.09	0.02	0.01	0.10	0.00	-0.05
	GHB2	0.23	-0.19	**0.86**	-0.06	-0.03	-0.10	0.01	0.01	0.10	-0.02	0.06
	GHB3	0.12	-0.25	**0.85**	-0.12	-0.06	-0.09	0.04	0.06	0.07	0.06	0.01
Green-IT self-efficacy	SEF1	**0.89**	-0.07	0.22	-0.09	-0.04	-0.09	0.01	0.04	0.09	-0.06	0.03
	SEF2	**0.92**	-0.04	0.17	-0.06	-0.03	-0.06	0.07	0.02	0.11	-0.07	0.04
	SEF3	**0.89**	-0.11	0.12	-0.08	-0.05	-0.10	0.04	0.04	0.10	-0.09	0.03
% Cum. var. explained		8.30	16.40	24.30	32.10	39.70	46.90	54.00	61.00	67.50	73.60	78.80

Table A.6 Factor Loadings in the Measurement Model (CFA)*					
Constructs	**Variables**	**Loading**	**t-value**	**R^2**	
				Youths	**Adults**
Anti-anthropocentrism	ANT1	1.000	0.00	0.79	0.80
	ANT2	0.894	10.88	0.54	0.53
Environmental belief	ENV1	0.990	14.65	0.44	0.52
	ENV2	1.000	0.00	0.46	0.57
	ENV3	0.908	15.36	0.45	0.46
Altruism	ALT1	0.972	12.50	0.50	0.46
	ALT2	0.990	12.89	0.67	0.65
	ALT3	1.000	0.00	0.66	0.59
Social norm	SOC1	0.981	17.17	0.63	0.61
	SOC2	0.971	18.93	0.67	0.53
	SOC3	1.000	0.00	0.61	0.40
Green-IT enjoyment	ENJ1	0.981	37.09	0.85	0.86
	ENJ2	1.000	0.00	0.88	0.95
	ENJ3	0.761	21.30	0.57	0.57
Green-IT efficacy	GEF1	0.905	25.82	0.69	0.58
	GEF2	1.000	0.00	0.72	0.86
	GEF3	0.875	23.30	0.65	0.73
Green-IT personal net benefit	BEN1	1.000	0.00	0.64	0.66
	BEN2	0.892	13.51	0.49	0.61
	BEN3	0.930	13.60	0.38	0.52
Green-IT attitude	ATT1	0.922	18.88	0.76	0.70
	ATT2	0.937	25.31	0.73	0.53
	ATT3	1.000	0.00	0.78	0.66
Paper habit	PHB1	1.000	0.00	0.86	0.96
	PHB2	0.723	19.71	0.57	0.65
	PHB3	0.817	26.93	0.64	0.67
Green-IT habit	GHB1	1.000	0.00	0.75	0.76
	GHB2	0.953	29.29	0.79	0.86
	GHB3	0.936	30.98	0.73	0.75
Green-IT self-efficacy	SEF1	0.970	36.31	0.83	0.84
	SEF2	1.000	0.00	0.85	0.90
	SEF3	0.995	33.68	0.80	0.72

*Youth and Adults group had the same loading values.

Table A.7 Use of Individual Technologies as the Dependent Variable

Green-IT Use	Youths					Adults				
	G-IT Attitude	G-IT Habit	Paper Habit	Self-Efficacy	R^2	G-IT Attitude	G-IT Habit	Paper Habit	Self-Efficacy	R^2
eBill	Ns	.46***	Ns	.41***	.14***	.92***	.56***	-.15**	Ns	.31***
eBook	Ns	.26***	Ns	.23***	.09***	.44***	ns	-.13*	.17**	.07*
eCard	.16***	.16***	Ns	ns	.05**	.61***	ns	ns	.35***	.13***
eNews	.14*	.37***	Ns	.13**	.11***	.28*	.33***	. 09*	.22***	.14***

*** p<0.01, **p<0.05, * p<0.10. The other paths and fit indices either remained unchanged, or had minor changes in second decimal places.

APPENDIX B

Table B.1 Scale Development		
Construct	**Operational Definition**	**Major Sources**
Environmental Concern	Electricity consumer's concern about the fragility of nature and human's role in damaging it.	Schwartz 1992, 1994, Steg et al. 2005
Perceived Usefulness of Consumption Information	Electricity consumer's belief about the usefulness of the information related to his/her consumption historical information and performance.	Chen 2012, Davis 1989, Venkatesh et al. 2003
Perceived Quality of Saving Advice	Electricity consumer's belief about the relevance of application's information on saving recommendations.	McKinney et al. 2002
Perceived Usefulness of Social Comparative Information	Electricity consumer's belief about the usefulness of the social comparative information.	Chen 2012, Davis 1989, Venkatesh et al. 2003
Privacy Concern	Electricity consumer's degree of worry about privacy invasion of consumption information	Bansal et al. 2010, Awad and Krishnan 2006
Perceived Commitment to Feedback Application Goal	Electricity consumer's commitment to attain the target level of reduced consumption which is set on the feedback application.	Hollenbeck et al. 1989
Feedback Application Descriptive Normative Belief	Electricity consumer's belief about behavior of their peers and classmates in terms of feedback application use.	Fishbein and Ajzen 2010
Perceived Usefulness of Feedback Application	Electricity consumer's belief about the usefulness of the feedback application as a tool to help save electricity.	Chen 2012, Davis 1989, Venkatesh et al. 2003
Feedback Application Attitude	Electricity consumer's favorable or unfavorable feelings towards using feedback application.	Venkatesh et al. 2003
Feedback Application Subjective Norm	Electricity consumer's perceptions of behavior of normative referents in terms of use of feedback application..	Fishbein and Ajzen 2010
Feedback Application Self-Efficacy	Electricity consumer's perceived	Dinev and Hu 2007

	self-confidence in executing the steps needed to use feedback application.	
Reported Use of Feedback Application	The electricity consumer's reported extent of use of feedback application.	Chen 2012
Electricity Conservation	Electricity consumer's perceived reduction of electricity consumption.	Specific to this study
Peers Positive & Close Relationship	Individual’s perception of the quality and depth of his/her relationship with peers.	Carmeli et al. 2009

Table B.2 Survey Instrument

Constructs	Codes	Items
Environmental Concern		Considering the **environment**, I believe
	ENC1	preserving nature (is not important at all/ is very important for sure)
	ENC2	reducing pollution (is not important at all/ is very important for sure)
	ENC3	protecting living creatures and plants (is not important at all/ is very important for sure)
Perceived Quality of Saving Advice		Considering the **quality of tips in** “How can I save more?” screen in iSaveElec, for **me** the tips were:
	ADQ1	not applicable at all/ very applicable for sure
	ADQ2	not relevant at all/ very relevant to for sure
	ADQ3	the tips **information** was: not of good quality at all/ of good quality for sure
Perceived Commitment to Feedback Application (FA) Goal		Considering **my iSaveElec goal for cutting electricity use**, I:
	GLC1	did not care about it at all/ cared about it for sure
	GLC2	did not take it seriously at all/ took it seriously for sure
	GLC3	the level of **my commitment to this goal** was very low/very high
FA Descriptive Normative Belief		Based on the information provided in the “Me compared to others…” screen, the **use of iSaveElec by** most **of my peers and classmates** was:
	DNR1	very low/ very high
	DNR2	not likely at all/ most likely for sure
	DNR3	not probable at all/ very probable for sure
Perceived Usefulness of Social Comparative Information		For increasing **my knowledge about the level of electricity consumption of other people like me,** the information provided in the “Me compared to others…” screen was:
	PUS1	not helpful at all/ very helpful for sure
	PUS2	not valuable at all/ very valuable for sure
	PUS3	not useful at all/ very useful for sure
Perceived Usefulness of Consumption Information		For increasing **my awareness about how much I consume electricity**, the information provided in the “My consumption information & saving grade ...” screen was:
	PUI1	not helpful at all/ very helpful for sure
	PUI2	not valuable at all/ very valuable for sure
	PUI3	not useful at all/ very useful for sure
Privacy Concern	PRC1	I believe **providing information about my electricity consumption** to iSaveElec was: advisable for sure/ not advisable at all
	PRC2	I believe the provided information to iSaveElec will: not be shared without authorization at all/ be shared without authorization for sure
	PRC3	I believe the provided information to iSaveElec will: not be abused at all/ be abused for sure
Perceived Usefulness of FA		I believe **iSaveElec as a tool to help me save electricity** is:
	PUF1	not helpful at all/ very helpful for sure
	PUF2	not valuable at all/ very valuable for sure
	PUF3	not useful at all/ very useful for sure
FA Attitude		I think that **using iSaveElec** is:
	FAA1	a very bad idea/ a very good idea

	FAA2	very foolish/ very wise
	FAA3	a very unpleasant idea/ a very pleasant idea
FA Subjective Norm		When it comes to **using iSaveElec by most people who are like me:**
	FAS1	The **likelihood** is very low/very high
	FAS2	The **probability** is very low/ very high
FA Self-Efficacy		When it comes to **using iSaveElec, the level of my**:
	FAE1	skills is (very low/very high)
	FAE2	knowledge is (very low/very high)
	FAE3	confidence is (very low/very high)
Reported Use of FA		During the last two months - relative to the expected interaction time with iSaveElec of 10 minutes per month, the **extent of my**
	FAU1	interaction with iSaveElec was (very low/ very high)
	FAU2	use of iSaveElec was (very low/ very high)
	FAU3	time spent on iSaveElec was (very low/ very high)
Electricity Conservation	EXS1	In the **last two months**, my electricity saving (did not increase at all/ increased for sure)
	EXS2	In the **last two months**, my electricity bill was (not reduced at all/ reduced for sure)
	EXS3	In the last two months, my electricity consumption was (not reduced at all/ reduced for sure)
Peers Positive & Close Relationship		When it come to my relationships with my peers and classmates, I feel that
	PRL1	they are not like me at all/ they are like me for sure
	PRL2	they don't understand me at all/ they understand me for sure
	PRL3	we do not have close relationships at all/we have close relationships for sure

Table B.3 Exploratory Factor Analysis														
Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Factor 11	Factor 12	Factor 13	Factor 14
ENC1	-0.03	0.12	-0.14	**-0.87**	-0.15	0.19	-0.09	-0.13	0.04	0.10	-0.12	0.02	0.06	0.08
ENC2	0.04	0.11	-0.07	**-0.87**	-0.19	0.14	-0.08	0.00	0.11	0.14	-0.05	0.19	0.04	0.00
ENC3	0.09	-0.01	-0.04	**-0.87**	-0.13	0.15	-0.12	-0.06	0.16	0.14	-0.06	0.11	0.08	0.09
ADQ1	0.11	0.07	-0.05	-0.19	**-0.82**	0.19	-0.18	-0.07	0.08	-0.03	-0.12	0.15	0.15	0.16
ADQ2	0.12	0.06	-0.09	-0.17	**-0.88**	0.12	-0.14	-0.13	0.13	0.01	-0.11	0.14	0.04	0.00
ADQ3	0.15	0.06	-0.08	-0.21	**-0.73**	0.13	-0.34	-0.01	0.14	0.02	-0.13	0.17	0.25	0.06
GLC1	0.15	0.13	-0.17	-0.15	-0.23	0.14	**-0.76**	-0.08	0.14	-0.04	-0.02	0.21	0.24	0.13
GLC2	0.18	0.12	-0.06	-0.09	-0.29	0.19	**-0.78**	-0.13	0.06	0.00	-0.08	0.12	0.15	0.18
GLC3	0.35	0.18	-0.17	-0.15	-0.16	0.04	**-0.71**	-0.06	0.04	0.04	-0.20	0.17	0.03	0.14
DNR1	0.08	0.07	**-0.85**	-0.05	-0.05	0.01	-0.08	0.01	0.23	-0.07	-0.12	0.10	-0.02	0.03
DNR2	0.16	0.12	**-0.86**	-0.08	-0.04	0.20	-0.10	-0.13	0.08	-0.08	-0.18	0.08	0.10	0.09
DNR3	0.14	0.11	**-0.84**	-0.13	-0.10	0.15	-0.12	-0.11	0.12	-0.07	-0.21	0.08	0.13	0.10
PUS1	0.17	0.06	-0.32	-0.13	-0.16	0.25	-0.13	-0.20	0.24	0.03	**-0.72**	0.07	0.17	0.06
PUS2	0.15	0.13	-0.28	-0.12	-0.19	0.22	-0.11	-0.27	0.26	-0.01	**-0.74**	0.09	0.13	0.12
PUS3	0.14	0.13	-0.28	-0.09	-0.16	0.15	-0.11	-0.26	0.27	-0.02	**-0.75**	0.15	0.11	0.13
PUI1	0.11	0.18	-0.27	-0.12	-0.13	0.21	-0.09	-0.17	**0.75**	0.17	-0.24	0.16	0.15	0.11
PUI2	0.13	0.18	-0.22	-0.20	-0.19	0.22	-0.08	-0.11	**0.76**	0.08	-0.27	0.15	0.15	0.10
PUI3	0.19	0.20	-0.20	-0.17	-0.15	0.17	-0.12	-0.13	**0.72**	0.10	-0.24	0.21	0.15	0.11
PRC1	0.01	0.03	-0.11	0.19	0.03	0.02	-0.02	0.03	-0.02	**-0.84**	0.09	-0.14	-0.02	-0.03
PRC2	0.19	0.01	-0.01	0.16	0.03	-0.20	-0.04	-0.03	-0.04	**-0.86**	-0.02	-0.11	-0.03	0.09
PRC3	0.02	0.04	-0.06	-0.02	-0.05	-0.11	0.05	-0.01	-0.12	**-0.87**	-0.07	0.16	0.03	0.06
PUF1	0.28	0.22	-0.12	-0.12	-0.29	0.05	-0.21	-0.05	0.23	0.04	-0.21	0.30	**0.67**	0.19
PUF2	0.25	0.21	-0.13	-0.12	-0.26	0.08	-0.28	-0.09	0.21	0.01	-0.20	0.31	**0.66**	0.21
PUF3	0.26	0.18	-0.16	-0.12	-0.28	0.10	-0.31	-0.09	0.23	0.00	-0.18	0.33	**0.62**	0.21
FAA1	0.17	0.12	-0.14	-0.23	-0.27	0.15	-0.23	-0.10	0.20	0.01	-0.06	**0.66**	0.28	0.24
FAA2	0.16	0.10	-0.14	-0.17	-0.28	0.17	-0.24	-0.10	0.25	0.06	-0.13	**0.70**	0.25	0.12
FAA3	0.23	0.14	-0.17	-0.19	-0.19	0.19	-0.23	-0.18	0.17	0.12	-0.15	**0.68**	0.17	0.19
FAS1	0.22	0.18	-0.18	-0.14	-0.14	0.13	-0.29	-0.13	0.16	-0.10	-0.15	0.24	0.20	**0.74**
FAS2	0.22	0.22	-0.14	-0.13	-0.14	0.11	-0.30	-0.13	0.16	-0.13	-0.16	0.25	0.22	**0.72**
FAE1	0.07	0.13	-0.06	-0.12	-0.17	**0.84**	-0.08	-0.13	0.14	0.18	-0.06	0.17	0.02	0.12
FAE2	0.05	0.17	-0.16	-0.26	-0.12	**0.82**	-0.11	-0.13	0.15	0.05	-0.15	0.11	0.05	0.08
FAE3	0.08	0.14	-0.18	-0.18	-0.12	**0.80**	-0.15	-0.13	0.14	0.13	-0.23	0.03	0.06	-0.03
FAU1	**0.88**	0.17	-0.11	-0.08	-0.09	0.10	-0.16	-0.07	0.10	-0.06	-0.09	0.09	0.11	0.07
FAU2	**0.86**	0.14	-0.14	-0.02	-0.12	0.11	-0.17	-0.05	0.13	-0.07	-0.08	0.14	0.16	0.04
FAU3	**0.82**	0.15	-0.11	0.01	-0.11	-0.03	-0.13	-0.10	0.06	-0.11	-0.11	0.08	0.07	0.15
EXS1	0.12	**0.89**	-0.07	-0.07	-0.01	0.13	-0.10	-0.11	0.03	0.01	-0.11	0.16	0.10	0.05
EXS2	0.17	**0.91**	-0.09	-0.08	-0.07	0.09	-0.11	-0.04	0.15	-0.06	-0.06	0.03	0.12	0.06
EXS3	0.16	**0.91**	-0.12	-0.05	-0.10	0.14	-0.11	-0.06	0.17	-0.04	-0.03	0.02	0.03	0.12
PRL1	0.13	0.05	-0.04	0.00	-0.01	0.06	-0.01	**-0.87**	0.10	0.06	-0.18	0.14	-0.04	-0.01
PRL2	0.04	0.10	-0.21	-0.13	-0.15	0.25	-0.02	**-0.81**	0.05	-0.04	-0.08	0.09	0.02	0.12
PRL3	0.04	0.06	0.02	-0.05	-0.04	0.05	-0.15	**-0.86**	0.08	-0.03	-0.11	-0.02	0.11	0.06
% Cum. var. exp	7.70	15.30	22.80	30.10	37.40	44.30	50.90	57.40	63.60	69.60	75.50	81.20	85.90	89.80

Table B.4 Factor Loadings in the Measurement Model (CFA)				
Constructs	**Items**	**Loading**	**t-value**	**R^2**
Environmental Concern	ENC1	0.90	64.55	0.80
	ENC2	0.92	55.29	0.84
	ENC3	0.92	53.66	0.84
Perceived Quality of Saving Advice	ADQ1	0.91	45.48	0.82
	ADQ2	0.88	39.55	0.78
	ADQ3	0.90	44.71	0.81
Perceived Commitment to Feedback Application (FA) Goal	GLC1	0.91	46.35	0.83
	GLC2	0.89	48.91	0.79
	GLC3	0.80	24.94	0.64
FA Descriptive Normative Belief	DNR1	0.77	21.62	0.60
	DNR2	0.97	65.87	0.94
	DNR3	0.95	57.13	0.91
Perceived Usefulness of Social Comparative Information	PUS1	0.92	67.11	0.84
	PUS2	0.97	172.50	0.95
	PUS3	0.95	100.01	0.91
Perceived Usefulness of Consumption Information	PUI1	0.94	81.45	0.89
	PUI2	0.97	122.44	0.94
	PUI3	0.92	58.47	0.84
Privacy Concern	PRC1	0.74	19.19	0.55
	PRC2	0.95	39.19	0.91
	PRC3	0.76	17.65	0.57
Perceived Usefulness of FA	PUF1	0.97	158.92	0.93
	PUF2	0.98	231.20	0.96
	PUF3	0.97	185.49	0.95
FA Attitude	FAA1	0.93	54.48	0.86
	FAA2	0.95	83.30	0.90

	FAA3	0.88	46.91	0.77
FA Subjective Norm	FAS1	0.97	91.85	0.93
	FAS2	0.99	141.68	0.98
FA Self-Efficacy	FAE1	0.89	47.94	0.78
	FAE2	0.94	75.91	0.89
	FAE3	0.88	40.28	0.77
Reported Use of FA	FAU1	0.96	86.36	0.93
	FAU2	0.95	72.82	0.91
	FAU3	0.79	25.48	0.63
Electricity Conservation	EXS1	0.89	39.25	0.79
	EXS2	0.97	75.54	0.93
	EXS3	0.97	93.22	0.94
Peers Positive & Close Relationship	PRL1	0.85	31.86	0.72
	PRL2	0.86	33.39	0.74
	PRL3	0.76	20.88	0.58

APPENDIX C – Questionnaire (Essay 1)

The extent of humans' rights to modify the natural environment to suit their needs is:

(very high=1,very low=10) 1—2—3—4—5—6—7—8—9—10

The extent of humans' rights to rule over the rest of nature is:

(very high=1,very low=10) 1—2—3—4—5—6—7—8—9—10

When humans interfere with nature, the consequences are (not disastrous at all=1,very disastrous=10) 1—2—3—4—5—6—7—8—9—10

The balance of nature is (not delicate and cannot easily be upset=1,delicate and can be easily be upset=10) 1—2—3—4—5—6—7—8—9—10

The treatment of environment by humans is (not abusive at all=1, very abusive=10)

1—2—3—4—5—6—7—8—9—10

How important is each statement as a guiding principle in your own life? (not important at all=1,very important=10)

A world at peace, free of war and conflict 1—2—3—4—5—6—7—8—9—10

Equality, equal opportunity for all 1—2—3—4—5—6—7—8—9—10

Social justice, correcting injustice, care for the weak 1—2—3—4—5—6—7—8—9—10

When it comes to opinions of people most important to me:

If I take actions to protect the environment, they will (not approve for sure=1,approve for sure=10) 1—2—3—4—5—6—7—8—9—10

They think that taking actions to protect the environment is (not desirable at all=1,very desirable for sure=10) 1—2—3—4—5—6—7—8—9—10

If I take actions to protect the environment, they will: (not praise me for my actions at all=1,praise me for my actions for sure=10) 1—2—3—4—5—6—7—8—9—10

In comparing paperless technologies with using papers,

I believe that paperless technologies are: (not as enjoyable as using paper at all=1,as enjoyable as using paper for sure=10) 1—2—3—4—5—6—7—8—9—10

In comparing paperless technologies with using papers, I believe that paperless technologies are (not as pleasurable as using paper at all=1,as pleasurable as using paper for sure=10) 1—2—3—4—5—6—7—8—9—10

In comparing paperless technologies with using papers, I believe that paperless technologies are: (not as exciting as using paper at all=1,are as exciting as using paper for sure=10) 1—2—3—4—5—6—7—8—9—10

My opinion about the impact of using paperless technologies on the environment,

I believe that the impact is (very low=1,very high=10)

1—2—3—4—5—6—7—8—9—10

I believe that the impact is (not significant at all=1,very significant=10)

1—2—3—4—5—6—7—8—9—10

I believe that the impact is (will not make any difference in the future=1,will make a difference in the future=10)

1—2—3—4—5—6—7—8—9—10

In comparing costs and benefits of paperless technologies, for me they:

(Require at a lot of effort=1,do not require a lot of effort at all=10)

1—2—3—4—5—6—7—8—9—10

(Are too time consuming=1,are not time consuming at all=10)

1—2—3—4—5—6—7—8—9—10

(Are very costly=1,are not costly at all=10)

1—2—3—4—5—6—7—8—9—10

I think that using paperless technologies is:

(a bad idea for sure=1,a very good idea=10) 1—2—3—4—5—6—7—8—9—10

(very foolish=1,very wise=10) 1—2—3—4—5—6—7—8—9—10

(a very unpleasant idea=1,a very pleasant idea=10) 1—2—3—4—5—6—7—8—9—10

Using paper (one or more of the following: paper cards, paper bills, paper books, newspapers) is:

(not a habit for me at all=1,a habit for me for sure=10)

1—2—3—4—5—6—7—8—9—10

(not natural to me at all1=1,natural to me for sure=10)

1—2—3—4—5—6—7—8—9—10

(not an automatic choice for me at all=1,an automatic choice for me for sure=10)

1—2—3—4—5—6—7—8—9—10

Using paperless technologies (one or more of eCard, eBill, eBook, or eNews) is:

(not a habit for me at all=1,a habit for me for sure=10)

1—2—3—4—5—6—7—8—9—10

(not natural to me at all=1,natural to me for sure=10)

1—2—3—4—5—6—7—8—9—10

(not an automatic choice for me at all=1,an automatic choice for me for sure=10)

1—2—3—4—5—6—7—8—9—10

When it comes to using paperless technologies: (very low=1,very high=10)

The level of my skills is	1—2—3—4—5—6—7—8—9—10
The level of my knowledge is	1—2—3—4—5—6—7—8—9—10
The level of my confidence is	1—2—3—4—5—6—7—8—9—10

Do you use eCards for special occasions in place of paper cards?

(never=1,very often=10) 1—2—3—4—5—6—7—8—9—10

Do you use eBook in place of paper books?

(never=1,very often=10) 1—2—3—4—5—6—7—8—9—10

Do you read news on the Web in place of newspapers?

(never=1,very often=10) 1—2—3—4—5—6—7—8—9—10

Do you pay your bills online in place of paper bills?

(never=1,very often=10) 1—2—3—4—5—6—7—8—9—10

APPENDIX D - Questionnaire (Essay 2)

Electricity consumption feedback application is an application that provides feedback on household electricity consumption in order to enhance electricity conservation.

The purpose of this study is to find out your preferences for various features of displays for such devices.

You are asked about your preferences for various features of displays in “electricity-consumption feedback applications.” In this section, you are asked to rate your preference or the importance of information content features. Click on a circle on each row to choose your rating.

Focusing on the detail level of the information about my electricity consumption, my preference for having: (0=is very low, 10=is very high)

Consumption per Appliance	0—1—2—3—4—5—6—7—8—9—10
Consumption per Room	0—1—2—3—4—5—6—7—8—9—10
Consumption per Household	0—1—2—3—4—5—6—7—8—9—10

In general, for me, the detail level of the information about my electricity consumption: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on how often my electricity consumption information is updated, my preference for having: (0=is very low, 10=is very high)

Consumption per Second	0—1—2—3—4—5—6—7—8—9—10
Consumption per Hour	0—1—2—3—4—5—6—7—8—9—10
Consumption per Day	0—1—2—3—4—5—6—7—8—9—10
Consumption per Week	0—1—2—3—4—5—6—7—8—9—10
Consumption per Month	0—1—2—3—4—5—6—7—8—9—10

In general, for me, the frequency level of the information (how often my information is updated): (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

In general, for me, the information granularity (detail level and frequency level): (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on the electricity consumption data type, my preference for having my electricity consumption data in: (0=is very low, 10=is very high)

Kilowatts per hour consumed (KWh)	0—1—2—3—4—5—6—7—8—9—10
Cost in $	0—1—2—3—4—5—6—7—8—9—10
Amount of CO2 Emissions	0—1—2—3—4—5—6—7—8—9—10

In general, for me, the data type: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on comparing my current electricity consumption with my previous consumptions, my preference for comparing my consumption with my consumption in: (0=is very low, 10=is very high)

Previous time period (ex. previous month)

0—1—2—3—4—5—6—7—8—9—10

Similar time period (ex. same month, last year)

0—1—2—3—4—5—6—7—8—9—10

3 previous time periods (ex. past three months)

0—1—2—3—4—5—6—7—8—9—10

3 similar time periods (ex. same month in the last three years)

0—1—2—3—4—5—6—7—8—9—10

In general, for me, comparing my current consumption with my previous consumptions: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on comparing my electricity consumption with other people's consumptions, my preference for knowing: (0=is very low, 10=is very high)

How I compare to my neighbors

0—1—2—3—4—5—6—7—8—9—10

How I compare to households in my city or town

0—1—2—3—4—5—6—7—8—9—10

How I compare to households in my country

0—1—2—3—4—5—6—7—8—9—10

How I compare to similar households which have same size

0—1—2—3—4—5—6—7—8—9—10

How I compare to the most efficient households

0—1—2—3—4—5—6—7—8—9—10

In general, for me, comparing my electricity consumption with other people's consumptions: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on comparing on my electricity consumption with others' consumptions and sharing my electricity consumption with others, my preference for having the information posted in the following online sites: (0=is very low, 10=is very high)

Online social communities (ex. facebook, twitter)

0—1—2—3—4—5—6—7—8—9—10

Special online communities (special energy saving communities)

0—1—2—3—4—5—6—7—8—9—10

Online games (compete with other individuals in a game community)

0—1—2—3—4—5—6—7—8—9—10

In general, for me, the type of online sites for posting my electricity consumption in comparison with other people’s consumptions and sharing it with other people: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on comparing my electricity consumption with what is expected of a household like mine (similar size, number of individuals, etc...), my preference for knowing: (0=is very low, 10=is very high)

My expected level of electricity consumption relative to the most efficient households

0—1—2—3—4—5—6—7—8—9—10

My expected level of electricity consumption relative to the average efficient households

0—1—2—3—4—5—6—7—8—9—10

In general, for me, comparing my electricity consumption with what is expected of a household like mine (as provided by the feedback application): (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

In general, for me, the comparative information (my own previous consumptions, other people's consumptions, or expected consumption): (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on information and tips on how to save electricity, my preference for having: (0=is very low, 10=is very high)

General information and tips for saving electricity

0—1—2—3—4—5—6—7—8—9—10

Online quizzes (questions which will increase my electricity saving knowledge)

0—1—2—3—4—5—6—7—8—9—10

Future forecasts (based on my appliance's electricity consumption)

0—1—2—3—4—5—6—7—8—9—10

Saving tips that are personalized for my needs

0—1—2—3—4—5—6—7—8—9—10

In general, for me, having information and tips for saving electricity: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on my target electricity consumptions goals, my preference for: (0=is very low, 10=is very high)

Setting my own goals

0—1—2—3—4—5—6—7—8—9—10

Having my goals assigned by the application

0—1—2—3—4—5—6—7—8—9—10

In general, for me, having target electricity consumption goals: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on the notification messages, my preference for receiving a notification message when my electricity consumption reaches: (0=is very low, 10=is very high)

65 % of my goal	0—1—2—3—4—5—6—7—8—9—10
90 % of my goal	0—1—2—3—4—5—6—7—8—9—10
100 % of my goal	0—1—2—3—4—5—6—7—8—9—10

In general, for me, receiving a notification message about my electricity consumption compared to my goal: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on warning messages, my preference for receiving a warning message when my electricity consumption passes: (0=is very low, 10=is very high)

110 % of my goal 0—1—2—3—4—5—6—7—8—9—10

135 % of my goal 0—1—2—3—4—5—6—7—8—9—10

Above 135% of my goal 0—1—2—3—4—5—6—7—8—9—10

In general, for me, receiving a warning message about my electricity consumption compared to my goal: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

In general, for me, having the display features for saving tips, goal setting, notification, and warning: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on the intensity of notification alerts, my preference for having the intensity of my alerts as: (0=is very low, 10=is very high)

High & abrupt 0—1—2—3—4—5—6—7—8—9—10

Medium 0—1—2—3—4—5—6—7—8—9—10

Low & calm 0—1—2—3—4—5—6—7—8—9—10

In general, for me, the intensity of my notification alerts: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on the intensity of warning alerts, my preference for having the intensity of my warnings as: (0=is very low, 10=is very high)

High & abrupt 0—1—2—3—4—5—6—7—8—9—10

Medium 0—1—2—3—4—5—6—7—8—9—10

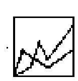
Low & calm 0—1—2—3—4—5—6—7—8—9—10

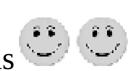
In general, for me, the intensity of my warning alerts: (0=is not important at all, 10=is very important for sure) 0—1—2—3—4—5—6—7—8—9—10

For displaying my current electricity consumption, my preference for displaying it as: (0=is very low, 10=is very high)

Numbers 0—1—2—3—4—5—6—7—8—9—10

Dashboard  0—1—2—3—4—5—6—7—8—9—10

Line graph  0—1—2—3—4—5—6—7—8—9—10

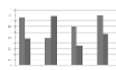
Images or icons  0—1—2—3—4—5—6—7—8—9—10

In general, for me, the method of display for my current electricity consumption: (0=is not important at all, 10=is very important for sure)

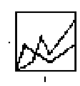
0—1—2—3—4—5—6—7—8—9—10

For comparison displays of appliances' electricity consumptions, my preference for displaying it as: (0=is very low, 10=is very high)

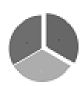
Numbers 0—1—2—3—4—5—6—7—8—9—10

Bar graph  0—1—2—3—4—5—6—7—8—9—10

Several Dashboards  0—1—2—3—4—5—6—7—8—9—10

Line graph  0—1—2—3—4—5—6—7—8—9—10

Images or icons  0—1—2—3—4—5—6—7—8—9—10

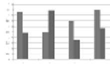
Pie Chart  0—1—2—3—4—5—6—7—8—9—10

In general, for me, the type of displays for comparing electricity consumption of appliances: (0=is not important at all, 10=is very important for sure)

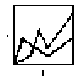
0—1—2—3—4—5—6—7—8—9—10

For comparison displays of electricity consumptions of rooms, my preference for displaying it as: (0=is very low, 10=is very high)

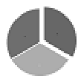
Numbers 0—1—2—3—4—5—6—7—8—9—10

Bar graph  0—1—2—3—4—5—6—7—8—9—10

Several Dashboards  0—1—2—3—4—5—6—7—8—9—10

Line graph  0—1—2—3—4—5—6—7—8—9—10

Images or icons  0—1—2—3—4—5—6—7—8—9—10

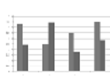
Pie Chart  0—1—2—3—4—5—6—7—8—9—10

In general, for me, the type of displays for comparing electricity consumption of rooms: (0=is not important at all, 10=is very important for sure)

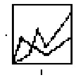
0—1—2—3—4—5—6—7—8—9—10

For displays comparing my electricity consumption with others people' consumptions such as showing "How I compare to the average consumption of my neighbors", my preference for the display is: (0=is very low, 10=is very high)

Numbers 0—1—2—3—4—5—6—7—8—9—10

Bar graph  0—1—2—3—4—5—6—7—8—9—10

Several Dashboards  0—1—2—3—4—5—6—7—8—9—10

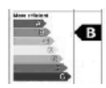
Line graph  0—1—2—3—4—5—6—7—8—9—10

Images or icons  0—1—2—3—4—5—6—7—8—9—10

In general, for me, the type of displays for comparing my electricity consumption with others people' consumptions: (0=is not important at all, 10=is very important for sure)

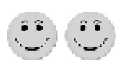
0—1—2—3—4—5—6—7—8—9—10

For displays comparing my electricity consumption with what is expected of a household like mine, my preference for the display is: (0=is very low, 10=is very high)

Grading Scales (A to G) 

0—1—2—3—4—5—6—7—8—9—10

Dashboard  0—1—2—3—4—5—6—7—8—9—10

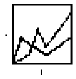
Images or icons  0—1—2—3—4—5—6—7—8—9—10

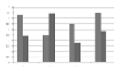
In general, for me, the type of displays comparing my electricity consumption with what is expected of a household like mine: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

For displaying the comparison of my current consumption with my previous electricity consumptions, my preference for displaying it as: (0=is very low, 10=is very high)

Numbers 0—1—2—3—4—5—6—7—8—9—10

Line graph  0—1—2—3—4—5—6—7—8—9—10

Bar graph  0—1—2—3—4—5—6—7—8—9—10

In general, for me, the type of displays for comparing my current consumption with my previous electricity consumptions: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on the control over the choice of images used for displaying appliances or rooms, my preference for having: (0=is very low, 10=is very high)

Pre-assigned image 0—1—2—3—4—5—6—7—8—9—10

My own selected image 0—1—2—3—4—5—6—7—8—9—10

Focusing on the control over the choice of text for describing appliances or rooms (such as “my living room” or “Alex’s room”), my preference for having: (0=is very low, 10=is very high)

Pre-assigned assigned text 0—1—2—3—4—5—6—7—8—9—10

My own selected text 0—1—2—3—4—5—6—7—8—9—10

In general, for me, the control over the choice of images/text of appliances or rooms: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

In general, for me, choosing various displays for comparing and showing my electricity consumption: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on the colors used in graphical presentations (such as bar graph, dashboard, line graph), my preference for such graphs to include the following colors: (0=is very low, 10=is very high)

Red 0—1—2—3—4—5—6—7—8—9—10

Orange 0—1—2—3—4—5—6—7—8—9—10

Yellow 0—1—2—3—4—5—6—7—8—9—10

Brown 0—1—2—3—4—5—6—7—8—9—10

Green 0—1—2—3—4—5—6—7—8—9—10

Blue 0—1—2—3—4—5—6—7—8—9—10

Violet 0—1—2—3—4—5—6—7—8—9—10

Black 0—1—2—3—4—5—6—7—8—9—10

In general, for me, the choice of colors used in graphical presentations: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on the colors used in textual/numerical information, my preference for having: (0=is very low, 10=is very high)

Black on white background 0—1—2—3—4—5—6—7—8—9—10

White on black ground 0—1—2—3—4—5—6—7—8—9—10

Color on color background 0—1—2—3—4—5—6—7—8—9—10

In general, for me, the choice of colors used in textual/numerical information: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

In general, for me, the choice of colors for graphical presentations or textual/numerical information: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on the type of devices that show my electricity consumption, my preference for having my consumption displayed on: (0=is very low, 10=is very high)

Dedicated home display devices that show my energy consumption

0—1—2—3—4—5—6—7—8—9—10

Desktop Computer

0—1—2—3—4—5—6—7—8—9—10

Laptop

0—1—2—3—4—5—6—7—8—9—10

Tablet

0—1—2—3—4—5—6—7—8—9—10

Smart Phone

0—1—2—3—4—5—6—7—8—9—10

In general, for me, the type of devices that shows my electricity consumption: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on the privacy of my electricity consumption information, my preference for having the information considered as: (0=is very low, 10=is very high)

Private (info inside household only. Not to be shared outside my household)

0—1—2—3—4—5—6—7—8—9—10

Semi-Public (delivered to my utility company or its direct partner who manages the electricity feedback application)

0—1—2—3—4—5—6—7—8—9—10

Public (shown on social networks, marketing companies, 3rd parties)

0—1—2—3—4—5—6—7—8—9—10

In general, for me, the choice of privacy setting of my electricity consumption information: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

Focusing on the security of my electricity consumption information, my preference for having: (0=is very low, 10=is very high)

Requiring login (username & password)

0—1—2—3—4—5—6—7—8—9—10

Encrypting data (scrambling) when communicated over the web

0—1—2—3—4—5—6—7—8—9—10

In general, for me, the choice of security setting of my electricity consumption information: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

My previous experience with using electricity feedback applications is: (0=is not important at all, 10=is very important for sure)

0—1—2—3—4—5—6—7—8—9—10

The level of my access to the internet using my desktop or laptop at home is: (0=is very low, 10=is very high)

0—1—2—3—4—5—6—7—8—9—10

The level of my access to the internet using my smartphone is: (0=is very low, 10=is very high)

0—1—2—3—4—5—6—7—8—9—10

The level of my access to the internet using my tablet is: (0=is very low, 10=is very high)

0—1—2—3—4—5—6—7—8—9—10

Focusing on environmental beliefs, for me: (0=is very low, 10=is very high)

In general, protecting environment is 0—1—2—3—4—5—6—7—8—9—10

My age is

My gender is

- Male
- Female

The country I was born in is:

The country I spent most of my adult life in is:

My highest educational level is

- Some school, none degree
- High school graduate
- Some college, none degree/college students
- Professional degree/2-year associate degree
- Bachelor's degree
- Master's degree
- Doctorate degree

APPENDIX E: Questionnaire (Essay 3)

Considering the **environment**, I believe (is not important at all=1,is very important for sure=10)

preserving nature	1—2—3—4—5—6—7—8—9—10
reducing pollution	1—2—3—4—5—6—7—8—9—10
protecting living creatures and plants	1—2—3—4—5—6—7—8—9—10

Considering the quality of tips in “How can I save more?” screen in iSaveElec, for me the tips were:

(not applicable at all=1, very applicable for sure=10)

1—2—3—4—5—6—7—8—9—10

(not relevant at all=1, very relevant to for sure=10)

1—2—3—4—5—6—7—8—9—10

the tips information was: (not of good quality at all=1, of good quality for sure=10)

1—2—3—4—5—6—7—8—9—10

Considering my iSaveElec goal for cutting electricity use, I:

(did not care about it at all=1, cared about it for sure=10)

1—2—3—4—5—6—7—8—9—10

(did not take it seriously at all=1, took it seriously for sure=10)

1—2—3—4—5—6—7—8—9—10

the level of my commitment to this goal was (very low=1, very high=10)

1—2—3—4—5—6—7—8—9—10

Based on the information provided in the "Me compared to others…" screen, the use of iSaveElec by most of my peers and classmates was:

(very low=1,very high=10) 1—2—3—4—5—6—7—8—9—10

(not likely at all=1,most likely for sure=10) 1—2—3—4—5—6—7—8—9—10

(not probable at all=1, very probable for sure=10) 1—2—3—4—5—6—7—8—9—10

For increasing my knowledge about the level of electricity consumption of other people like me, the information provided in the "Me compared to others…" screen was:

(not helpful at all=1,very helpful for sure=10) 1—2—3—4—5—6—7—8—9—10

(not valuable at all=1,very valuable for sure=10) 1—2—3—4—5—6—7—8—9—10

(not useful at all=1, very useful for sure=10) 1—2—3—4—5—6—7—8—9—10

For increasing my awareness about how much I consume electricity, the information provided in the "My consumption information & saving grade ..." screen was:

(not helpful at all=1,very helpful for sure=10) 1—2—3—4—5—6—7—8—9—10

(not valuable at all=1, very valuable for sure=10) 1—2—3—4—5—6—7—8—9—10

(not useful at all=1, very useful for sure=10) 1—2—3—4—5—6—7—8—9—10

I believe providing information about my electricity consumption to iSaveElec was:

(advisable for sure=1, not advisable at all=10) 1—2—3—4—5—6—7—8—9—10

I believe the provided information to iSaveElec will: (not be shared without authorization at all=1,be shared without authorization for sure=10)

1—2—3—4—5—6—7—8—9—10

I believe the provided information to iSaveElec will: (not be abused at all=1, be abused for sure=10) 1—2—3—4—5—6—7—8—9—10

I believe iSaveElec as a tool to help me save electricity is:

(not helpful at all=1, very helpful for sure=10) 1—2—3—4—5—6—7—8—9—10

(not valuable at all=1,very valuable for sure=10) 1—2—3—4—5—6—7—8—9—10

(not useful at all=1,very useful for sure=10) 1—2—3—4—5—6—7—8—9—10

I think that using iSaveElec is:

(a very bad idea=1,a very good idea=10) 1—2—3—4—5—6—7—8—9—10

(very foolish=1,very wise=10) 1—2—3—4—5—6—7—8—9—10

(a very unpleasant idea=1,a very pleasant idea=10) 1—2—3—4—5—6—7—8—9—10

When it comes to using iSaveElec by most people who are like me:

The likelihood is (very low=1,very high=10) 1—2—3—4—5—6—7—8—9—10

The probability is (very low=1,very high=10) 1—2—3—4—5—6—7—8—9—10

When it comes to using iSaveElec, the level of my:

skills is (very low=1,very high=10) 1—2—3—4—5—6—7—8—9—10

knowledge is (very low=1,very high=10) 1—2—3—4—5—6—7—8—9—10

confidence is (very low=1,very high=10) 1—2—3—4—5—6—7—8—9—10

During the last two months - relative to the expected interaction time with iSaveElec of 10 minutes per month, the extent of my :

interaction with iSaveElec was (very low=1,very high=10)

1—2—3—4—5—6—7—8—9—10

use of iSaveElec was (very low=1,very high=10)

1—2—3—4—5—6—7—8—9—10

time spent on iSaveElec was (very low=1,very high=10)

1—2—3—4—5—6—7—8—9—10

In the last two months, my electricity saving (did not increase at all=1, increased for sure=10) 1—2—3—4—5—6—7—8—9—10

In the last two months, my electricity bill was (not reduced at all=1,reduced for sure=10)

1—2—3—4—5—6—7—8—9—10

In the last two months, my electricity consumption was (not reduced at all=1, reduced for sure=10) 1—2—3—4—5—6—7—8—9—10

When it comes to my relationships with my peers and classmates, I feel that:

(they are not like me at all=1,they are like me for sure=10)

1—2—3—4—5—6—7—8—9—10

(they don’t understand me at all=1, they understand me for sure=10)

1—2—3—4—5—6—7—8—9—10

(we do not have close relationships at all=1,we have close relationships for sure=10)

1—2—3—4—5—6—7—8—9—10

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EDUCATION

Aug. 2014 Ph.D. Candidate in Management Information Systems (Minor in Strategy & Organizations), Sheldon B. Lubar School of Business, University of Wisconsin – Milwaukee (UWM).

Dissertation: "Three Essays on the Role of IT in Environmental Sustainability : Motivating Individuals to Use Green It, Enhancing Their User Experience, and Promoting Electricity Conservation"
Dissertation Chair: Dr. Fatemeh (Mariam) Zahedi

Feb. 2006 Masters of Business Administration (MBA), Lebanese American University.

Feb. 2004 Bachelors of Computer Science (with distinction), Lebanese American University.

RESEARCH AWARDS AND ACHIEVEMENTS

- International Conference on Information Systems (ICIS) Doctoral Consortium Fellow, 2013.
- 2013-2014: Roger L. Fitzsimonds Doctoral Scholarship, University of Wisconsin-Milwaukee. This scholarship is awarded to two doctoral students annually for excellence in research and scholarly activities.
- 2012: UWM Graduate School Travel Award. A highly competitive university-wide award, given biannually to students presenting their research in national/international conferences.
- 2012: Teaching Evaluations: 5.0/5.0 (Spring 2012).
- 2010-2011: Business Advisory Council Doctoral Scholarships. Awarded to two doctoral students annually for excellence in research and scholarly activities.
- 2004: Received the European Foundation Cash Award for Academic Achievements.

REFEREED CONFERENCE PRESENTATIONS & PUBLICATIONS

Albizri, A. and Ramamurthy, K. “IT Alignment: Different Firm Types, Different Alignment Configurations” *34th Proceedings of the International Conference on Information Systems-ICIS*, Milano, Italy, December 2013.

Albizri, A. and Zahedi, F. M. “Theory-based Taxonomy of Feedback Application Design for Electricity Conservation: A User-Centric Approach” *11th Proceedings of the Annual Pre-ICIS HCI Workshop,* Orlando, Florida, December 2012.

Albizri, A. and Zahedi, F. M. “Enhancing Trust Equity by Web-Design Elements that Manifest Pro-Environment Commitments” *7th Proceedings of* the *Midwest AIS Conference,* Green Bay, Wisconsin, May 2012.

Albizri, A. and Zahedi, F. M. “Green IT Behavior: Individual Beliefs and Antecedents,” in the *Pre-ICIS SIGGreen Conference,* St. Louis, Missouri, December, 2010.

INVITED TALKS AND DOCTORAL CONSORTIA

International Conference on Information Systems (ICIS) Doctoral Consortium, December, 2013, Milan, Italy.

Americas Conference on Information Systems (AMCIS) Doctoral Consortium, August, 2013, Chicago, Illinois.

BIG-10 Information Systems Symposium, 2013, University of Minnesota, Minneapolis, Minnesota.

TEACHING EXPERIENCE

University of Wisconsin - Milwaukee, Sheldon B. Lubar School of Business

Adjunct Faculty / Independent Instructor

Fall 2013- Spring 2014: Introduction to e-Business (BUS ADM 530 – Senior MIS course)

- This course introduces students to e-business models, technology and infrastructure, web languages, security, and social aspects of using the web for business activities.
- The highlight of this course is enabling students to develop a viable ‘Business Model,’ including a detailed business plan and a functional website prototype with a database.

Teaching Assistant

2009-2013: Introduction to Information Technology Management (BUS ADM 230)

- Instructed discussion sections for undergraduate students.
- Lead Teaching Assistant (2012): Facilitated curriculum transition to MS Office 2010 (developed new course materials and assignments for the discussion section) and led a team of five TA’s.
- Average Rating: 4.4 (out of 5).

Grader
2011-2013: Global IT Management (BUS ADM 535 – Online)

- Responsible of providing feedback and grading forums, technology assignments, deliverables, and papers.

SCHOLARLY SERVICE RESPONSIBILITIES

- Conference Reviewer: AMCIS (2011 and 2013) and ICIS (2013 and 2014)
- Conference Volunteer: DESRIST 2011 and AMCIS 2013
- President, MIS Ph.D. Academic Research Club, UW-Milwaukee 2010-2013

WORK EXPERIENCE

University of Wisconsin–Milwaukee
Research Assistant with Dr. M. Zahedi.(Jan 2014-May 2014)
Research project using web text mining and machine learning techniques for electricity load forecasting. (using R)
Research Assistant with Dr. A. Abbasi.(Aug. 2010-May 2011)
Data collection and data analysis for Fraud Detection models: Building specific fraud detection models by implementing clustering analysis, attribute evaluation, and classification algorithms. (tools used: Weka, Rapid Miner, R, JAVA)

BLOM BANK -– Beirut, Lebanon (June 2006 – July 2009)
Strategic Planning and Organization Officer
- Participated extensively in the development of business plans, financial models, and manuals (covering operations, compliance, risk, and corporate governance).
- Participated in IT systems selection and in the implementation project of a new core banking application for one of the bank's subsidiaries, including the requirements analysis, parameters definitions, and testing phases.
- Coordinated between various departments and the IT department regarding information system issues and prepared IT job requests.
- Assisted in the development of organizational structure/charts, job descriptions, process flows, and policies for the bank’s operations.