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# ASSESSING THE INFLUENCE OF PERSUASIVE SYSTEMS FOR SUSTAINABILITY ACROSS WORK-HOME- COMMUNITY BOUNDARIES

Jacqueline Corbett

*Laval University*, jacqueline.corbett@fsa.ulaval.ca

Sarah Cherki El Idrissi

*Laval University*, sarah.cherki-el-idrissi.1@ulaval.ca

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# ASSESSING THE INFLUENCE OF PERSUASIVE SYSTEMS FOR SUSTAINABILITY ACROSS WORK-HOME-COMMUNITY BOUNDARIES

*Research in Progress*

Corbett, Jacqueline, Université Laval, Québec, Canada, [jacqueline.corbett@fsa.ulaval.ca](mailto:jacqueline.corbett@fsa.ulaval.ca)

Cherki El Idrissi, Sarah, Université Laval, Québec, Canada, [sarah.cherki-el-idrissi.1@ulaval.ca](mailto:sarah.cherki-el-idrissi.1@ulaval.ca)

## Abstract

*Little doubt remains that human activities have contributed to climate change and environmental degradation over the past century. Humans must now alter their behaviours if the devastating consequences of climate change are to be avoided. To this end, persuasive systems for sustainability present a novel opportunity for encouraging environmentally responsible behaviours. This paper is part of ongoing research seeking to assess the influence of a persuasive system for sustainability deployed in one domain, such as a utility-sponsored energy conservation application, on individual behaviours within that domain, and also in other domains, such as at work or in the community. Here, we report on the development of measures to evaluate our constructs of interest, namely environmentally responsible behaviours at work, home and in the community, rebound effects, work-home-community boundary strengths, complexity of change and system characteristics of perceived persuasiveness and integration support. Through a process that included item creation, card sorting and exploratory factor analysis based on a survey of 168 participants, we have been successful in developing certain measures. Although still in progress, this work contributes to the Green IS literature by developing new measures and drawing attention to mechanisms for enhancing organizational and inter-organizational sustainability initiatives.*

*Keywords: environmentally responsible behaviours, persuasive systems, boundary theory, green information systems, cross-context.*

## 1 Introduction

Little doubt remains that human activities have contributed to climate change (IPCC, 2007) and environmental degradation over the past century. Humans must alter their behaviours if the potentially devastating consequences of climate change are to be avoided. The information systems (IS) community has taken up the sustainability challenge, with various authors calling for impactful research in this area (e.g., Malhotra, Melville and Watson, 2013; Watson, Corbett, Boudreau and Webster, 2012). The current research-in-progress responds to these calls by seeking to assess the influence of IS on individual environmental behaviours.

We approach this challenge from the perspective of persuasive systems. Persuasive systems are “computerized software or information systems designed to reinforce, change or shape attitudes or behaviours or both without using coercion or deception” (Oinas-Kukkonen and Harjumaa, 2008, p. 3) and are used unambiguously to change the beliefs or behaviours of their users (Fogg, 2003). Persuasive systems have been applied successfully in contexts such as personal health care (Chatterjee and Price, 2009; Lehto, Oinas-Kukkonen, Pätäälä and Saarelma, 2013; Nguyen and Masthoff, 2008), safety (Chittaro, 2012; Miranda, Jere, Alharbi, Lakshmi, Khouja and Chatterjee, 2013) and physical activity (Toscos, Faber, An and Gandhi, 2006). Persuasive systems have also been suggested as a means of

reducing energy consumption (Kjeldskov, Skov, Paay and Pathmanathan, 2012; Pierce, Schiano and Paulos, 2010; Shiraishi, Washio, Takayama, Lehdonvirta, Kimura and Nakajima, 2009) and Shevchuk and Oinas-Kukkonen (2016) suggest that the persuasive systems design model holds a great potential for encouraging environmental behaviours. However, a number of factors, including the selection of design principles (Shevchuk and Oinas-Kukkonen, 2016), the specific nature of user goals and perceptions (Ebermann and Brauer, 2016) and context awareness in regard to location and users' personalities (Anagnostopoulou, Bothos, Magoutas, Schrammel and Mentzas, 2016), may influence the effectiveness of a persuasive system in achieving its intended behavioural changes.

The current research represents a continuation and extension of this research stream. In an earlier phase of the research (Corbett and Cherki El Idrissi, 2015), we developed a conceptual model proposing that the use of a persuasive system for sustainability (PSS) in one domain (e.g., at work) will not only influence an individual's environmentally responsible behaviours (ERBs) in that domain, but also in another domains (e.g., at home). This overarching hypothesis is based on the theory of spillover effects. Spillover effects, which occur when attitudes and behaviours in one area affect actions in other areas (Muster and Schrader, 2011) have been identified in the context of environmental behaviours (Cambra-Fierro, Polo-Redondo and Wilson, 2008; Corbett, 2013a). We further postulated that the perceived persuasiveness of the PSS, integration support, complexity of the target change in behaviour and the boundary strength between the domains would moderate the relationship between PSS use and ERBs. A simplified version of the model is presented in Figure 1.

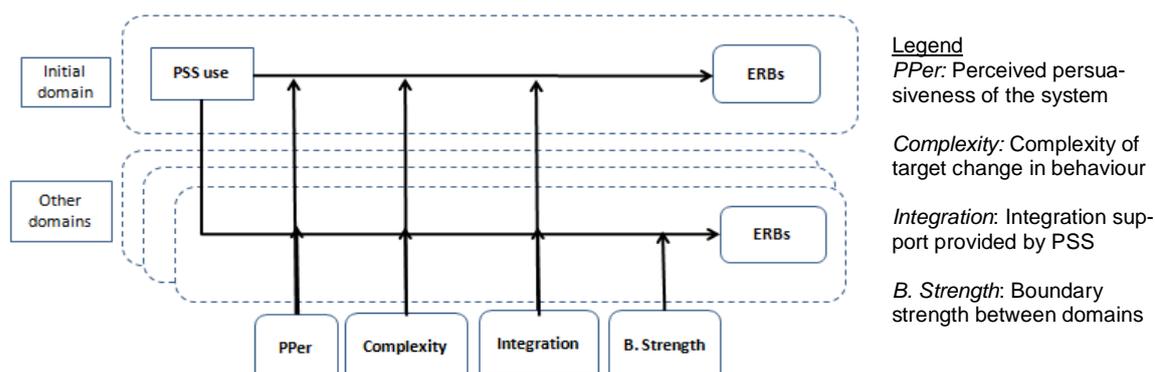


Figure 1. Model of Persuasive Systems for Sustainability across Domains (adapted from Authors, 2015)

In order to quantitatively test the model, it is necessary to develop appropriate measures. This paper reports our preliminary results in this regard. In the next section, we define the main constructs of interest. Then, we describe our methodology for construct development, followed by the results of the exploratory factor analysis. We conclude with a brief description of the contributions of this work.

## 2 Conceptual Definition of Constructs

### 2.1 Persuasive System Use

Information system use has received much attention in the IS literature and has been conceptualized in different ways. In this research, we define use as the way an individual user employs features of a system for a specific goal or task (Burton-Jones and Straub, 2006). To be consistent with previous persuasive systems research, we measure PSS use through duration of use, frequency of use (Lehto and Oinas-Kukkonen, 2015), and extent of use adapted from Afonso et al. (2014), percentage of system functionality used. As these are fairly well-accepted measures for IS use, we did not include this construct in our item development process and do not elaborate on it further in this paper.

## 2.2 Environmentally Responsible Behaviours and Rebound Effects

As noted above, our main dependent variable is ERBs, which are actions taken by individuals or groups to alleviate their adverse environmental impacts (Lee, Jan and Yang, 2013). Despite variations in terminology, the literature on ERBs focuses on two main groups of ERBs: those performed in the work domain and those performed within the personal domain. Drawing from work on organizational citizenship behaviours (Organ, 1988), ERBs in the workplace are defined as optional uncompensated acts by employees within the organization that are directed toward environmental enhancement (Daily, Bishop and Govindarajulu, 2009). Workplace ERBs represent actions taken by employees to improve the environmental performance of the organization (Ramus and Steger, 2000), including behaviours such as conservation of resources, recycling, pollution prevention, and advocacy for environmental change (Russell, 2007). On the other hand, all sustainable behaviours that relate to daily consumption practices at home and community are considered personal ERBs and represent patterns of a ‘sustainable lifestyle’ (Barr, Gilg and Shaw, 2011). In this research, we further differentiate between ERBs performed within the private confines of one’s home and those performed more publicly within the community. Community ERBs represent individuals’ activities within another social sphere, which makes it valuable to investigate in the context of PSS. Recent studies have suggested that community level ERBs have important impacts on environmental lifestyles decisions (Dresner, Handelman, Braun and Rollwagen-Bollens, 2015; Kahn, 2007).

In addition to evaluating positive behavioural changes that occur as a result of using a PSS, we wish to examine whether there are also negative impacts, in particular, rebound effects (Sorrell, 2009). Rebound effects occur when savings arising from a particular activity (e.g., increases in fuel efficient vehicles) paradoxically result in increased consumption (e.g., more driving) that offsets the savings. This construct was not included in our initial conceptual model (Figure 1), but research suggests that interventions to encourage ERBs may result in rebound effects (Corbett, 2013b; Hertwich, 2005).

## 2.3 Intervening Variables

### 2.3.1 Perceived Persuasiveness and Integration Support

For the first two intervening variables, we consider characteristics of the PSS itself: its perceived persuasiveness and its level of integration support. Perceived persuasiveness is the ability of a person or a system to affect one’s behavioural intentions (Magee and Kalyanaraman, 2010). Implementing various persuasive design principles can enhance individual’s subjective evaluation of the system’s persuasiveness (Lehto, Oinas-Kukkonen and Drozd, 2012), thereby increasing the chances of behavioural modifications.

A second characteristic that may influence the effectiveness of a PSS is the level of integration support provided by the system. This is a new persuasive design category that emphasizes the ability of a PSS to link with other systems within or outside the sponsor organization (Corbett, 2013a). Considering that we are interested in examining cross-context influence of PSS, this design category is of particular interest in our research.

### 2.3.2 Complexity of Change

The complexity of change construct represents the difficulty associated with behavioural changes according to the nature, duration and frequency of changes (Fogg and Hreha, 2010). It has been used in models of behaviours, such as the Theory of Planned Behaviour (Ajzen, 1985), and theories of change, such as the Framework for Environmental Education (Monroe, Andrews and Biedenweg, 2008). Previous research suggests the target behavioural changes of persuasive systems can range from the adoption of new behaviours or attitudes to the cessation or modification of other habits and behaviours (Oinas-Kukkonen, 2013). Recognizing that a PSS may target different behaviours having different levels of complexity, we suggest this may be a relevant intervening variable for understanding the effects of a PSS both within its given domain and across domains.

### 2.3.3 Boundary Strength

Individuals assume many different roles in their lives, such as consumer, citizen, employee and family member. This multiplicity of roles requires that individuals create boundaries (Clark, 2000; Nippert-Eng, 1996) in order to keep each domain protected, while having the possibility to cross them when required (Ashforth, Kreiner and Fugate, 2000; Barnett and Baruch, 1985). Boundaries define the perimeter and scope of a domain (Sayah, 2013). This conceptual line of demarcation determines the contrast between two spheres (Ashforth et al., 2000) and defines the point at which domain relevant behaviours begin or end (Clark, 2000). The potential for spillover effects, both positive and negative, between domains (Williams and Alliger, 1994) is linked to the need to maintain consistencies in individual convictions, disposition, practices and identities (Thøgersen and Ölander, 2003; Whitmarsh and O'Neill, 2010). In this study we consider three domains – work, home and community – and thus three boundaries – work-home, work-community, community-home.

The literature related to the work-home boundary is well established. For example, Clark's (2000)'s border theory includes a detailed framework of psychological and physical boundaries between work and family. In contrast, only few scholars have studied community boundaries. Dresner et al. (2015) included an evaluation of community ERBs in an attempt to understand spillover effects that might create a loop of urban resiliency, while Kahn (2007) found that environmentalism at the community level impacts private transportation choices.

Across the boundary research, there is a consensus that boundaries exist on a continuum characterized by degree of integration and segmentation (Ashforth et al., 2000; Clark, 2000; Nippert-Eng, 1996). Low boundary strength allows for easy and frequent cross-over between domains, whereas, high boundary strength results in little or no transference (spillover) between the domains.

## 3 Methodology

To support testing of the model, we undertook to develop measures for ten new constructs (Table 1). The process included three major stages as suggested by Moore and Benbasat (1991) and Lewis et al. (2005). The first stage, item creation, focused on establishing the domain of the idea (Lewis et al., 2005) and aimed to create pools of items identified via existing scales and by creating items that fit the construct definitions. The second stage focused on instrument construction (Lewis et al., 2005) and scale development. For this we used a card sorting exercise to gain feedback on the instrument as well as to group items and eliminate any ambiguities in wording. The third stage involved a preliminary evaluation of the measurement properties of the instrument (Lewis et al., 2005). As described below, we used the instrument to collect data from 168 respondents and conducted exploratory factor analysis, created factors and calculated Cronbach Alpha to assess internal reliability.

### 3.1 Item creation

A comprehensive literature review was completed to define the constructs and identify an initial list of items. Generating items that cover the domain of a construct determines the validity and reliability of an instrument (Churchill Jr, 1979). Where we were unable to find appropriate measures in the literature, we adapted or developed items that we believed captured the meaning of the construct.

### 3.2 Scale development

After developing the items, we conducted a card sort to improve content validity of the new items (Fidel, 2000). For this stage, we recruited twelve individuals through our personal and professional networks, which included professors and doctoral students in the IS field. Each participant was sent an email with an excel file including descriptions of nine constructs (Table 1) and the 85 items we had created for these constructs. The items for perceived persuasiveness were not included as they relate to a particular system and would have been confusing for the card sort participants. The participants were asked to read a description of each construct and then assign each item to a single construct. Once the

completed excel files were returned, we calculated the level of agreement for each item. We considered a level of agreement of greater than 50% satisfactory at this stage. Thirteen items were removed because of low agreement and one was eliminated due to duplication. Based on participant feedback certain items were revised to eliminate ambiguities of the measures.

Construct	Item sources	Included in card sort?	Number of items in survey	Number of items retained	Cronbach's Alpha
PSS use	Lehto and Oinas-Kukkonen (2015), Afonso et al (2014)	No	4	4	N/A
Perceived persuasiveness	Adapted from Lehto et al. (2012)	No	2	5 (perceived persuasiveness and integration support) or 9	5-item: .893 9-item: .930
Integration support	Self-developed based on Corbett (2013a)	Yes	3		
Complexity of change	Self-developed based on Oinas-Kukkonen (2013)	Yes	4		
Boundary strength: Work-Home	Hecht and Allen (2009)	Yes	14	2 new constructs: HomeToWork (7) WorkToHome (5)	HomeToWork: .935 WorkToHome: .859
Boundary strength: Work-Community	Self-developed	Yes	6		
Boundary strength: Home-Community	Self-developed	Yes	7	7	.903
ERBs home	Adapted from Lee et al. (2013)	Yes	10	9	.912
ERBs work	Adapted from Boiral and Paillé (2012)	Yes	11	7	.903
ERBs community	Adapted from Lee et al. (2013)	Yes	6	6	.816
Rebound Effects	Self-developed	Yes	10	10	.973

Table 1. Constructs Under Development

### 3.3 Instrument Testing

Following the card sort, we created an instrument with 73 items (including perceived persuasiveness, but excluding use and other demographic and control variables). Each of these were evaluated on a 7-point Likert scale with one being “strongly disagree” and 7 being “strongly agree”. Seven items were reverse-worded. Prior to analysis, the values of these items were appropriately adjusted.

Initially the questionnaire was built on the SurveyMonkey platform and invitations to participate were emailed to approximately 75 personal acquaintances and former students of an MBA introductory IS course. From this recruitment effort we received 18 completed surveys. Recognizing the need for a larger sample, we engaged with Qualtrics to recruit participants who were over 18 years old and had used an IS (e.g., a website or a mobile application) offered by their employer, community or utility company with a view to adopting ERBs. Online survey panels, such as that offered by Qualtrics, have been used in IS research have been found to provide reliable data (O’Leary, Wilson and Metiu, 2014). Qualtrics contacted qualified individuals within their research participant pools (in the United States and Canada) until the desired number of responses was achieved. Participants split evenly between users of employer-sponsored PSS, community-sponsored PSS and utility-sponsored PSS. From this phase, we received 150 completed surveys, for a total of 168 surveys.

In addition to quality assurance checks implemented during the survey administration, we performed additional data quality assessments, including screening for answering patterns, time to completion and response outliers for all 168 responses. This led to the exclusion of 14 responses, resulting in a total of 154 valid responses for the exploratory factor analysis.

### 3.3.1 Profile of Survey Participants

Most survey participants were experienced PSS users with a full third (33.8%) using the system for over a year, and 18.8% using the system for 6 to 12 months. There was substantial variation in the frequency of use: 15% reported using the system on a daily basis, 9.7% used it weekly, 23.4% monthly, and 22.7% of participants reported using the system less than once per month. In terms of time of use, more than two-thirds (71.4%) of participants used the system for less than 30 minutes per visit, 35.7% spent 15 to 29 minutes per visit and 35.7% less than 15 minutes per visit. With respect to functionality used, 28.6 % of participants reported using 25-49% of the system's functionality, while 21.4% used 10-24%, and 20.8% reported using 50-75% of the system's functionality.

### 3.3.2 Exploratory Factor Analysis

Prior to conducting EFA, we performed typical tests for data normality in SPSS using numerical and graphical methods. Numerical methods adopted for this study included skewness and kurtosis values. The graphical methods used normal Q-Q plot and histograms. Normality assessments showed that most items were normally distributed. A few items had negative skewness or negative kurtosis. We used a 'reflect and logarithmic' transformation to correct the normality where appropriate.

Factor analysis is a statistical tool to uncover the latent dimensions of a set of variables. It reduces a large number of variables to a smaller number of factors (Fidel, 2000). Taking into account the recommendations of Lewis et al. (2005) and Boudreau et al. (2001), we conducted a number of preliminary tests to assess the suitability of our data for EFA. Inspection of the correlation matrix showed that all variables had at least one correlation coefficient greater than 0.3. The overall Kaiser-Meyer-Olkin (KMO) measure was above 0.8 with individual KMO measures all greater than 0.7, classifications of 'middling' to 'meritorious' according to Kaiser (1974). Bartlett's test of sphericity was statistically significant ( $p < .0005$ ), indicating that the data was likely factorizable (Lewis et al., 2005). We used Varimax orthogonal rotation to aid interpretability. After examining the results of EFA we created factors and calculated scale reliability using Cronbach Alpha.

## 4 Results

To simplify the EFA and consistent with our theoretical distinctions, we conducted the EFA in two groups. The first group included the dependent variables (ERBs with rebound effects) and the second group was composed of the other intervening variables.

### 4.1 Environmentally Responsible Behaviours and Rebound Effects

The EFA for the dependent variables revealed six components that had eigenvalues greater than one and which explained 76.54% of the total variance. Visual inspection of the scree plot indicated that four components should be retained. In addition, a four-component solution met the interpretability criterion. As such, four components were retained for this group. The four-component solution explained over 70% of the total variance. In reviewing the solution, we noticed that a number of items had negative loadings or cross-loaded, particularly with the construct of Work ERBs. Although these items were adopted from existing measures, we speculate that these challenges may have arisen as a result of our attempt to differentiate between work, home and community ERBs, which is an extension of prior work. We decided to remove these items in order to create the four factors. All four demonstrate good internal reliability with Cronbach Alphas in excess of .816 (see Table 1).

## 4.2 Intervening Variables

For the second EFA, we included the 36 items related to the six intervening factors. The initial EFA produced a solution with seven factors with eigenvalues greater than one and explaining 73.17% of the total variance. However, visual inspection of the scree plot indicated that only five components should be retained. Rerunning the EFA with the constraint of five factors returned a solution that appeared to be a 'simple structure': most items loaded strongly on only one component and each component comprised at least three items. To build the factors, we retained items that had loadings above 0.5 as we consider it an acceptable level at this stage of the research.

Examining the results more closely, we made three general observations. First, we noticed that the factors that emerged with regard to boundary strength were not consistent with our expectations. This is discussed further below. Second, the results of the EFA suggested no differentiation between three constructs of perceived persuasiveness, integration support and complexity of change. This is perhaps not surprising, given that many of these items were newly created. Again, we discuss this further below. Third, the EFA returned a fifth factor of five items that we have not been able to theoretically justify. This factor included the reverse worded items. We included these items in our questionnaire in order to remove potential effects of response biases as suggested by psychometricians to balance Likert multi-item scales. We also reverse coded them in the analysis phase to ensure consistency of scores meaning. However, research has shown that when subjected to factor analysis, these items tend to load on a separate factor (Wong, Rindfleisch and Burroughs, 2003). At this stage of the research we have decided to exclude these items pending additional analyses.

### 4.2.1 Boundary Strength

As expected, three factors emerged with respect to boundary strength; however, these do not align with our intended constructs of work-home, work-community and home-community boundary strengths. Although measures for work-home boundaries exist in the literature, we attempted to create items that would differentiate between the three spheres. For instance, for work-home boundary strength, we created an item "*I often schedule personal activities (e.g., exercise or reading) during working hours*", whereas for the work-community boundary we created an item "*I often talk about community issues with my work colleagues*". Despite the wording differences, it appears that the community domain may not be as salient or differentiated from the home domain as we theorize it. Instead, individuals may largely see the division as one between 'work' and 'personal'. As our research aims to understand the spillover effects across multiple domains, further investigation in this area is warranted.

In relation to the work-home/community boundary, the EFA returned two components. The first seems to relate to personal activities (including both home and community-related activities) imposing on the work situation. Items include for example: "*I often spend time communicating with friends and family during working hours*" and "*I often attend community events during working hours*". In contrast, the second factor seems to relate to work imposing on the personal domain. Items loading on this factor include items such as "*I frequently receive work-related correspondence at home*". The emergence of these two factors is less surprising when viewed in light of research suggesting the influence across domain boundaries is not symmetrical. For example, work tends to influence (or interfere with) family more than family influences (or interferes with work) (Golden, 2013; Keeney, Boyd, Sinha, Westring and Ryan, 2013). Taking this into account, we created a 7-item measure for called 'HomeToWork' with a Cronbach Alpha of .935 for the first factor and a 5-item factor called 'WorkToHome' with a Cronbach Alpha of .859 for the second.

Despite the blurring between home and community in relation to their boundaries with work, the fourth component to emerge was consistent with our conceptualization of home-community boundary. The resulting 7-item shows strong internal reliability with a Cronbach Alpha of .903.

#### 4.2.2 Perceived Persuasiveness, Integration Support and Complexity of Change

The fourth factor to emerge from the EFA for intervening variables included all nine items related to perceived persuasiveness, integration support and complexity of change. Theoretically, it makes sense that the level of integration support and the personal relevance of the system would be related and could collectively provide a measure for the perceived persuasiveness of the PSS. We have somewhat more difficulty making the theoretical link between the complexity of change that is targeted by the PSS and the perceived persuasiveness of the system. If we exclude those four items for theoretical reasons, we can create a 5-item measure for perceived persuasiveness with a Cronbach Alpha of .893.

Taking an alternative perspective, based on our understanding of the literature, we operationalized complexity of change in terms of the goals of individual using the system. It may be that our operationalization was not appropriate, or that the goals of using the system (and the related complexity of the desired change behaviours) are interconnected with how users perceive the persuasiveness of the system. From this perspective, a measure including all 9 items (Cronbach Alpha of .930) could be appropriate.

## 5 Conclusion and Future Work

In this paper, we report our efforts to create and validate a set of measures that will allow us to assess the influence of PSS across three domains: work, home and the community. As such, this work enhances our understanding of how innovative use of IS can help to effect voluntary behavioural changes. While we were successful in developing certain measures, some challenges remain. For instance, reliable measures were developed for the dependent variables (i.e., ERBs, rebound effects), which will allow us to better measure the impacts of persuasive systems. The results for intervening variables were more equivocal. Although perceived persuasiveness (Lehto et al., 2012), integration support (Corbett, 2013a) and complexity of change (Oinas-Kukkonen, 2013) are defined in the literature and have a certain theoretical appeal, their operationalization remains somewhat elusive. There are a number of possible explanations for these results, including poorly worded or unclear items, data quality issues or lack of theoretical clarity. It is also important to note that the research relies on self-reported measures and there was no control over type of PSS used by the participants. Accordingly, there may be inconsistencies in terms of objectives and design characteristics of the different systems used. Our ongoing research will focus on resolving these issues. In addition, we intend to collect additional data which will allow us to evaluate the proposed theoretical model.

Despite the early stage of this research, there are three notable contributions of this work. It extends scholarship related to persuasive systems for sustainability by introducing the idea that persuasive systems can have impacts beyond the specific domain in which they are implemented. Not only is this interesting theoretically, but it also has practical relevance as diverse organizations develop initiatives to encourage their stakeholders to make more environmentally responsible choices. Second, we provide validated measures (available from the authors upon request) for assessing both positive (ERBs) and negative effects (rebound effects) associated with PSS. A third contribution (albeit still in development) is the disentanglement of behaviours occurring within the private home and more public, community domains. In doing so, we hope to extend the rich boundary literature en route to better understanding how boundaries between multiple domains affects enhances or impedes ERBs.

Rising to the challenge of climate change requires that we make conscious and responsible decisions in every domain of our lives. We believe that persuasive systems for sustainability can be part of the solution and we hope that our research will have a positive impact on making that happen.

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