Acceptation of a Demand-response Enabling Technology for using Electricity at Home upon a Simulated Marketing Campaign

Role of Sociodemographic Variables and Prior Energy Behaviors, in Tandem with Expectations and Attitudes Formed to the Message Target

Maria São João Breda[1] and Marta Lopes[2,3]

[1]*Institute of Cognitive Psychology, Faculty of Psychology and Educational Sciences, University of Coimbra, R. Colégio Novo, 3001-802 Coimbra, Portugal*

[2]*Dept. of Environment, ESAC - Polytechnic Institute of Coimbra, 3045-601 Coimbra, Portugal*

[3]*INESC Coimbra, Rua Antero de Quental 199, 3000-033 Coimbra, Portugal*

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Abstract: The present work addresses the usefulness of IT acceptance frameworks for studying consumers' adoption intentions upon learning of a new technology described as affording demand-response and energy conservation at home. A survey study was conceived which relied on the exposure of respondents to a marketing campaign for this technology. In preceding steps *Theory of Planned Behavior* and *Technology Acceptance Unified Theory* were applied to adequately model and test predictive relations upon intention to adopt that technology and upon expectation of remaining with known methods that compete with the technology, with a Partial Least Squares structural modeling approach. Results suggest that the frameworks are useful for predicting intention to adopt this type of technology. Especially important predictors were *Effort Expectancy, Social Factors* and *Positive Attitudes*. Given validation of the nomological network, the goal is to comprehensively integrate differences in adoption across socio-demographic strata and tied to consumers' energy behaviors with the structural network linking IT predictors to dependents.

1 INTRODUCTION

The present work complements a study on the applicability of Information Technology (IT) acceptance models Theory of Planned Behavior (TPB) (Fishbein and Ajzen, 2005) and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) to the understanding of residential consumers' response, in terms of intention to adopt a technological proposal for energy efficiency and for demand-response to dynamic tariffs, in the context of a simulated marketing campaign. Empirical support for the applicability and usefulness of these frameworks for predictive purposes was obtained from questionnaire data, i.e., from self-reported perceptions of the message conveyed in the campaign, through building and testing measurement and structural models which model adoption intention, and expectation of continuing to use known methods alternative to the technology, as a function of a set of expectations, attitudes, affect and social factors.

Two alternative models were developed and tested, differing in the operationalization of attitude. The dependent variables were intention to adopt and expectation of remaining with known methods that compete with the technology. Predictors contemplated positive and negative attitudes (bidimensionality), performance and effort expectancies, social factors, and perceived behavior control.

The present study draws on positive evidence on the usefulness of the nomological network with its associated blocks of indicator variables, and inspects the role of consumer variables, e.g. socio-demographic and prior energy behaviors, posited to work in tandem with the cognitive-affective ones. Gender and age have been found to draw associated differences in adoption intention for technology in workplace in the United States. Are they to be found in regard to this particular technology, in a

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Portuguese sample? If so, is the structural model proposed also useful to understand or represent processes whereby such adoption differences build across groups of respondents, or are these independent effects (via other social, cognitive and/or behavioral processes)? If they are not independent, do the predictors and structural links in the model convey groups' differences (mediating effect), or is it necessary to differentiate the importance of specific predictors according to groups of respondents (moderation effects)?

Energy behaviors are an important subject matter in sustainability studies (Lopes et al., 2012). In light of the concept of "Intelligent efficiency" (Elliott et al., 2012) energy behaviors become challenged by becoming more involved with technology systems. This is increased with the 'Smart grid', and Demand Response initiatives, (Santacana et al., 2010). These behaviors belong to multiple types (Black et al., 1985); (Stern, 2000) e.g., investment in efficient equipment and whether and how they may impact the willingness to acquire or use automating technology is unknown. Prior energy behaviors of respondents are likely to affect their acceptation intention but they may do so through different processes represented in alternative attitude-behavior or behavior-attitude theories. Moreover given the multiplicity of energy behaviors and their potential similitude to one or the other conative variables (*adoption intention*; *expectation to remain with known methods*), various hypotheses are studied.

Energy behaviors involving technology, similar in that regard to *adoption intention*, may enhance *positive attitude towards adoption*, according to behavior-attitude theory, and thus promote *intention to adopt*. Alternatively, behaviors similar to adoption may strengthen certain heuristic processing such that considerations on the cost or easiness of behavior enactment rather than the considerations on outcomes probabilities become more salient (Kidwell & Jewell, 2008).

2 REVISION OF IT ACCEPTANCE LITERATURE

The Attitude-behavior concepts pertaining to TPB (Fishbein and Ajzen, 2005) have been successfully applied in multiple behavioral domains (Armitage and Christian, 2003), including the energy realm when expanded with personal norm (Abrahamse and Steg, 2009); (Gadenne et al., 2011) pro-environmental behavior (Oreg and Katz-Gerro, 2011), as well as IT acceptation in the workplace (Taylor and Todd, 1995). IT acceptance studies have highlighted the role of users' attitudes and beliefs about the technology as antecedents of acceptance versus rejection, and the importance of understanding the factors that motivate or hinder those attitudes. Acceptance refers to the willingness of a potential user, with some degree of choice, to intentionally employ a technology for the purposes or tasks it was conceived for (Dillon, 2001). A change in measurement paradigm towards expectations/ appraisals referring to spheres of experience (utilitarian, experiential, and enjoyment) underlies Technology Acceptance Model and Decomposed TPB (Davies et al., 1989); (Bagozzi et al., 2002). Framework for measurement of users' perceptions and attitude by operationalization of core constructs after revision of the literature has been proposed by Venkatesh et al., (2003). The UTAUT was based upon seven different models of technology acceptance.

As a novel application of IT acceptance literature, studying the intention or willingness to adopt automation technology for energy efficiency, in the context of transitioning to smart grids, and ensuing dynamic tariff policies for demand-response (Livengood and Larson, 2009), implied conducting a survey, and, subsequently, modeling the adoption response, by broadening the scope of the variables, both the dependent variables and attitudinal ones. Table 1 summarizes the constructs of TPB and UTAUT in IT studies for the prediction of intention under circumstances of little experience with the technology, and illustrates how constructs were operationalized in our study.

2.1 Respondents, Preceding Steps and Results

Respondents were 504 members from a marketing panel from the center region of Portugal. They were eligible to the survey if their educational level was the 12th grade and if they paid their own electricity bill. Sixty two percent (311) were women, age ranged from 25 to 60 years old (mean of 33.5 and standard deviation of 7.2); educational level was balanced across the two levels (54% had higher education). The sample was then randomly divided into two halves, for exploratory factor and confirmatory Partial Least Squares analyses (PLS).

The (future) smart grid context was presented to respondents highlighting its purpose of efficiency, peak reduction, and environmental protection. The technology concept was introduced in terms of tasks

Table 1: Constructs and findings regarding TPB and UTAUT and the adapted operationalization in our survey. Adapted from Venkatesh et al., (2003a).

Theory Concepts	Definition	Operationalization (examples)	Operationalization adaptation for our study (examples)
TPB			
Attitude towards behavior	"an individual's positive or negative feelings (evaluative affect) about performing the target behavior" (Fishbein & Ajzen, 1975)	Global evaluative ratings	(cf. infra) plus Beliefs: *"By adopting the EnergyBox at home, when the Smart Grid exists, I will contribute to the reduction of the greenhouse effect emissions to the environment"; "By adopting this device at home, I will contribute to reduce the grid consumption peaks"; "Using the EnergyBox at home will allow me to increase the habit of saving energy and money"*
Subjective Norm (S.N.)	"The person's perception that most people who are important to him think he should or should not perform the behavior" (Ibid)	"People who influence my behavior think I should use the system"	"*People who are influent to me will think that I ought to adopt this type of device"*
Perceived Behavior Control (P.B.C.)	"The perceived ease or difficulty of performing the behavior (Ajzen, 1991); "Perception of internal or external constraints on behavior" (Taylor & Todd, 1995); Relates to self-efficacy, and facilitating conditions regarding resources, as well as regarding the technology	"Given the resources, the opportunities and knowledge necessary, it will be easy for me to use the system";	*"Using this device will take too much time, considering all I have to do"*
UTAUT			
Performance Expectancy (PE)	"the degree to which an individual believes that using the system will help him or her to attain gains in job performance". It integrates constructs of: perceived usefulness (TAM), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT), and outcome expectations (SCT) .	"I would find the system useful in my job" "Using the system enables me to accomplish my tasks more quickly"	"*At home, using a monitor to keep track of the domestic electric consumption will allow me to save energy and money*"; "*At home, if I use the Autonomous Decision aid I will probably be able to displace the consumption to whenever the energy is cheaper*": "*Even when using the Smart Grid, I trust my own ability to place the consumption times to whenever electricity is cheaper or more available at home, by myself, without the help of the Autonomous Decision aid*"
Effort Expectancy (EE)	"The degree of ease associated with the use of the system" encompassing: perceived ease of use (TAM), complexity (MPCU), and ease of use (IDT)	"I would find the system ease to use" "Learning to operate the system is easy for me"	*"It will be easy to learn how to use the EnergyBox monitor to check consumptions"; "When adapting to the Smart Grid, it will be easy to learn how to use the EnergyBox"*
Social Influence	"the degree to which an ind. perceives that important others believe he or she should use the new system" and relates to constructs of: S.N. (TPB), social factors (MPCU), and image (IDT)	"People who influence my behavior think I should use the system"	*"People from my group of colleagues and friends who use the EnergyBox will have a higher social status than the ones who don't"*
Attitude towards using technology	Positive feelings about performing the behavior; Reflects constructs of: Attitude towards behavior (TPB), Intrinsic Motivation; Affect towards Use; and Affect.	"Using the system is a bad/ good idea" "The system makes work more interesting"	*"Adopting the EnergyBox is a good idea"; "Adopting the E. in a context of Smart Grid is a wise idea"; "I will grow bored of using this type of device"; "It will be hard for me to accept that the Autonomous Decision aid is in charge of the use of electricity at home"; "With the E., managing the expenses at home will be more interesting"*
Behavioral Intention (BehvIntent Expc)	A self-generated instruction to perform an action, "behavioral plan making possible the achieving of a behavioral goal" (Ajzen, 1986)	I intend to use the system in the next () months	*"I intend to be one of the first people to install and use the device"; "I can foresee that I will use this device as soon as it is available"* *"I think I will use more or less the methods I already use, without any specific devices, in electrical consumption*"

to meet in demand-side initiatives and price policies. The message and the survey followed the principles of the Utilitarian Information and Persuasive Communication. The survey was constituted by sets of questions dealing with socio-demographic information, residence and electricity consumption and behaviors; adoption of the technology under the current and future smart grid, anticipated feelings to monitoring and to using automated decision aids.

Measurement and structural models' tests were performed with PLS path modeling, employing SmartPLS version 2.0.3. (Ringle et al., 2006). Adjusted models aimed at explaining dependent variables of adoption intention (*BehvIntenExpc*), and also resistance to adoption, e.g., expectations of keeping using the methods already known to manage electricity consumption at home (*Pessim_AltMethods*). The models recognized the bidimensionality of the attitudinal concept, making place for positive and negative attitudes towards adoption. Two models were developed and adjusted, and simplified versions with only higher magnitude path coefficients were retained. The first comprises as predictors variables of *Effort Expectancy, Social*

Image and Performance Expectancy, as well as two attitudinal variables with different valences that partially overlap conceptually with *Performance Expectancy*, and are understood as a compound of respectively, *positive, and negative, affect and expectancy*, and, lastly, a variable of *valuations of outcomes of conserving electricity*. The second model (Fig 1) aimed at achieving a higher discrimination between expectancy and attitudinal blocks of items. It operationalized attitude as anticipated emotions to performing behaviors implied in the technology's functionalities, namely, checking on overall and detailed electricity consumptions with a monitor; and relying on an automated decision system to schedule and set in functioning the equipment at home. Otherwise, it was similar to the first model.

Estimation and evaluation of the measurement component of the models afforded psychometrically good measures. The two structural models displayed adequate predictive capacity globally and upon selected endogenous, by criteria of coefficient of determination R^2, R^2 change and cv-redundancy. They converge in the pattern of results regarding prediction of both variables. In the prediction of *Adoption Intention*, three expectations factors about spheres of experience with technology are important: *EE, S.I.; and also P*ositive *affect anticipated to the behaviors*. In predicting *expectations of using already known methods that are alternative to the technology*, the major explanatory factor is *Negative Attitude/Negative Affect;* and *Perceived Behavior Control*.

3 SOCIODEMOGRAPHIC DIFFERENCES

3.1 Research Goals and Hypotheses

The effects of gender and age (Venkatesh et al., 2003a; b); (Venkatesh and Morris, 2000); (Venkatesh et al., 2000) and of prior experience with technology, are addressed within IT acceptance studies. They have been addressed in terms of moderator effects, i.e., group differences in variations in importance of the different factors or predictors that contribute to adoption. Within the framework of TAM (Venkatesh et al., 2003b); (Venkatesh and Morris, 2000), it has been found that men had their intention to adopt more closely associated to Perceived Usefulness (a Performance Expectancy factor); and women to Perceived Ease of Use (Effort Expectancy variable). Under the contingency that experience was low, Subjective Norm was more salient for women (Venkatesh et al., 2003b). In our study experience can only exist with other technology, e.g. with employing other programming devices, experience is assumed to be low by default. Within TPB model, Venkatesh et al., (2000) suggested that *Attitude* was more important to men, and *SN* and *PBC* more for women when experience is low. Regarding age, it was found that younger workers had *Attitude* contribute more to adoption intention, and older workers, *PBC*. *SN* was more important for older women (Venkatesh et al., 2003b).

3.2 Analysis and Results

Moderator analysis for gender and for age relies on multi-group analysis (PLS_MGA), wherein our choice was to employ the parametric approach (Keil et al., 2000, cit in Hair et al., 2014). In the case of age, the variable was discretized into 3 categories: from 25 to 30 years old (212 respondents); higher than 30 but below 41 years of age (215respondents), and over 40 years up to 60 years of age (77 respondents).

Gender (being of female as opposed to male gender) did not have a significant impact in adoption intention (structural path coefficient beta = -0,038; bootstrapping asymptotic t=0,71), nor in expectation to keep with old methods (beta= 0,067; t=1,097).

For moderation analysis, the procedure was to perform separate estimations for each group, followed by a modified version of a 2-independent samples t-test, to compare path coefficients across the 2 groups of data. T test provides the statistical significance of the difference between the two groups' path estimates.

With a simplified model, retaining only one dependent variable (*Adoption Intention*) we find male respondents compared to female respondents give higher importance to *Performance Expectancy of the technology* in forming *Intention to adopt* (betas for the two groups respectively of 0,205 [t=2.38] and 0.116 [t=2.01]) and in *PBC* (betas respectively of 0.314 [t=3.35] and 0.134 [t=1.94]), and female respondents' group had higher salience of Effort Expectancy both in forming anticipated positive affective feelings (betas respectively of 0.47 [t=4.29] and 0.135 [t=1.47])and in Intention to adopt (betas respectively of 0.23 [t=4.14] and 0.14 [t=1.87]). One-tail t tests of the differences were significant at minimum at 0.05 alpha level, exception made of EE to BehIntentAdopt at 0.1 alpha level.

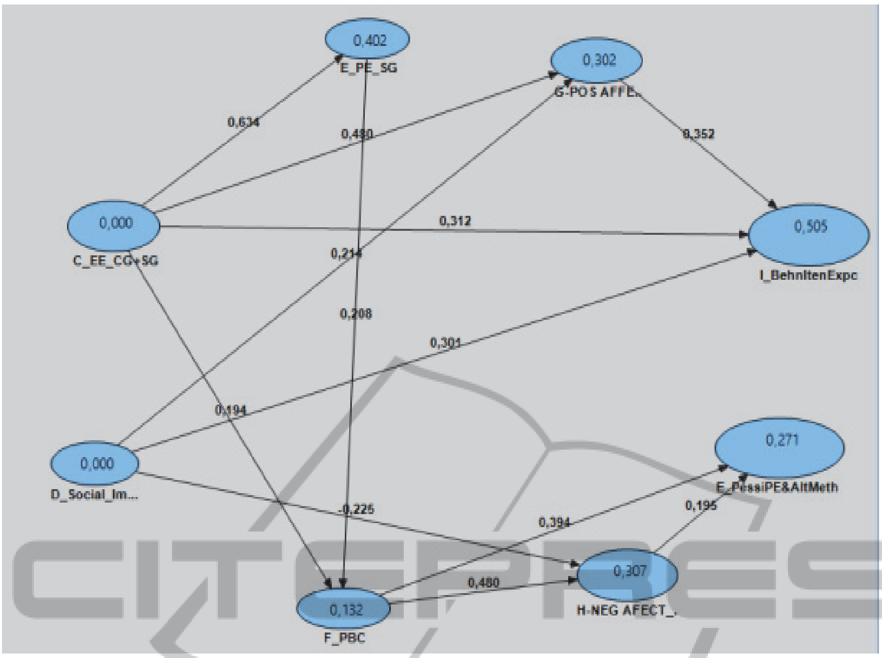

Figure 1: The second structural equation model tested in explanation of the dependent variables Adoption Intention (*BehvIntenExpc*), and Pessimistic expectations and expectation to employ other methods (*PessimPE&AltMeth*).

Age categories were compared in MG approach. Younger than 30 compared to respondents in their 30s: a) Had higher association between PE_SG (performance expectancy items referring to smart grid) and Anticipated Positive Affect to behaviors (beta_category1: 0.25 (sig); beta_ category2: 0,09 (n.s.); p value associated to t test for the difference in path coefficients (2 tail): 0.05; but they had not more important paths from PE_SG to Adoption Intention; b) Maintained less association between PBC and PE-SG (beta_category1: 0.02 (n.s.); beta_category2: 0.27 (sig); p value of t test: 0.005; c) Had less salient path from Pessism_AltMethod to Intention to Adopt: (beta_category1: 0.11 (n.s.); beta_category2: 0.25 (sig); p value of t test: 0.06. Other differences were not quantitatively relevant. In synthesis, significant and relevant differences between younger respondents as compared to ones in their 30s, were that the younger group responded to Intention to adopting in a way that was less consistent with their expressed intention to employ alternative methods, and they gave less importance to valuations of outcomes of conserving in their expressed intention to adopt the technology.

Respondents over 40 years of age compared to the ones in the 30s: a) Had a higher association of *PBC* to *Intention to Adopt* (beta_category3: 0.27 (sig) against beta_category2: -0.12 (n.s.); p value of test for the difference 2-tail: 0.003); b) Lower importance of *Anticipated Positive Affect* upon *Intention to Adopt* (beta_category3: 0.08 (n.s.) against beta_category2: 0.26 (sig); p value of t test (2 tail): 0.03); c) lower importance of *Performance Expectation* (items referring to current grid) to *Anticipated Positive Affect* (beta_category3: -0.01 (n.s.) against beta_category2: 0.23 (sig); p value associated to t test: 0,002).Thus, respondents older than 40, compared to those in their 30s, had higher salience of *PBC* in *Adopting Intentions*, but lower salience of *Anticipated Positive Affect to the behaviors*.

Group differences due to educational level and occupational field were analyzed. Educational level assumed 2 levels: 12^{th} grade (educ_level 1) and higher education (educ_level2). Occupational field was classified according to the degree of importance of ICT technology. Importance of computers and technology for the occupation was coded after Portuguese occupational taxonomies (e.g., taxon of Technology field Portuguese Inventory of Occupational Preferences). This lead to organizing 2 categories: lower use of technological knowledge and skill about computers, software and programming, or higher. There was some overlap between technology load and educational level categories (Pearson's Phi of 0.303).

These variables were first checked regarding their potential role as predictors of the dependent variables, and either non-significant or extremely low, effects were obtained. Relevant differences among occupational level and field/technology categories were found in path coefficients (thus manifesting moderating roles of these variables) statistically significant at alpha level of 0.05, in a two tail adapted t-test. Respondents with higher education, comparatively with those with 12^{th} grade, gave lower importance to *Performance Expectation* in forming Adopting intentions (beta_educlevel_1: 0.21 (sig); beta_educlevel_2: 0.07 (n.s.); t test (16.66 d.f.) =2.48, p(2 tail)=0.025). Thus for educational level, a significant and relevant effect was that the more highly educated respondents seemed to be less driven in their adopting considerations by *performance expectations*. Respondents whose occupation were classified as less infused with ICT tasks and skills (category 1) displayed higher paths between PE_SG and two other constructs. One of these constructs was *PBC*, so that performance perception depended upon the PCB significantly or the reciprocal, whereas this is not the case with more ICT loaded occupations (Path_Categ1: 0.22 (sig); Path_Categ2: 0.05 (n.s.), t(21.28 d.f.)=3.86, p(2t)=0.001). The other construct more highly linked to PE_SG by Category-1 group was *Anticipated Positive Affect*: They accorded higher importance to *PE_SG* in their ratings of *positive anticipated affect to adoption*. (Path_categ1: 0.18 (sig); Path_Category2: 0.05 (n.s.), t(25.19)= 2.64; p=0.014.

The same former group also had more strong negative association between *Social Image* and *Negative Affect* (so that Social Image factors implied the presence of more anticipated negative affect), a link that was non-significant for the group with more technologically loaded occupations. (Path_Categ1: -0.30 (sig); Path_Categ2: -0.07 (n.s.); t(16.66)=3.44; p(2t)=0.003).

4 ENERGY BEHAVIORS

The concept of Intelligent Efficiency positions technology and people's energy behaviors as integrated parts of efficient solutions, to which accrues demand-response management as policy on tariffs and prices, in the transition toward more intensely digitalized grids. Energy behaviors (Black et al., 1985) are a set of different kinds of behaviors theorized to impact the way energy is consumed at home and the energy consumption outcome e.g., switching off lights in unoccupied rooms; checking the invoice, buying efficient equipment; performing small thermal improvements in the house, but to those we added the use of automation or programming for setting goals (e.g. temperature). For 431 participants for whom a subset of energy behaviors were jointly applicable, self-reported frequency of these behaviors was not highly correlated overall. Instead, a subset of behaviors could be used to compose a consistent formative construct, namely: buy efficient equipment, checking invoice; switch off equipment at button and perform small improvements in thermal insulation of the house. Two other behaviors (regulating ambient temperature according to season; and employing programmer) were studied, treated with a single indicator variable approach. Frequency in the case of highly repetitive behaviors controlled by specific cues may constitute habit.

Hypothesis on relations between energy behaviors and adoption intention can be derived from TPB in Conner and Armitage's (Conner and Armitage, 1998); (Armitage and Christian, 2003) extended version with past behavior as a factor, possibly mediated by self-identity as discussed by Smith, Terry and Manstead (2008). If this kind of influence predominates, different sets of energy behaviors may be direct predictors of each of the dependent variables. Hypotheses relating those behaviors - when accessible to memory - to attitudes originate from frameworks in Attitude literature favoring the behavior–attitude link, namely self-perception theory, under conditions where pre-existing attitudes might not be clear nor supported by knowledge structures (Eagly and Chaiken, 1993); (Olson and Stone, 2005). Thus self-report of specific sets of energy behaviors is expected to covary with Valuation of Outcomes of Conserving, and also with Attitudes, either in favor or counter the adoption of the technology depending upon the behaviors' overlap with technology use. This association may have different causes, such as salient motives for the behaviors, consistency effects of self-perception and self-inference of attitude, and even possible social desirability bias.

Distinct hypotheses on potential moderating role of prior behaviors of a similar kind as the dependent(s), within TPB framework, are formulated by Kidwell and Jewell (Kidwell and Jewell, 2008) by theorizing their role as sources of activation of specific heuristics in the information processing for decision. As prior experience with the behaviors calls attention to information obtained from experience, it is then expected to change the importance of TPB variables upon behavior Intention/ behavior considerations, by decreasing the importance of Attitude (outcome probability), and by increasing the importance of behavioral control considerations. But, conversely, if the accessibility to memory of sets prior behaviors is the starting point for consumers' inference of own attitudes to the technology adoption, the salience of attitude (e.g., positive attitude) in adoption considerations is not expected to decrease for the respondents with a high frequency of similar behaviors.

Self-ratings of frequency of a sample of energy behaviors were part of the survey. In order for energy behaviors to be analyzed together, they needed to be applicable in the respondents' home with an identical rate (because energy behaviors derive from activation of energy services, they are applicable if the corresponding services are chosen and activated by consumer at home). Groups of respondents who indicated the behaviors as applying were the basis for partitioning the sample of behaviors and the sample of respondents into subsets. For two behaviors - **employing programming devices in setting parameters for ambient temperature for a longer time ahead** and **adjust ambient temperature according to different benchmarks in winter and in summertime –** applicability largely overlapped. A set of other behaviors afforded a consistent formative construct: **buy efficient**, **checking invoice, switch off at button** and **thermal insulation. Employing a programmer** is considered the most similar behavior to *Adoption*, whereas *AltMethods* may be more similar behaviors such as **keeping doors closed of the rooms being heated**, or **switching off equipment using the button**, and **checking the invoice.**

4.1 Analysis and Results

In a first step, a model where each behavior is entered as a predictor of the main dependent variable is estimated and analyzed. In a second step, two sets of moderating effects are checked for: the potential moderation of *Attitude* upon *Intention*, in the present case, *Positive Affect* upon *Adoption Intention*, and also *Negative Affect* upon *Pessismim_AltMethod;* and potential moderation of *PBC* upon *Adoption Intention*, and by extension, the moderation of *EE* upon *Adoption Intention* and *Pessism_Alt Method*.

Employing a programmer had a significant relation to *Effort Expectancy* (0.21; t=2.26); but not to *Positive Affect*, and, differently from other energy behaviors, no association to *valuation of outcomes of conserving electricity*.

Adjusting ambient temperature according to season had a significant association with *Valuations of outcomes of conserving* (0.21; t=2.72), Performance *Expectancy*_CG (0.17; t=2.95).

A formative construct composed of 4 energy behaviors - **buy energetically efficient equipment; checking invoice; switch off equipment at button; thermal insulation of the home**, displays significant paths with *Valuations of conserving* and with *Performance Expectancy_CG* (0.24; t=4.88); with *Effort Expectancy* (0.15; t=3.20) ; with *Social Image* (0.10; t=2.12), with *Negative Affect to behaviors* (0.11; t=2.68);

Results of moderator analysis: **Employing a programmer:** does not significantly (at alpha 0.05) interact with *Pos Affect* upon *Intention to Adopt* (0.10; t= 1.14); nor with *Neg Affect* in predicting *Pesssimis-AltMethod* (-0,08; t= 1,22) although there is a trend in that direction. The second interaction is significant at 0.11, in a one-tail test. T**he latter interaction is negative,** as predicted in the hypothesis that prior behaviors lower the importance of attitudes to adoption considerations. But, regarding its potential role in interaction with PBC, there is no significant interaction, nor with *Effort Expectancy*.

Adjusting ambient temperature according to season does not display significant interaction with *Positive affect* in prediction of *Adoption Intention*; nor with *Negative Affect* in prediction of *Alt Method*. No significant interaction exists with PBC. With EE, however, the interaction reaches a statistically significant coefficient of 0.196 in prediction of Alt Method (t=2.89) which is high. Thus, with higher behaviors of adjusting ambient temperature seasonally there is a trend towards an increase in importance of EE in choosing alternative methods.

5 CONCLUSIONS

Gender, age and occupational groups may differ among each other in several aspects that potentially impact adoption of technological solutions for managing the use of electricity at home, and for conserving in the current conditions, and in the future scenario of the smart grid. Being of female, in contrast to male, gender did not have a significant impact in adoption intention, but it did change the importance of considerations regarding outcomes (performance) and behavior barriers (PBC), lowering them, and the importance of perceptions of ease of learning and of using the technology (EE), increasing it.

The emphasis upon behavior control (behavioral barriers) considerations of older respondents in thinking about technology adoption appears as a theme in several IT acceptance studies and also in our study. Additionally, our results suggest that this age group (above 40years of age) may also be less concerned with outcome probabilities (performance) and report less importance of hot, emotional, thoughts around the issue of adopting.

Much younger groups (below 30s in comparison with those in their 30s) may be less concerned with consistency between *performance expectancy* i.e., outcome expectations and *behavior control*, and more concerned with coherence between *outcome (performance*) and *affect to behaviors*. Younger respondents may be also less concerned with the consistency between alternative (or competitive) methods of managing the use of electricity.

Regarding education level, the more highly educated respondents seemed to be less driven in their adopting considerations by *performance expectations*, compared to those with high school education. A possible explanation is that more highly instructed respondents may have lower pressure to perform in reducing and controlling energy use in their homes, and this is not the primary motivational source of adoption; but a different explanation is that they may require more precise information to elaborate a perception that they can feel as a bases for decision.

Educational and occupational groups differing in IT knowledge do not differ in regard to the most structural paths with higher coefficients in the overall model: From *Social Image to Anticipated Positive Affect*, and to *Adoption Intention*; from *Effort Expectancy to Positive Affect* and to *Adoption Intentions*; and from *PBC to Negative Affect and to Pessimism_Alternative Methods*. The structural model seems to hold for both groups analyzed. However, less technologically informed respondents had a more consistent or uniform pattern of responses in relating *Performance expectations (outcome probabilities they express), PBC, and positive affect to adoption behaviors,* while more instructed and technology informed respondents have more differentiated patterns.

Energy technology acceptation takes part with energy behaviors, e.g., conservation, monitoring, investments, as well as the use of automation or programming for setting goals (e.g. temperature) or automating decision. An integrated view of energy efficiency, under the conceptual umbrella of Intelligent Efficiency, positions technology and people's energy behaviors as integrated parts of efficient solutions, and furthermore, electrical grid changes towards the digital grid are integral with new market and economic policies on tariffs, including demand-response. Hypotheses on the role of prior energy behaviors of a similar kind as the dependent(s), stem from their postulated role as sources of inferences on own attitudes towards adoption, or alternatively, as sources of activation of specific heuristics in the information processing for decision, by changing the importance of TPB variables Attitude and PBC upon Intention/ behavior considerations. But in the larger context, acceptation of new technology is also designed to help consumers change their energy behaviors.

Energy behaviors appear to constitute a multifaceted construct. Prior energy behaviors are correlated to some predictors of *adoption intention*, or *to alternative methods*. A behavior that presupposes automation technology (**employing a programmer)** enhances *EE*, leading to higher perception of ease of learning to use the new technology, but they were not found to have a role in attitudes, i.e. affect, nor to alter the importance of (positive or negative) attitudes/affect and behavior control, upon considerations of adoption. But another behavior - **Adjusting ambient temperature according to season** incremented *Performance Expectation*, and led to a higher dependence of *Expectation to employ alternative methods* from *Effort expectancy*. Other behaviors studied enhance almost all predictors of adoption, including absence of negative anticipated affect. In this regard, the results in our study are mixed, not leading to closure in the competing hypotheses of processes whereby energy behaviors and adoption considerations meet.

Goals and hypotheses are rooted in well-established attitude, persuasion, and IT acceptance literatures, and jointly contribute to advancing the understanding of issues and processes in the attitude formation for developing technologies for smart grid adaptation, and identifying consumer segments in regard to the adoption of this type of technologies.

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