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Abstract

Although a number of frameworks exist that incorporate social and psychological elements of behaviour, these frameworks still rely on assumptions of cognitive and deliberate decision-making. Household energy consumption behaviours, however, span a spectrum from reasoned and deliberate to unplanned and automatic. The aim of this research is to advance knowledge of reasoned and unplanned behaviours in the context of pro-environmental action. Using results of a survey administered to occupants of an urban residential green building this study explores five household consumption behaviours, and tests the hypothesis that unplanned behaviours will be poorly predicted by a reasoned, values-based behavioural framework. Using path analyses, variables in Stern’s (2000) Values Beliefs Norms (VBN) framework are used to predict surveyed behaviours. Findings indicate that behaviours hypothesized to be unplanned were not well predicted by the VBN framework. The framework successfully predicted what was hypothesized to be a fully reasoned behaviour. This paper discusses three potential reasons for the lack of prediction of some behaviours. A deeper understanding of how unplanned, automatic or habitual behaviours intervene in conservation intentions can help policymakers and building designers better respond to influences of occupant behaviour on building performance.

Keywords: habits, reasoned behaviour, occupant behaviour, values, environmental beliefs, residential

Many researchers acknowledge the important role that occupant behaviour plays in building-wide energy consumption (Fabi, Andersen, Corgnati, & Olesen, 2012; Jain, Taylor, & Culligan, 2013). Some argue that occupant behaviour is a key reason for the large gap between predicted and actual energy consumption and efficiency in buildings, and that assumptions made about how occupants will behave are often unrealistic (Fabi et al., 2012). Residential buildings often do not meet their designed energy efficiency targets once they are occupied, despite a high level of design and materials innovation (Blumstein, Goldstone, & Lutzenhiser, 2000). Understanding the various motivations and drivers of occupant action is an important part of better understanding the impacts occupants have on building performance, but
many of the daily behaviours that lead residents to conserve or consume electricity and resources at home are likely to be unplanned, automatic, or habitual (Bamberg, 2002; de Vries, Aarts, & Midden, 2011; Knussen, Yule, MacKenzie, & Wells, 2004; Macey & Brown, 1983; Stern, 2000). The aim of this research is to further the field’s understanding of unplanned behaviour in the context of decision-making for pro-environmental action.

In this study, results of a survey administered to residents of an urban multifamily green building are used to explore five household consumption behaviours expected to span a range from unplanned to reasoned. The behaviours studied here include monthly household kWh consumption, loads of laundry per week, frequency of dishwasher usage, choice of light bulb type (e.g. traditional incandescent versus compact fluorescent or other), and decision to move to the study building because it is green. This study is primarily concerned with behaviors that impact electricity consumption; as such, the above behaviors were selected from the full survey for further study because of their role (direct or indirect) in determining household energy consumption.

This study explores the hypothesis that behaviours that are unplanned, repeated often or undertaken automatically lead to an “override” of attitudinal constructs like values, beliefs, and norms and, as such, will be weakly predicted by a behavioural framework reliant on assumptions of reasoned action. More specifically, it hypothesizes that behaviours measured in the study building that occur often or with little advance planning or thought, such as turning on lights, washing laundry, and running the dishwasher, are more likely to be automatic and unplanned, and
therefore less likely to follow the causal chain outlined in a behavioural framework that assumes reasoned action. Similarly, this study hypothesizes that significant decisions that may carry a high cost or risk, such as choosing to move to the study building because it is green, fall well within the bounds of reasoned behaviour and, as such, are likely to be well predicted by a reasoned behavioural framework. Other reasoned behaviours – although not measured in the survey for this study – would include weatherizing one’s home, purchasing a hybrid vehicle, or undertaking an energy audit with the local utility. These behaviours differ from those unlikely to be reasoned because of the infrequent nature of their occurrence and/or their potentially high cost or significance. It is important to note that the distinction made for this research between reasoned and unplanned behaviors is a simplification for purposes of illustrating the distinction between the two; actual behaviors are more complex, interact with other behaviors, and are not neatly categorized.

**Background**

**Reasoned action**

As a response to criticisms about the limitations of purely rational assumptions about behaviour, a number of researchers have developed frameworks for behaviour prediction that acknowledge humans’ limits to rationality and include constructs such as values, attitudes, social norms, and beliefs (Jackson, 2005). Some of these frameworks have been well studied empirically and offer insight into the complex role of social and psychological factors in human action.

One of the best known of these frameworks is Ajzen and Fishbein’s (1980) Theory of Planned Behavior (TPB), which posits that a causal chain of beliefs,
attitudes, subjective norms and perceived control lead to the formation of an intention to act, which is a very effective predictor of actual behaviour (Ajzen, 1985; Ajzen & Fishbein, 1980). Another well-known framework is Schwartz’s (1977) Norm-Activation Theory, which hypothesizes that a moral norm about a behaviour is a direct predictor of undertaking an action, regardless of the formation of an intention (Godin, Connor & Sheeran, 2005; Jackson, 2005; Schwartz, 1977). These and other frameworks have been used to test and explain behaviours as varied as healthy eating habits to choice of transportation mode (Ajzen, 2005; Jackson, 2005). In the environmental realm, Stern’s (2000) Values-Beliefs-Norms (VBN) framework stands out as a tool for prediction of pro-environmental behaviours as a specific type of action. This study relies on the VBN framework for analysis, and it will be explained in more detail in a later section.

**Unplanned behaviours**

Although these and other frameworks have successfully incorporated social and psychological elements to rational actor models of human behaviour, these frameworks still rest on a shared assumption of cognition; that is, they assume a deliberate reasoning process undertaken with conscious intent to perform a behaviour. However, this is very often not the case, especially with consumption behaviours undertaken at home, which are often repeated daily and triggered by familiar situational cues and contexts.

Individuals may not perform behaviours they intend to undertake for a number of reasons; researchers refer to this as the intention-behaviour gap (Ajzen, 2005; Godin, Conner, & Sheeran, 2005; Jackson, 2005; Stern, 2000). Ajzen (2005)
explains that individuals may be less likely to perform intended behaviours if they do not clearly formulate the details of undertaking the action. Similarly, individuals may have limited control over factors that impact the likelihood of successfully performing the behaviour (Ajzen, 2005). Further, once behaviours have been performed a number of times, they require less cognitive effort to undertake them; as such, individuals then begin to rely on heuristics or other shortcuts to undertake the behaviour, instead of a conscious intention (Ajzen, 2005; Jackson, 2005; Ouellette & Wood, 1998). This line between cognition and automaticity is blurry; behaviours that at first are reasoned can become automatic or habitual over time.

**Values-Beliefs-Norms framework**

This study utilizes Stern’s (2000) Values-Beliefs-Norms (VBN) framework, which differs from other frameworks in that it evaluates pro-environmental behaviour as a distinct realm of decision-making. VBN posits that a causal chain of five variables, representing a linkage of three attitudinal constructs, lead to behaviour. The first component is personal values theory (“Values”), in which relatively stable personality elements individuals hold about the environment are evaluated. The second construct is comprised of a set of beliefs about the environment (“Beliefs”), consisting of 3 variables that identify the individual’s environmental worldview, understanding and awareness of consequences of particular environmental threats, and the individual’s ability to take action to lessen those consequences. The third component of the causal chain consists of the activation of personal norms for pro-environmental action (“Norms”). Norms – identified by Stern (2000) as a “sense of obligation to take pro-environmental actions” – immediately precede behaviour in the
VBN framework (p. 412). See Figure 1 for an overview of VBN and the hypotheses for this study regarding unplanned and reasoned behaviour.

**Contributions of this study**

While researchers have found the VBN framework to be empirically predictive of personal norms and resulting behaviours (Cordano, Welcomer, Scherer, Pradenas, & Parada, 2011; de Groot & Steg, 2010; Steg, Dreijerink, & Abrahamse, 2005; Stern, Deitz, Abel, Guagnano, & Kalof, 1999), VBN is not as widely cited in the literature as other frameworks; thus, this study contributes to the literature by further testing this framework. Additionally, the use of VBN to test behaviors that may be unreasoned, automatic, unplanned or habitual is a new use of this framework. Finally, although a number of researchers have empirically studied behavioral frameworks and the role of automated or habitual behaviors, no studies, to the knowledge of the researchers, attempt to specifically designate residents of a green building as the study subjects on this topic. This is a unique approach in that green buildings tend to bring specific assumptions about energy performance that may or may not carry through to occupants. Not all green building occupants behave in environmentally conscious ways, and this study allows for a further exploration of this important occupant behavior consideration.

**Method**

**Site**

This research was conducted in a single green residential high-rise building in a large city in the Northeastern United States completed in 2003 with 293 apartments, ranging in size from studios to three bedrooms. Although definitions vary, for
purposes of this research the term “green building” is used to mean one that has achieved a Leadership in Energy and Environmental Design (LEED) certification from the United States Green Building Council (USGBC), indicating it has met certain criteria for water conservation, energy efficiency, materials and finishes, and indoor air quality. This particular building is approximately 30 stories with gross square footage of 32,500m² (350,000 SF) and a centralized ventilation system for cooling and heating. It is rated LEED Platinum for Existing Buildings: Operations & Maintenance, and includes on-site photovoltaic panels, provides 100% fresh outside air and individual thermal comfort control, avoids certain building materials that are sources of indoor air contaminants, and offers enhanced maintenance. Buildings earning this certification must meet minimum energy efficiency requirements by benchmarking energy use to demonstrate that the building performs at or better than the 69th percentile of similar buildings using national source energy data available in the Environmental Protection Agency’s Portfolio Manager tool (United States Green Building Council, 2014). Mean monthly household electricity consumption for all apartments in the building for the 12-month period from October 2010 to September 2011 was 375.8 kWh/month. This figure includes only household plug-load consumption, and does not include heat, air conditioning, ventilation, gas stoves, domestic hot water or common areas. The building overall consumed 381 kWh/m² in 2011 (this figure includes electricity, natural gas, and on-site photovoltaic production, and includes building common areas). The building has been occupied for 11 years.
**Study design**

A building-wide survey was administered in early December 2011. As an incentive for participating in the survey, respondents were offered the opportunity to be entered into a draw for an iPad. The 15-minute survey was administered via an email link sent to residents by building management, in person on laptops and via paper hard copy in the building lobby; choice of survey instrument was at the discretion of the resident. The survey was presented to residents as an independent study by an academic research center having no affiliation with the building or building management. Residents were told the goals of the study were to learn more about the building’s performance, occupant satisfaction with the building and their apartments, and occupant behaviour within the building. The survey consisted of a range of questions regarding resource consumption at home, opinions about the building and apartment unit, beliefs and opinions regarding energy and environmental conservation, and explanations for why they moved into this green building. No stratification was utilized, and of the total population of 293 apartments, 161 responses were received. The building is the full population in this case; this response rate represents over 50% of the population.

**Participants**

Overall, the building represents a high-income, highly educated demographic of family oriented young professionals. There is little variation by age, education, and income among residents. Gender is nearly evenly split, and over 70% of residents are between the ages of 30 and 49. A large number of households (approximately 40%) have children under age 10. Over 90% of residents are college-educated, holding a
bachelor’s degree or higher, and 80% of residents reported an income of above US$200,000/year. The survey did not ask respondents to report their race or ethnicity. Anecdotally, there was observed some ethnic diversity among residents in the building, but this is not expected to explain much variation in survey responses given the consistency of other demographic factors and the use of the single building as survey population. The demographics are indicative of a homogeneous population of building residents.

Measures

Behaviours tested.

The following five behaviours were measured as focal dependent variables: Electricity consumption on a per apartment basis for the most recent six months available prior to the survey, loads of laundry per week for the household, frequency of dishwasher usage per week, percentage of traditional incandescent light bulbs used by the household, and choosing to move the study building because it is green. Of the five measures, kWh usage is observed data, while the remaining four are self-reported by respondents. All five behaviours are tested as dependent variables in the VBN framework (explained in more detail in the Procedure and Results sections).

Monthly kWh electricity usage data was collected from apartments building-wide for the most recent six months available prior to the survey (April through September 2011). Building management, who obtained electricity bills from the local utility provider for the building, made this data available for this study. Some survey respondents have lived in the building for a relatively short period of time; thus, not every survey can be matched to kWh consumption (for instance, if apartment A
moved to the building in September 2011, only two months of electricity consumption would be attributable to the resident that filled out the survey in November 2011; the remaining kWh data made available would be consumption from the prior resident and not usable in the analysis. Thus, there are fewer kWh observations than survey respondents. Apartments are sub-metered for electricity usage, but this includes plug load only. Heating, cooling and hot water are provided by a central plant and are not reflected on monthly bills (therefore little seasonal variation in electricity consumption is expected).

The variable “loads of laundry” was measured with fifteen numerical categories ranging from one load per week to more than 15 loads. For purposes of this question, a single load of laundry is assumed to be one washer-full of clothing. Washers in the apartment are water and energy efficient units with approximately 12 m³ (4.4 cubic feet) of capacity.

The variable “dishwasher use” was measured ordinarily in 5 categories (Everyday to Never) and asked, “During a typical week, how frequently do you use the dishwasher?”

The variable “percentage of incandescent bulbs” was measured with four ordinal percentage categories ranging from 0% to 100% and asked, “What fraction of your lights are traditional incandescent light bulbs (rather than compact fluorescent, LEDs, or others)?”

The variable “green building” asked about the respondent’s choice of moving to the building because it is green. This question asked respondents, “Please check the three most important reasons for your choosing to move to this building.”
Residents were given 12 response categories, with “Because it is a green building” listed as one of them. Respondents were not asked to rank their three selections in order of preference, but only to select three of the response categories. Not all response categories were environmentally focused; for instance, residents could select reasons such as convenience to workplace, views, and child-friendly neighborhood.

See the Appendix for response categories, coding, and descriptive statistics for all dependent variables, as well as the full list of answer choices for reasons for moving to the building.

**Independent variables.**

**Measures of values, beliefs, and norms.**

Values were measured with one survey question (“Protecting the environment is an important goal in our society”). Respondents were asked to rank their agreement with the statement on a 5-point scale. Environmental beliefs were measured using the 15-question New Ecological Paradigm (NEP) scale (Dunlap, Van Liere, Mertig, & Jones, 2000). The NEP has been used countless times as an empirical tool to measure environmental worldview (Dunlap, 2008; for a meta-analysis see also Hawcroft & Milfont, 2010). Questions were reverse-coded as needed in order to create a scale. A Cronbach’s Alpha test returned a favorable alpha value of .78. The scale was utilized as a single conceptual measure for further data analysis, and each survey response was given an environmental beliefs score. The lowest possible value for this score was 15 (if the respondent answered “strongly disagree” on all 15 questions), and the highest possible value for this score was a 75 (if the respondent answered “strongly agree” on all 15 questions). A set of six
questions measured personal norms. The questions asked respondents about the importance of conserving various resources (“How important is it for you to actively conserve: Cold water/Hot water/Electricity/Natural gas/Space heating/Space cooling”). The six questions were treated as a unified scale (alpha = .93) and combined into a single value as a new variable. See the Appendix for response categories, coding, and descriptive statistics of the independent variables, as well as the full NEP scale.

Validity and reliability of measures.

Given the less frequent use of VBN in the literature relative to other behavioural frameworks, there are few studies available by which to assess measures used, and some of those that analyze the VBN framework only do so partially or do so in combination with variables from other frameworks (see Cordano et al., 2011; de Groot & Steg, 2010; Klockner & Matthies, 2004; Steg et al., 2005; Stern et al., 1999). The research presented here relied on these studies as models, but modified questions as needed to fit the goals of the study. For the values construct, other studies (Cordano et al., 2011; de Groot & Steg, 2010; Steg et al., 2005; Stern et al., 1999) rely on Schwartz’ (1994) universal values scale to measure values across numerous categories. This study focuses only on biospheric values (level of concern for the environment and other species). Although the statistical models incorporate only one construct for values, and it is recognized that this presents a limitation, the question offers a reasonable assessment of individuals’ environmental leaning.

For environmental beliefs, Stern (2000) relied on the NEP scale. This study also used the NEP scale as the measure of beliefs, but the entire scale is included in
this research (with some questions reverse coded for analysis), while Stern and others used an abbreviated version. Some researchers argue that modifying the scale or only using some of its components lessens its predictive strength; thus, it was retained in full here (Hawcroft & Milifont, 2010). This study does not have appropriate measures for the two additional constructs for beliefs (adverse consequences and ability to reduce threat of consequences) and they are not included in the analysis. Although this may reduce reliability of the beliefs component, the researchers deemed it most important to measure the three primary constructs of the framework (values, beliefs, and norms). There is some precedent for this approach; Steg et al. (2005) cite two prior studies that did not include beliefs about reducing environmental threats.

Researchers have used a variety of measures for the construct of personal norms; the commonality is that they all address individual behavioural expectations or standards. This study took a similar approach. Although the questions used in this research offered only three response categories, which can lead to loss of information, the reliability of these questions is increased by combining six questions into a single scale.

**Control variables.**

A number of variables were included in the analysis as control variables. These included apartment size (studio, 1 bedroom, 2 bedroom, or 3 bedroom), number of appliances in the household, number of people in the household, and household income. The control variables were included as needed. Response categories, coding, and descriptive statistics for control variables can also be found in the Appendix.
Procedure

Path analyses were generated using the variables outlined in the VBN behavioural framework and the dependent variables mentioned above. A path analysis, which is a type of structural equation modeling (SEM), is generally a combination of assumed causal theory (VBN in this research) with empirical evidence (survey results in this research) (Acock, 2013; Grace, 2006). More specifically, a path analysis assumes some level of mediation between variables, which is an appropriate method for better understanding a causal chain. Path analyses for this research were created using the Structural Equation Modeling (SEM) tool in Stata. The path analyses generated for this study include only observed exogenous and endogenous variables; no latent variables were modeled. A path analysis was conducted for each of the five behaviours; control variables were included in each equation. All coefficients have been standardized. It should also be noted that a number of the dependent variables are either binary or in ordinal categories. Running these binary or categorical variables as linear equations would violate the linearity assumption required to use Ordinary Least Squares (OLS) estimation procedures. Thus, logit and ordinal logit equations were performed on these data where necessary using Stata’s Generalized SEM tool. See Figures 2-6.

Determining sample representativeness for possible weighting is difficult, because many parameters of the full population (all building residents) are unknown. As one measure of representativeness, number of apartments of each type (one bedroom, two bedroom, etc.) in the building overall were analyzed and compared to responses in the sample. Results indicate that survey respondents are representative
of the total configuration of apartment units in the building. Studio apartments comprise 5% of units in the building and 3% in the sample. One bedroom apartments comprise 45% of units in the building and 40% in the sample. Two bedroom apartments comprise 32% of units in the building and 37% in the sample. Three bedroom apartments comprise 18% of units in the building and 19% in the sample. Thus, analysis has been performed on unweighted data.

**Results**

**Kilowatt-hour path analysis**

Results from the kWh path analysis can be found in Figure 2. The path analysis returned significant coefficients in predicting beliefs from values and personal norms from environmental beliefs (p < .001). The link between a personal norm and behaviour (kWh consumption) was not significant. Control variables of number of appliances and apartment size were significant predictors of kWh consumption (p < .001). Number of people in the household was a significant predictor of apartment type (p < .001) and thus an indirect predictor of kWh consumption.

**Loads of laundry path analysis**

Path analysis results for loads of laundry per week can be found in Figure 3. In this model, the regression predicting environmental beliefs from values was significant (p < .005). The analysis returned a significant coefficient (p < .001) in predicting personal norms from environmental beliefs. However, personal norms were not predictive of number of loads of laundry per week in the household. The control variable of number of people in the household was predictive of loads of
laundry per week as well as apartment type (p < .001). Control variables of number of appliances and apartment type were predictive of kWh consumption (p < .005 and p < .001, respectively). Additionally, loads of laundry per week was not predictive of kWh consumption.

**Dishwasher path analysis**

The results of the path analysis for weekly dishwasher usage can be found in Figure 4. Again, the model returned a significant coefficient (p < .001) in predicting beliefs from values and personal norms from beliefs. There was no significance in the model in predicting dishwasher usage from personal norms. As in the previous model, dishwasher usage was predicted by the control variable number of people (p < .001). In this model, number of people predicted apartment type (p < .001) and number of appliances (p < .010). Once again, appliances and apartment type were predictive of kWh consumption (p < .005 and p < .001, respectively).

**Incandescent bulb path analysis**

Results of the path analysis predicting incandescent bulb usage can be found in Figure 5. Again, as in the prior models, the model returned a significant coefficient (p < .001) in predicting beliefs from values and personal norms from beliefs. There was no significance in predicting more or less use of incandescent bulbs from a personal norm to conserve resources. Incandescent bulb use was also not predicted by control variables, nor did it predict kWh consumption. Number of people was again predictive of apartment type (p < .001) and number of appliances (p < .010), and apartment type and number of appliances were again predictive of kWh consumption (p < .001 and p < .005, respectively).
Green building path analysis

The analysis predicting the respondent’s choice to move to the building because of its green features can be found in Figure 6. This model also returned significant coefficients (p < .001) in predicting beliefs from values and personal norms from beliefs. In this model, a personal norm to conserve resources did predict the respondent’s choice of moving to the building because of its green features (p < .001). No control variables predicted the green building choice, and moving to the building because it is green did not predict kWh consumption. As in prior models, number of people again predicted apartment type (p < .001) and number of appliances (p < .010), and apartment type and number of appliances again predicted kWh consumption (p < .001 and p < .005, respectively).

Discussion

This research explored the hypothesis that unplanned, automatic, or habit-based behaviours would be weakly predicted by the VBN framework. The analysis confirmed this. Specific findings regarding each behaviour will be discussed in turn.

First, one behaviour (moving to the study building because it is green) was well predicted by the personal norm variable (see Figure 6). This lends support to the hypothesis that as a major decision with a high cost that is undertaken infrequently, this behaviour is likely to be a fully reasoned action. As a reasoned action, it was expected that it would be well predicted by the causal chain of VBN and, in particular, the immediate precursor to behaviour, the personal pro-environmental norm variable. These findings confirm the work done by others regarding the predictive power of the VBN model in the case of reasoned behaviour.
Four household consumption behaviours (kWh usage, loads of laundry per week, dishwasher frequency, and percentage of incandescent bulbs) were not predicted by the personal norms variable in the VBN framework (see Figures 3, 4, and 5). This indicates that although individuals may express pro-environmental beliefs and values, there is a disconnect or gap in this case between intent and action for these particular behaviours in this particular building (this is stressed because it is important to note that these findings are context specific. It will not be universally true, for instance, that laundry behaviour is never a reasoned action). In the study building, this is evidence that these behaviours are not reasoned, but unplanned, automatic, or habitual instead.

There are a number of reasons why a particular behaviour may not be reasoned or rely on cognitive decision-making. This study points to three possible factors.

First, the behaviour in question may be habitual. A number of studies lend empirical support to the notion that behaviours with a tendency to be repeated often are likely to rely less on an individual’s intent to act, while more novel behaviours, or those requiring a more cognitive decision-making process, will align more strongly with reasoned behaviour theories (Aarts & Dijksterhuis, 2000; Aarts, Paulusson, & Schaalma, 1997; Bamberg 2006; Bamberg & Schmidt 2003; de Vries et al., 2011; Ittiravongs, 2012; Knussen et al., 2004; Landis, Triandis, & Adamopoulos 1978; Macey & Brown, 1983; Ouellette & Wood, 1998). Many researchers find that repetition is a key component of the development of habits (Aarts & Dijksterhuis, 2000; Aarts et al., 1997; Ajzen, 2005; de Vries et al., 2011; Gollwitzer, 1999; Landis
et al., 1978; Ouellette & Wood, 1998). These researchers argue that habits are actions that are undertaken repeatedly, under the same or very similar circumstances or conditions, allowing them to be performed automatically and with little advance planning. Others take a more expansive approach to habits, viewing them not simply as the repetition of a behaviour, but as a package of behaviours that usually occur together, conditioned on situational cues and context (de Vries et al., 2011; Klockner & Matthies 2004; Verplanken & Orbell, 2003). Aarts and Dijksterhuis (2000) find classic psychological models of habits, which attribute habitual action only to the frequency of past behaviours undertaken and the presence of current cues to trigger those same behaviours, to be limiting. They argue that these theories position humans as “victims” of habitual actions; they contrast this view with their idea that habits – although often undertaken automatically – still depend on an initial goal. They explain, “People automatically enter the garage and take their car or bicycle only if there is a reason to do so (even though they may not be aware of this reason at the time of action)” (p. 61).

Many studies have used statistical analysis to give further weight to the field’s understanding of habit, determining the predictive power of an intention to be weak in the presence of a habit (Bamberg & Schmidt, 2003; de Vries et al., 2011; Ouellette & Wood, 1998). In particular, Bamberg and Schmidt (2003) attempted to distinguish habitual behaviours from other types of behaviours by testing three behavioural frameworks, including the Theory of Interpersonal Behaviour, which includes habits as a variable for predicting behaviour (Triandis, 1977). They found Triandis’ framework more predictive of behaviour when habits were at play.
Given the existing work mentioned above, it is likely that the particular behaviours in question from this study that were not well predicted by VBN, such as using the dishwasher and doing laundry, could be habitual. They fall into the category of frequent repetition. Additionally, these behaviours occur at home, which is likely to be a highly stable context; as such, the physical environment and surroundings many researchers mention as important to habit formation are likely be present here (de Vries et al., 2011; Klockner & Matthies 2004; Ouellette & Wood, 1998).

Although Ajzen (2005) argues that some empirical work has proven that intentions are good predictors of behaviour even when habitual, such studies are limited, and most research has found empirically that habits work in opposition to intentions (Knussen et al., 2004; Landis et al., 1978). However, there are few frameworks that explicitly include habits as a behavioural construct, and testing habits is difficult. Most researchers rely on some measure of behaviour frequency as a metric for quantifying habits (Landis et al., 1978; Ouellette & Wood, 1998; Triandis, 1977). Triandis (1977) includes habit as a causal variable in the Theory of Interpersonal Behaviour (TIB) but, to our knowledge, is the only framework to do so. However, Stern (2000) argues that habits are an entirely distinct causal variable, and thus would fall outside of an attitudinal-based set of behavioural predictors. Further, although Triandis measures habit in TIB, the variable is based only on a weighted measure of behaviour frequency; as the existing literature illustrates, many researchers believe habits to be based not solely on behaviour frequency, but also on some measure of importance, context, situational cues, or a pre-existing goal. Thus, there are inconsistencies regarding how and when to identify and measure habits.
Complicating this further, de Vries et al. (2011) found non-acting habits (or, a habit of not undertaking a behaviour) to be just as problematic as acting habits, particularly in the case of electricity consumption behaviour.

Second, it is possible that in the case of this particular study building, given the very high income of most households, many consumption behaviours are simply not worth reasoning about; households have little constraint on income and expenses, and the monthly electricity bill represents a very small percentage of their income. As such, consumption could be driven by routine, context, preferences for comfort and convenience, time constraints, and other factors, and simply not be significant enough to undertake deliberate cognitive reasoning before taking action on behaviours that will impact their monthly electricity bill. In the study building, for example, 102 out of 112 surveyed households (or 91%) for whom both income and electricity data were available pay less than 1% of their annual income for electricity.

Finally, it is possible that some behaviours are not well predicted by VBN because they are not a single behaviour, but many nested behaviours, which creates a gap between the actions and the end goal. Ajzen (2005) points to the importance of distinguishing between goals (having a clean kitchen after dinner, for instance) and individual behaviours required to meet the goal (clearing the table, loading the dishwasher, adding soap, determining what washing and cleaning settings to use, etc.). Electricity consumption is particularly complex in this regard. Kilowatt-hour data is an observed and objective measure of electricity usage; however, it is not a behaviour in and of itself, as one does not consume electricity just to consume it, but to meet other needs, such as lighting or watching television. This adds a layer of difficulty to
the task of attempting to measure, understand and ultimately change consumption
behaviour in households.

In this research, kWh was also not well predicted by other household
behaviours that use electricity (loads of laundry, frequency of dishwasher usage, and
percentage of incandescent bulb usage). There are a few points to make regarding this
challenge. First, behavioural frameworks available to researchers (VBN and others)
typically focus on the individual. Kilowatt-hour consumption, however, is at the scale
of the household. This complicates the ability of researchers to trace the true drivers
of electricity consumption at home. Behavioural frameworks might be effective at
predicting action undertaken by an individual agent, but perhaps are not well suited to
understanding a more macro-level unit of analysis like the household. Also, some
control variables are good predictors of kWh. This makes intuitive sense, as it would
be expected that number of appliances and type of apartment would influence kWh
consumption. Number of people was not a significant predictor of kWh consumption
in the models, but number of people is more likely to influence size of apartment,
which in turn influences amount of electricity used.

Further, the work of de Vries et al. (2011), which focuses on non-acting habits,
is helpful here. As they explain, the habit of not undertaking an action (e.g. having a
habit of not switching off a lamp when leaving a room) is just as strong a behavioural
influence as a habit of taking a particular action. In the case of kWh consumption in
particular, this is likely to be a salient point, as electricity is often consumed in the
background as individuals perform other behaviours, and certain lifestyle patterns
become routinized (such as leaving lights on when leaving a room, leaving the television on when eating, etc.).

**Limitations**

There are some limitations to this research. First, caution should be employed in the use of self-reported variables. It would be helpful to support them with more observed data, but such data is often difficult to obtain in a residential context. The literature is mixed as to the reliability of self-reported behaviours, and researchers caution that self-reports are not always accurate (Chao & Lam, 2011; Rubin & Babbie, 2010). In particular, this study relies on the use of a self-reported measure for moving to the building because of its green features. As Rubin and Babbie (2010) explain, a survey respondent may have given no thought to a topic until questioned about it, forming an opinion as they answer the question based on the context of the survey. Thus, if a respondent tends to align with environmental views more broadly, they may select the green building choice as one reason for moving to the building simply because they are presented with it. However, respondents were given a number of choices to select from on this survey question, many of which were not environmentally focused. The researchers of this study argue that respondents could have easily selected all non-environmental reasons for moving to the building (as many did). Thus, it is believed that there is a good amount of accuracy to the survey responses listing green as one reason why tenants moved to the building.

It is also possible that there is some social desirability bias occurring in the responses to questions about the environment, as respondents may answer in such a way that they are portrayed in a more favorable light (Groves, Fowler, Couper,
Lepkowski, Singer, & Tourangeau, 2009). However, research indicates that mode of survey administration can have an impact on the amount of social desirability that occurs, and that surveys taken privately by the respondent have much less incidence of social desirability than those administered by interviewers (Groves et al., 2009). Although the possibility of social desirability cannot be avoided entirely given the nature of the questions asked on this study’s survey, the survey was not administered in-person by interviewers. Many respondents took the survey in the privacy of their home through an email link or hard copy. This is likely to have played a role in the types of answers respondents selected for certain questions, and likely decreased the incidence of social desirability.

Further, regarding the use of self-reported data for some of the other analyses performed here, Dillman, Smyth, and Christian (2008) explain that, although survey respondents often have difficulty recalling the specifics of actions or behaviours that occurred some time ago, researchers can obtain more reliable results by using clear question wording that asks about very recent behaviours that people can easily recall. The self-reported behaviours asked about on the survey instrument posed questions about frequency of appliance use during a typical week. These are simple, regularly occurring, recent behaviours; thus, the responses given by residents are likely to be accurate.

An additional limitation is regarding the sample composition. Although the homogeneous sample can offer benefits to the work, it studies a single building and its occupants in isolation, which limits the broader understanding of how these results could apply elsewhere. The researchers recognize that these results cannot be
extrapolated to other buildings unless they are similar in demographic composition. Also, context is important, and expanding the scale of analysis from a single building to units of analysis further up the hierarchy, such as neighborhood or city, could offer more insight to researchers. To this end, the study could benefit from duplication in buildings with highly mixed demographic characteristics. Subsequent studies would be helpful. Similarly, multi-building studies, which would allow for a greater n-size, could offer more statistical flexibility in analyzing data.

**Conclusion**

The research presented above explored five household consumption behaviours and placed these behaviours into a causal framework for reasoned action – Stern’s (2000) VBN framework – to test the hypothesis that behaviours that are not reasoned actions would be poorly predicted from such a framework; results of multiple path analyses confirmed this hypothesis.

Prior work (Bamberg and Schmidt, 2003; de Vries et al., 2011) lends empirical weight to the argument that habits are a strong influence on behaviour, and that they often interfere in environmental intentions. This research adds to that work by exploring the VBN framework, which is not analyzed in either of the above studies and has received less attention in the literature than non-environmental behavioural frameworks. Additionally, this study tests a range of household behaviours in a single framework, instead of testing a single behaviour in multiple frameworks. This adds further depth and nuance to the field’s understanding of the VBN framework.
The findings also lend additional empirical support to the logic and ordering of the causal chain in VBN. As Stern (2000) explains, values should influence beliefs, and beliefs should influence personal norms; norms, in turn, should guide behaviour. The path analyses show significant coefficients in each model in predicting beliefs from values and norms from beliefs. Additionally, there is no statistical significance in any model in predicting norms from values. This aligns well with the VBN model, which indicates that values would be mediated by beliefs in indirectly influencing norms, but would not be a direct predictor of personal norms.

There are some policy and design implications from the analyses in this research that find many household behaviours to be non-reasoned. If many behaviours are in fact not reliant on personal norms, values or other attitudinal constructs, as these findings indicate, a first challenge becomes finding ways to activate these norms among building occupants. The work of Allcott (2011) highlights the success of mechanisms such as those used by OPower, which sends customers monthly bill inserts that compare household electricity consumption to that of nearby neighbors. Evaluation of this intervention showed small (3-5%) but important reductions in home energy consumption in those households that received the bill insert. The influence of peer pressure seems to be one effective means of driving behavior change, which points to the impact of social norms (if successfully activated).

It is clear, though, that not all behaviours will be responsive to interventions that target norms, values, or beliefs. For behaviors that are likely not to be responsive (e.g. unplanned or habitual behaviors) efforts should be focused on those behaviors
that occur in a context that offers opportunity points for change. For example, Bamberg (2006) found a residential relocation to be an opportunity for habit intervention, as individuals are in a transition period and more likely to adopt new behaviours. This work sheds light on the potential for social science-based interventions as important tools to be used for behavior change in conjunction with or in some cases instead of physical design interventions in the building. With further research these opportunities could carry over into other sectors.

For those in the architecture and design community, the findings highlight the importance of re-thinking building design and end-user technology. Some well-intended design features that are meant to help residents conserve electricity and resources at home may unintentionally target habit-based behaviours – acting and non-acting – and be bypassed by the resident. This could include features like master light switches, which allow a resident to control many outlets at home through a single switch. Although promising as a design feature, if residents have existing non-acting habits of leaving lights on, they are unlikely to change this habit because of the availability of a master switch in their home.

Additionally, an argument can emerge for more functions to be automated in buildings, leading to higher efficiency in instances where occupants are not likely to reason about a behaviour. For instance, in many commercial buildings lighting levels are set and controlled by a master system, not individual light switches; this is true for ventilation and temperature as well. This becomes much more difficult to implement in a residential setting, where households expect full control over their home environment, but some systems are emerging that give automation control to the
resident, via a “smart home” system. These systems allow the resident to pre-set many temperature, lighting and appliance controls and manage them remotely from a smart phone or internet connection. This removes much of the need for day-to-day decision making at home regarding these settings, where habit can intervene. However, it is important to caution that building automation is only a good strategy if it is user friendly. The master light switches mentioned above provide one example of a potential automation technology that may not successfully integrate into occupants’ lives.

Ultimately, a better understanding of the full range of the complexity of habitual behavior is needed, which this work only begins to touch on. Prior research has made clear that habits are not simply repeated behaviors, but dependent on context stability, achieving an end goal, and other factors; as such, much more qualitative information is needed about how individuals develop certain behaviors, why they maintain them, and what personal lifestyle characteristics hinder or support the continuation of these behaviors. This opens up a vast potential for future work.


### Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kWh consumption ($n = 120$)</td>
<td>2419.72</td>
<td>1021.6</td>
<td>406.35</td>
<td>5725.65</td>
</tr>
<tr>
<td>Loads of laundry per week ($n = 154$)</td>
<td>5.36</td>
<td>3.3</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Frequency of dishwasher usage ($n = 161$)</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Percentage of incandescent bulbs ($n = 157$)</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Moving to the building because green ($n = 157$)</td>
<td>0.5</td>
<td>0.5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Independent variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Values ($n = 159$)</td>
<td>4.5</td>
<td>0.8</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Beliefs (NEP) ($n = 129$)</td>
<td>51.59</td>
<td>8.3</td>
<td>22</td>
<td>71</td>
</tr>
<tr>
<td>Norms ($n = 156$)</td>
<td>13.98</td>
<td>3.3</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Control variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people ($n = 160$)</td>
<td>2.59</td>
<td>1.1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Number of appliances ($n = 161$)</td>
<td>6.14</td>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Apartment type ($n = 155$)</td>
<td>1.7</td>
<td>0.8</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Household income ($n = 147$)</td>
<td>5.38</td>
<td>1.6</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

**Answer choices for reasons for moving to the building**

- Convenient to my workplace
- Offers better air quality
- Is in an attractive location
- Because of its energy efficiency
- It offers good value (quality for price)
- Because of its water efficiency
- It is a child friendly neighborhood
- It is a green building
- Because of the view from the apartment
- It provides filtered water
- It is a new building
- It is a way to encourage green innovation

---

1. Response categories coded 1-5: Everyday, a few times a week, once a week, less than once a week, never.
2. Response categories coded 1-4: 0-25%, 26-50%, 51-75%, 76-100%
3. Response categories coded 1-5: Strongly disagree, somewhat disagree, Neither agree or disagree, somewhat agree, strongly agree
4. Original questions asked: How important is it for you to actively conserve (Electricity/Natural gas/Hot water/Cold water/Space heating/Space cooling). Response categories coded 1-3: Not important, somewhat important, very important. Six questions combined to create 18-point scale
5. Response categories coded 0-3: Studio, 1 bedroom, 2 bedroom, 3 bedroom
6. Response categories coded 1-7: Less than $50,000, $50,000 to $99,999, $100,00 to $149,999, $150,000 to $199,999, $200,000 to $299,999, $300,000 to $499,999, $500,000 or more
7. Answer choice used in analysis. Response categories coded 0-1: Yes, No
Measures of beliefs: NEP scale

- We are approaching the limit of the number of people the earth can support
- Humans have the right to modify the natural environment to suit their needs (R)
- When humans interfere with nature it often produces disastrous consequences
- Human ingenuity will insure that we do NOT make the earth unlivable (R)
- Humans are severely abusing the environment
- The earth has plenty of natural resources if we just learn how to develop them (R)
- Plants and animals have as much right as humans to exist
- The balance of nature is strong enough to cope with the impacts of modern industrial nations (R)
- Despite our special abilities humans are still subject to the laws of nature
- The so-called "ecological crisis" facing humankind has been greatly exaggerated (R)
- The earth is like a spaceship with very limited room and resources
- Humans were meant to rule over the rest of nature (R)
- The balance of nature is very delicate and easily upset
- Humans will eventually learn enough about how nature works to be able to control it (R)
- If things continue on their present course, we will soon experience a major ecological catastrophe

*R = reverse-coded questions for scale creation

8 Response categories coded 1-5: Strongly disagree, mildly disagree, unsure, mildly agree, strongly agree
Figure 1.

VBN Framework (Stern, 2000)

Values → Beliefs

Not reasoned; personal norm not activated

Spectrum between unplanned and reasoned behavior

FULLY AUTOMATIC

UNPLANNED

Reasoned action; personal norm activated

NEW BEHAVIOR

FULLY REASONED
Figure 2. kWh Consumption

*90% significance level
**95% significance level
***99% significance level

Protecting the environment is important societal goal.

Values

Beliefs

Norms

NEP score

Importance of conserving (elec, H2O, natural gas, space heating/cooling)

kWh

Total kWh consumption for previous 6 months

Type of Apt

No. of appliances

Appliances

Studio, 1BR, 2BR, or 3BR

Number of people

2.2

.35***

.4***

.084

-.16

.4***

.079

.27***

.58***

.64***

.23

.63

.59

.95

1
Figure 4. Dishwasher Frequency

Values

Beliefs

Norms

Protecting environment is important societal goal

NEP score

Importance of conserving (elec, H2O, natural gas, space heating/cooling)

Values

Beliefs

Norms

Dishwasher frequency

Number of appliances

Appliances

kWh

Apt Type

# People

Number of people in household

- .021

- .4

.32***

.88

.11

.39***

.83

.024

.021

- .098

.84

.96

.2**

.0027

.0046

- .3

.58***

.56

.19

.15

- .16***

.66***

.09

- .074

- .00048

* 90% significance level

** 95% significance level

*** 99% significance level
Figure 5. Incandescent Bulbs

*90% significance level
**95% significance level
***99% significance level

Values → Bulbs
Beliefs → Bulbs
Norms → Bulbs

Percentage of incandescent bulbs

Protecting environment important societal goal

NEP score → Bulbs

Importance of conserving (elec, H2O, natural gas, space heating/cooling)

Number of appliances

kWh

Apt Type

Number of people in household

Number of appliances

E_1

E_2

E_3

E_4

.96
.19**
.59***
.21*
.66***
.14
.13
.16
.048
.0082
-.0027
-.00049

Figure 6. Green Building

*90% significance level
**95% significance level
***99% significance level

Protecting environment important societal goal

Values

Beliefs

NEP score

Weights:

\[ \varepsilon_1 = 0.32^{**} \]

\[ \varepsilon_2 = 0.83 \]

Norms

Importance of conserving (elec., H2O, natural gas, space heating/cooling)

\[ \varepsilon_3 = 0.11 \]

\[ \varepsilon_4 = 0.15 \]

\[ \varepsilon_5 = 0.96 \]

\[ \varepsilon_6 = 0.56 \]

\[ \varepsilon_7 = 0.66^{**} \]

\[ \varepsilon_8 = 0.00049 \]

\[ \varepsilon_9 = 0.21^{*} \]

\[ \varepsilon_{10} = 0.21^{**} \]

\[ \varepsilon_{11} = 0.58^{**} \]

\[ \varepsilon_{12} = 0.00084 \]

\[ \varepsilon_{13} = 0.11^{***} \]

\[ \varepsilon_{14} = 0.39^{***} \]

\[ \varepsilon_{15} = 0.26 \]

\[ \varepsilon_{16} = 1.1^{***} \]

\[ \varepsilon_{17} = 0.074 \]

Green

Moved to bldg because green

binomial

\[ \text{HH Income} \]

\[ \text{Income} \]

\[ \text{Number of appliances} \]

\[ \text{Apt Type} \]

\[ \text{Studio, 1BR, 2BR or 3BR} \]

\[ \text{kWh} \]

kWh consumption previous 6 months

\[ \text{# People} \]

Number of people in household

\[ \text{Values} \rightarrow \text{Beliefs} \]

\[ \text{Beliefs} \rightarrow \text{Norms} \]

\[ \text{Norms} \rightarrow \text{Green} \]

\[ \text{Green} \rightarrow \text{Apt Type} \]

\[ \text{Apt Type} \rightarrow \text{# People} \]

\[ \text{Green} \rightarrow \text{kWh} \]

\[ \text{kWh} \rightarrow \text{Number of appliances} \]

\[ \text{HH Income} \rightarrow \text{Income} \]

\[ \text{Income} \rightarrow \text{Number of appliances} \]

\[ \text{Number of appliances} \rightarrow \text{Apt Type} \]

\[ \text{Apt Type} \rightarrow \text{kWh} \]

\[ \text{kWh} \rightarrow \text{# People} \]
Figure Captions

Figure 1. Overview of VBN framework and hypothesized outcomes of unplanned vs. reasoned behavior.

Figure 2. Path analysis predicting household electricity consumption from VBN variables. Number of appliances, number of people, and type of apartment included as control variables. The path analysis returned significant coefficients in predicting beliefs from values and personal norms from environmental beliefs (p < .001). The link between a personal norm and behavior (electricity consumption) was not significant.

Figure 3. Path analysis predicting loads of laundry per week from VBN variables. Number of appliances, number of people, and type of apartment included as control variables. Loads of laundry also tested as a predictor of kWh consumption. The regression predicting environmental beliefs from values was significant (p < .005). The analysis returned a significant coefficient (p < .001) in predicting personal norms from environmental beliefs. Personal norms were not predictive of number of loads of laundry per week in the household.

Figure 4. Path analysis predicting frequency of dishwasher usage from VBN variables. Number of appliances, number of people, and type of apartment included as control variables. Dishwasher usage also tested as a predictor of kWh consumption. The model returned a significant coefficient (p < .001) in predicting beliefs from values and personal norms from beliefs. There was no significance in the model in predicting dishwasher usage from personal norms.

Figure 5. Path analysis predicting percentage of incandescent bulbs (vs. more efficient compact fluorescent or other) from VBN variables. Number of appliances, number of people, and type of apartment included as control variables. Percentage of incandescent bulbs also tested as a predictor of kWh consumption. The model returned a significant coefficient (p < .001) in predicting beliefs from values and personal norms from beliefs. There was no significance in predicting more or less use of incandescent bulbs from a personal norm to conserve resources.

Figure 6. Path analysis predicting choice of moving to the study building because it is green from VBN variables. Number of appliances, number of people, apartment type, and household income included as control variables. Variable for building choice also tested as a predictor of kWh consumption. This model returned significant coefficients (p < .001) in predicting beliefs from values and personal norms from beliefs. In this model, a personal norm to conserve resources did predict the respondent’s choice of moving to the building because of its green features (p < .001).