Can behavioral intentions predict domestic electricity consumer's actual behavior towards energy efficiency?

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Abstract

To reduce domestic electricity consumers consumption of electricity is a global concern. This pilot study investigates the extent to which domestic electricity consumers intend to use and use energy efficiently. A co-relational research design was used to investigate the relationship between the predictor variables and the independent variables in the constructs of the Theory of Planned Behavior which was selected as theoretical framework. A convenience stratified sample of 61 domestic electricity consumers was selected. A questionnaire and telephone response log was used to collect data. Simple linear regression analysis indicates significant statistical evidence of a linear relation between the predictor variables and the independent variables. The participants intended to save between 2% and 35% of their electricity consumption and the actual electricity consumption savings were between 2% and 30%.

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1. Introduction

The available electricity generation capacity of South Africa may not adequately meet the electricity demand unless additional generation capacity is built or the demand is reduced [1]. However, it can take up to 8 years to build a thermal power station whilst reductions in the electricity demand or consumption by using electricity efficiently can be implemented immediately. Since January 2008, the electricity utility in South Africa (Eskom), has been running a number of initiatives aimed at reducing the electricity consumption due to the fact that a number of power shortages were experienced.

The domestic electricity consumers account for approximately 19% of the total electricity consumption and the industrial, mining, manufacturing, agricultural and commercial sectors account for the remaining 81% in South Africa [2]. During the peak demand periods the electricity consumption increases by up to 15% [3]. These daily peak demand periods correspond to the activities of domestic consumers such as, lighting, water heating, cooking and space heating or cooling during the mornings as well as the late afternoons and/or evenings. The potential savings in electricity consumption by domestic consumers alone can reduce by up to 30% of their electricity consumption by using advanced energy efficiency technologies or devices, such as, compact fluorescent lights (CFL's), light emitting diodes (LED's) and low flow shower heads and changing their behavior [4]. To influence behavior change is an ongoing challenge and therefore consumer behavior research is needed [5].

In the early 1980's Canada decided to enforce the reduction of electricity consumption of the residential customers to mitigate the effects of energy scarcity [6]. One of the main contributors to this enforcement of electricity consumption reductions was the behavior of consumers, specifically their resistance to energy conservation because of their deeply entrenched ways of thinking and behavior with respect to energy use. This entrenched behavior could be attributed to an era of inexpensive energy. Similarly, in South Africa where this study is done, even when the electricity prices have doubled, there is no evidence that suggests that domestic consumers, in particular, use energy efficiently. It could well be that the South African domestic consumers have their own entrenched behaviors and thinking towards energy efficiency that emanate from the times of inexpensive electricity. Higher prices alone may not bring about the desired behavior [7].

A number of energy efficiency initiatives promise significant savings but results that have been obtained do not seem to reach the full potential [8]. Different ways of achieving the desired energy efficiency results from domestic consumers that emphasis behavior and/or behavior change have been researched and it was found that changing behavior is sometimes oversimplified and yet it a complex process [9].

The following classification or grouping of the theories and methods: Single Construct; Multi-Construct; Segmentation; Multi-level; Community-Based; Process approach was set out [10].

Multi-construct approach predict behavior by postulating relationships among various psychological constructs and behavior, recognizing the roles of a number of constructs and the impact on behavior[10]. In essence, they are aimed at determining which psychological constructs are significantly correlated to the target behavior and assume that the behavior can be determined from its causes. The Theory of Planned Behavior was selected for this study as the

approach that incorporates most of the determinants of behavior in the various Multi-Construct and Multi-Level models. The Theory of Planned Behavior aims to establish correlations between the different determinants of behavior. It must be noted that measuring psychological constructs that are internal to the mind and thus not directly observable, is difficult, as such factors often exist below consciousness [10].

2. The theory of planned behavior as theoretical framework

The theory of planned behavior was developed and is shown in Fig. 1 [11, 12]. It states that, human action is guided by three kinds of considerations, namely; behavioral beliefs (i.e. beliefs about the likely consequences of the behavior), normative beliefs (i.e. beliefs about the normative expectations of others) and control beliefs (i.e. beliefs about the presence of factors that may further or hinder performance of the behavior).
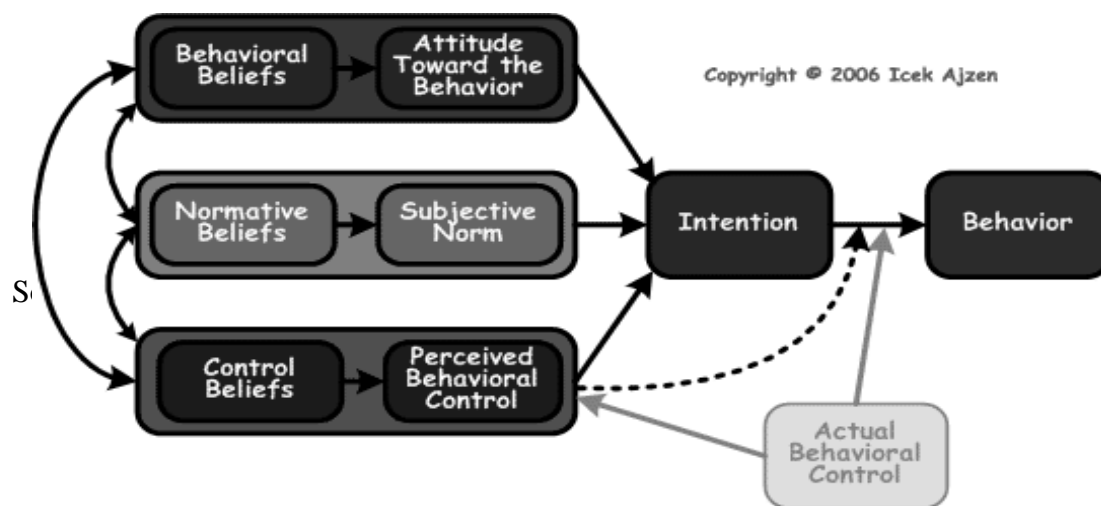

Fig. 1. The theory of planned behavior.

In their respective aggregates, behavioral beliefs produce a favorable or unfavorable attitude towards behavior; normative beliefs result in perceived social or subjective norm and control beliefs give rise to perceived behavioral control, the perceived ease or difficulty in performing a specific behavior [13].In combination, attitude toward the behavior, subjective norm and perception of behavioral control lead to the formation of a behavioral intention [11].

As a general rule, the more favorable the attitude and subjective norm, and the greater the perceived control, the stronger should be the person's intention to perform the behavior in question [13]. Given a sufficient degree of actual control over the behavior, people are expected to carry out their intentions when the opportunity arises [11]. Intention is thus assumed to be the immediate antecedent of behavior [14]. The following sections review the literature that focuses on the determinants of behavior as indicated by the Theory of Planned Behavior.

2. 2. Behavioral beliefs and attitude toward the behavior

Behavioral beliefs are beliefs about the likely outcomes of the behavior and the evaluation of the outcomes and in their respective aggregates they produce a favorable or unfavorable attitude toward the behavior [12]. Attitudes towards behavior are not isolated, but reflect the beliefs and values that a person holds [15]. People generally weigh the consequences of their behavior; if rewards are expected from a particular behavior, then that behavior is encouraged and if there will be penalties from a particular behavior, then that behavior is less likely [15].

People, in general, maintain a consistent relationship between their beliefs, values and attitudes [15]. However it is not uncommon for people to have positive beliefs about the likely outcome of their behavior as well as favorable attitudes towards that behavior but still behave differently [9]. For example, people can have positive beliefs and favorable attitudes towards the use of energy from renewable sources, such as solar water heaters, but act against the installation of such devices because the initial costs are high or because the neighbors do not approve of the appearance of these solar water heaters on the roofs in their neighborhood (or estate). The other factors that intervene between favorable attitudes and beliefs, such as normative and control beliefs are discussed in the sections that follow.

2. 3. Normative beliefs and subjective norm

Normative beliefs are beliefs about the normative expectations of other and motivation to comply with these expectations which result in subjective norms [12]. This notion is also supported by other social theorists who suggest that the context of behavior is framed not just by the environmental factors that work at the level of individual behavior, but also by "structural factors" which can influence entire groups of people to behave in a similar fashion [10]. When people believe that their significant others within the community, such as the community leader or father, will approve of their behavior, they are more likely to behave in the expected manner [16]. For example, when people know that littering is generally not accepted within their community, it is unlikely that they would litter. Similarly social structures can also constrain people's behavior [17].

2. 4. Control beliefs and perceived behavioral control

Control beliefs are beliefs about the presence of factors that may further or hinder performance of the behavior which give rise to perceived behavioral control [12]. The more volitional control a person has over behavior, the less important perceived behavioral control should be in that perceived behavioral control denotes the subjective degree of control over performance of the behavior itself [14]. People who believe they that they neither have the resources (e.g. money or technical knowhow) nor the opportunity (e.g. availability of energy efficient devices) to perform certain behavior are unlikely to form strong behavioral intentions to engage in it even if they hold favorable intentions, and believe that important others would approve [16]. For example, people who have positive attitudes towards energy conservation may want to implement some of the energy efficiency measures such as lowering the geyser temperature or buy the geyser timer switch. However if the person does not know how to reduce the temperature settings or does not know where to purchase the geyser timer switch or does not

know how to install the geyser timer switch or does not have the financial means to purchase the geyser timer switch and/or services of a contractor to install the timer and/or change the setting, it is unlikely that the person would perform the desired action or behavior [18]. Positive and/or favorable attitudes and beliefs are more likely to lead to the desired behavior when strong barriers to action are removed [9].

2. 5. Intentions and actual behavioral control

The combination of attitudes, subjective norm and perceived behavioral control leads to the formation of the behavioral intention [12]. This view is supported by stating that intentions are closely related to behavior and largely mediate behavior [14]. It appears that strong intentions towards a certain action predict high possibilities of behavior or behavior change. To the extent that perceived behavioral control is veridical, it can serve as a proxy for actual control and contribute to the prediction of the behavior in question [12]. This view is supported by stating that attitudes and perceived behavioral control have a significant influence on intentions and behavior [16].

A simple way of improving energy efficiency within a household is to change behavior [19]. Considering the limited success of the current energy efficiency initiatives in making the domestic electricity consumers' use their electricity efficiently, this pilot study aims to answer the following research question:

To what extent do domestic electricity consumers intend to use and use electricity efficiently?

The null hypothesis is:

H_0:   The behavioral intentions of the domestic electricity consumers towards energy efficiency do not affect their actual behavior.

This pilot study seeks to explore some of the claims in the abovementioned literature with respect to the behavioral intentions and/or behavior of the domestic consumers to reduce their electricity consumption. In addition it will also contribute to the body of knowledge about the behavior of domestic electricity consumers and the determinants of such behavior with respect to energy.

3. Intervention: energy @ home program

The Energy @ Home educational intervention was conducted over 13 weeks and consisted of a total of up to 5 hour educational intervention sessions per participant or household. The two educational interventions sessions were conducted as two separate sessions for each household. The educational intervention was focused on the owners of the household (i.e. parents, partners, owners) and rarely included other people within the household.

During session 1 *(2 hours 30 minutes per household)* the participants were required to complete the Energy Audit of the household. The Energy Auditor, developed by Eskom, calculates the electricity consumption of a household. Each household was required to provide a reasonable estimate of their usage of all appliances in the household in terms of time (i.e. minutes or hours). For example the participants were required to indicate how many times they boil water per day in a kettle and how much water they boiled; or how many times a day they

take a bath or shower; or whether the geyser is switched on/off at certain times and what the temperature setting of the geyser was. By requiring reasonable estimates of their usage of electricity per activity or appliance, the participants were being made aware of what they were consuming and whether there is an opportunity to alter their level of consumption by changing their behavior or appliances. The participants were also required to provide the power rating of the different appliances (which are written on the appliances) they use in the household. By so doing the participants were being made aware of another important feature they must consider when they purchase appliances.

The results were presented to the participant showing the different consumption levels of the different devices or appliances. At the end of session 1, each participant was shown the areas or activities in their consumption where they can use electricity efficiently and thus reduce their electricity consumption either by installing energy efficient devices or changing their behavior or both. Each participant was then required to consider actions they should take in order to reduce their consumption and prepare for the second session and second energy audit.

During session 2 *(2 hours 30 minutes per household)* the participants were shown some of the energy efficient technologies such as, CFL's and LED lights and low flow shower heads. The participants were shown via the Energy auditor the differences in consumption between the energy efficient lights and the incandescent lights as well as the difference in the amount of water that low flow shower heads use when compared to the normal flow shower heads. Further, participants were shown the amount of electricity that can be saved by reducing the usage time. For example, the participants were shown the amount of electricity that can be saved by switching off lights in unused rooms (without compromising the safety and security of the household) and by lowering the geyser temperature by at least one degree. Other demonstrations of changes in behavior or lifestyle included the following activities:

- A comparison of water used when taking a bath compared to the water used when taking a shower with a low flow shower head as well as the concomitant electricity usage reductions. For example, by showering using a low flow shower head instead of taking a bath, both the water and electricity consumption can be reduced by more than 20%.
- The amount of electricity consumed by a kettle when boiling water when it is full and when it is half full by measuring the time it took to boil a filled kettle versus a half filled kettle.

Other participants who had air-conditioners were also shown the reductions in energy consumption that can be achieved by lowering the air-conditioners' temperature by a degree or two and still derive the same comfort levels as well as the advantages of better insulation around the house.

The participants then completed the second energy audit after they were provided with information and tips on how to save electricity, indicating the areas and activities where they intended to reduce their consumption either by changing their behavior and/or install energy efficient devices or appliances. The participants indicated possible savings they intend to implement ranging from the change in behavior, such as showering instead of taking a bath or switching off the geyser and towel heaters in the bathrooms during the day, switching off lights

in unused rooms, reducing their pool pumps operating times, opening curtains in the mornings instead of switching on lights and so on.

The participants were then required to complete the second Energy audit showing the changes they intended to make. Participants were then required to implement the energy efficiency measures they indicated in this Energy audit.

All participants were given a "power pack" which consisted of compact fluorescent bulbs (up to 5), a geyser blanket, a low flow shower head, solar power outdoor lights (up to three). The participants that had already installed CFL's chose the low flow shower heads instead. Two of participant who were already in possession of the items contained in the "power pack" were given a solar cooker and an electronic display meter (called the Eco Eye that indicates the instantaneous consumption in the house at any given time).

3. 1. Research design

A co-relational research design was used to investigate the relationship between predictor variables and independent variables in the constructs of the Theory of Planned Behavior. In this study the predictor variables are the attitude, subjective norm and perceived behavioral control while the independent variable is the behavioral intention.

3. 2. Population and sample

There are approximately 10 million domestic electricity consumers in South Africa and more than 6 million of these consumers are located in one Province [1] where this study was done. Approximately 61% of the domestic electricity consumers are classified as low income consumers and the remaining 39% are classified as middle to high income consumers. Low income consumers typically use up to 105 kWh per month whilst middle to high income use a minimum of 200 kWh per month. In most cases low income consumers use electricity mainly for lighting and entertainment (i.e. television, radio, music players), but rarely use electricity for cooking, except using the microwave oven and the kettle to boil water either for cooking or washing dishes or bathing [1]. Middle to high income consumers use electricity for a range of activities including cooking, lighting, space heating and/or cooling, water heating, swimming pool pumps and other water features.

An advert was sent out via newspaper, radio and television adverts requiring people to participate in the Energy @ Home program. There were 290 domestic electricity consumers that responded to this advert. More than 75% of the respondents were located in an area of approximately 100 km^2. The convenience stratified random sampling method was used to select 61 participants (out of the 290 respondents). A convenience stratified sample is drawn from whichever members of the population available, whether the sample is representative or not [20]. The selection of the participants for convenience stratified samples was based on the knowledge of the population (i.e. author's own knowledge) as well as the knowledge of experts from Eskom (The South African electricity utility that generates, transmits, distributes and retails electricity) and NEEA (The National Energy Efficiency Agency that is responsible for the promotion of energy efficiency in South Africa) [21]. In this study the participants who consumed more than 200 kWh per month were selected because they use more energy per month when compared to

the low income participants and were seen to have the potential to reduce their electricity consumption.

From the 61 participants, 42 were contacted telephonically a year after the intervention in order to determine the participants' actual behavior. The remaining 19 participants contact details had changed and could not be reached.

3. 3. Instruments

Two instruments were used; a questionnaire and a telephone response log.

3. 4. Questionnaire

A questionnaire was designed using the manual for developing the Theory of Planned behavior questionnaire [22]. The manual specifies that the questionnaire must be designed for a specific target population, who will be performing a specific action, in a specific context and within a given time period. In this study the target population was the domestic electricity consumers, who will be required to use energy efficiently in their homes or households all the time.

The questionnaire consisted of 46 questions and is divided into Section A and B. Section A deals with the general or background information about the participant such as the current costs of electricity consumption, the activities electricity is used for, the number of people in a household, the type of electricity meter used, whether information or tips about energy efficiency was received, cost of consumption per unit or per month. Section B of the questionnaire which is based on the Theory of Planned Behavior, has 4 subsections that use the 7 point Likert scale as well as negative and positive scale with a range between -3 and + 3 (effectively 7 points) which are discussed below.

The first subsection measures the behavioral intentions direct (BID) towards energy efficiency and is labeled BID1 in the questionnaire. Although the Theory of Planned behavior shows that the behavioral intention is an aggregated sum of the attitude, subjective norm and perceived behavioral control, in some instances it is possible to observe the actual intended performance directly and this direct measurement is a useful tool for comparing the results [22].

The second subsection measures attitudes (AD) and subjective norm (SND) and perceived behavioral control (PDCD) directly and are labeled as AD1, SND1 to 4 and PBCDS/C1 to 3 respectively. The attitude direct measurement uses bipolar adjectives such as *worthless or useful,* where *worthless* has a score of 1 and *useful* has a score of 7 on the Likert scale. The subjective norm direct (SND) measurement uses statements requiring responses such as *strongly disagree* or *strongly agree*, where *strongly disagree* has a score of 1 and *strongly agree* has a score of 7. The perceived behavioral control direct measurement uses bipolar adjectives such *difficult* or *easy*, where *difficult* has a score of 1 and *easy* has a score of 7. The perceived behavioral control measurement is divided into two sub-parts as recommended by the manual for developing the Theory of planned behavior questionnaire [22], namely; the self-efficacy and controllability measurement in order to assess the following,

- Self-efficacy measurement: The person's perception about the difficulty of performing the task and the confidence of performing the task.

- Controllability measurement: The factors beyond the person's control that determine the behavior.

The third section of the questionnaire measures the indirect measurement of attitudes (AIBB = Attitude Indirect Behavioral Belief), subjective norm (SNINB = Subjective Norm Indirect Normative Belief), perceived behavioral control (PBCIB = Perceived Behavioral Control Indirect Belief). The perceived behavioral control was not split in the indirect measures. This was done in order to limit the length of the questionnaire. The indirect attitude measurement (AIBB) is obtained by using statements that require responses such as *unlikely* or *likely*, where *unlikely* has a score of 1 and *likely* has a score of 7. The indirect subjective norm measurement (SNI) uses statements that require responses such as *strongly disagree* or *strongly agree*, where *strongly disagree* has a score of 1 and *strongly agree* has a score of 7. The perceived behavioral control use statements that require responses such as *less likely* or *more likely,* where *less likely* has a score of 1 and *more likely* has a score of 7.

The fourth section of the questionnaire measures the outcome evaluations of the indirectly measured attitude (i.e. AIOE = Attitude Indirect Outcome evaluation), the subjective norm (i.e. SNIOE = Subjective Norm Indirect Outcome Evaluation), the perceived behavioral control strength (i.e. PBCIS = Perceived behavioral control strength). The outcome evaluations are evaluations of the expected attitude when a certain attitude is adopted. For example, AAIE1 is the outcome evaluation of the attitude AIBB1 in subsection 3 above. The attitude outcome evaluation (AIOE) used statements that required responses such as *bad* or *good,* where *bad* was assigned a score of -3 and *good* was assigned a score of +3. The -3 to +3 scale is used instead of 1 to 7 to enable the participants to express their positive or negative expectations is recommended by the manual for developing the Theory of planned behavior questionnaire (Francis et al. 2004). The subjective norm outcome evaluation (SNIOE) used statements that required responses such as *not at all* or *a lot*, where *not at all* was assigned a score of -3 and *a lot* was assigned a score of +3. The perceived behavioral control strengths (PBCIS) used statements that required responses such as *strongly disagree* or *strongly agree*, where *strongly disagree* has a score of -3 and *strongly agree* has a score of +3.

3. 5. *The telephone response log*

The telephone response log was developed to triangulate the behavioral intentions indicated by the participants in section B of the questionnaire. The participants were required to indicate what their current electricity costs are and whether they implemented the energy efficiency measures they intended to implement.

3. 6. *Reliability and validity of the instruments*

The questionnaire was pre-tested with 6 NERSA (The National Energy Regulator of South Africa that regulates the electricity supply industry) employees and 15 domestic consumers. However because the number of participants was not large enough to perform simple linear regression analysis the reliability of the instrument was taken at face value.

As part of ensuring that the questionnaire measures what it intends to measure the questionnaire was sent to two experts in the field of mathematics, science and technology

education that have experience in the use of the Theory of Planned behavior based questionnaire. The experts provided model questionnaires of studies they had conducted that used the Theory of Planned Behavior that were used to enhance this questionnaire. The suggestions, additional information and insights as well as the model questionnaires provided by the experts improved the structure of the questionnaire. With the suggested modifications and additions the experts' views were that the questionnaire will measure what it intends to measure.

The telephone response was validated against the current electricity costs of the participants and electricity units used. The participants provided the electricity costs and the electricity consumption per month at the time of making the telephone call, which was a year after the Energy @ Home program, as indicated in their electricity bills. These units were compared with the units that were indicated at the start of the Energy @ Home program to confirm the reductions in electricity costs and consumption. The reliability and validity of the Telephone response log of the electricity costs and consumption was taken at face value. This was done because the participants were not always available at times when the author could verify the electricity bills.

3. 7. Data collection

The questionnaire was mailed and/or hand delivered to the 61 participants. Some of the participants requested assistance in completing the questionnaire. The telephone response log was used during the telephone conversations to record the responses of the 42 participants that were contacted.

3. 8. Data analysis

Section A of the questionnaire presents the general information of the participants regarding the following measures: average monthly electricity costs; activities electricity is used for; number of people per household; type of electricity meter used; whether energy efficiency information is received or not; monthly average electricity usage; whether there has been a decrease or increase in the electricity consumption over the past 12 months (prior to the Energy @ Home program).

Section B of the questionnaire is analyzed by using the simple regression analysis technique and calculation of the mean and standard deviation where applicable and used. The computer software used for both the simple linear regression analysis and calculation of mean and standard deviation is the Statistics Analysis Software (SAS). Simple linear regression analysis is used to determine if there is a linear relationship between the continuous variables (i.e. the predictor variables and the response variable). In this study attitude, subjective norm and perceived behavioral control were predictor variables and behavioral intention the response variable. The best-fit (i.e. least squares) linear regression Eq. is calculated such that the distance between the observed data points and the predicted values estimated by the regression Eq. were minimized. Simple linear regression technique was applied to the results obtained from the direct measurements of attitude, subjective norm and perceived behavioral control (i.e. the second subsection of section B of the questionnaire) and the results obtained from the indirect measures (i.e. third and fourth subsection of the questionnaire).

The data was screened for errors and responses that may be outside the allowed ranges. All the scales that had the negative and positive scale such as, -3 to + 3 were re-coded to 1 to 7, where -3 was re-coded to 1 and +3 re-coded to 7. All the products obtained from the indirectly measured attitude, subjective norm and perceived behavioral control were normalized to fall between 1 and 7 (where 1 denotes *weak* and 7 denotes *strong)*, for comparison with the scores from the directly measured attitude, subjective norm and perceived behavioral control.

The data from the telephone response log were analyzed by comparing the behavioral intentions with actual behavior of the participants over the one year period. For example, the participants who indicated that they will implement measures such as installing Compact Fluorescent Lights (CFL) were required to confirm that they indeed installed the CFL's. Participants were also required to provide details from their latest electricity bill (or units bought for prepaid customers), such as the monthly electricity units consumed or average monthly consumption as reflected in the electricity bill and the costs for the month or average monthly costs.

4. Results

4. 1. The theory of planned behavior constructs

According to the Theory of Planned behavior, human action is guided by three kinds of considerations; namely behavioral beliefs, normative beliefs and control beliefs. In their respective aggregates, the behavioral beliefs produce favorable or unfavorable attitude toward the behavior; normative beliefs result in subjective norm; and control beliefs result in the perceived behavioral control. The combination of attitude towards the behavior, subjective norm and perceived behavioral control leads to the formation of a behavioral intention. The results of this section are presented as follows:

1. The Behavioral Intentions Direct (BID) measure.
2. The Behavior intention derived from the direct measures of attitude, subjective norm and perceived behavioral control
3. The Behavioral intention derived from indirect measures of attitude, subjective norm and perceived behavioral control and their expected outcomes.

4. 2. The behavioral intentions direct (BID) measure

The measurement of the behavioral intentions is for the purpose of comparing it with the behavioral intentions score obtained from the behavioral intentions measured both directly and indirectly for compatibility and consistency.

The results of the Behavioral Intentions Direct measurement are shown in table 1. Up to 81% (i.e. 49) of all the participants intended to switch off all unused appliances, 74% (i.e. 45) planned to boil the required amount of water with the kettle, 62% (i.e. 38) intend to install solar water heaters and 58% (i.e. 35) intend to fit Compact Fluorescent Lights (CFL's). Installing a geyser timer and switching the geyser off was intended by 41% (i.e. 25) and 44% (27) respectively. Switching off the pool and using gas stoves were the least activities intended with average scores of 16% (i.e. 10) each. Approximately 44% (i.e. 27) of participants that intend to fit a timer,

whilst 35% (i.e. 21) intended to lower the geyser temperature, 16% (i.e. 10) intended to switch off air conditioners and 42% (i.e. 26) intended to switch off the pool pumps or water features. Other activities such as installing a gas stove or gas heater were selected by 16% (i.e. 10) of the participants.

Table 1. Activities selected by participants as those intended to be implemented

Activities of efficient use of energy	% Total participants *(N = 61)*
Switching off unused appliances	81
Low Flow shower heads	47
Lowering geyser temperature	35
Switching off geyser	41
Installing geyser timer	44
Fitting Compact Fluorescent lights (CFLs)	58
Installing a Solar water heater	62
Air con off during peak times	16
Pool and water features off peak times	42
Boiling only the required amount in kettle	74
Cooking with proportional plate size	58
Other (gas stove/heater)	16

The mean score of the behavior intentions generalized, shown in table 2, is 5.65 and a standard deviation of 1.90. This indicates that the participants selected approximately 5.65 or 47% of the 12 listed energy efficiency activities that they intend to implement.

Table 2. The mean and standard deviation of the behavior intentions direct

Predictor Variables	N = 61	
	Mean (M)	Standard deviation (SD)
Behavioral Intentions Generalized (BIG)	5.65	1.90

4. 3. The behavior intention derived from the direct measures

The results (i.e. the Mean and Standard Deviation) of the direct measurements for the attitude, subjective norm and perceived behavioral control (both self-efficacy and controllability) are shown in table 3. The results shows a Mean score for the directly measured attitude (AD) of 5.46 out of 7 (or 78%), a Mean score of 5.40 out of 7 (or 77%) for the subjective norm and Mean scores of the perceived behavioral control for both self-efficacy and controllability of 4.10 (or 59%) and 4.94 (or 71%), respectively. The Standard Deviation of the direct measures is between 1.56 and 1.65.

Table 3. The mean and standard deviation predictor variables direct measurements for all groups

Predictor Variables	N = 61	
	Mean (M)	Standard deviation (SD)
Attitude Direct (AD)	5.46	1.56
Subjective Norm Direct (SND)	5.40	1.65
Perceived Behavioral Control Direct Self-efficacy (PBCDS)	4.10	1.65
Perceived Behavioral Control Direct Controllability (PBCDC)	4.94	1.58

The positive mean score of the attitude, subjective norm and perceived behavioral control indicate positive or favorable attitudes, subjective norm and perceived behavioral control of the participants.

A simplified version of the Theory of Planned Behavior using the direct measures to depict the results in table 3 is shown in Fig. 2. The simplified aggregation of the Behavioral Intention for the Theory of Planned Behavior, assuming that the attitude, subjective norm and perceived behavioral control contribute in equal proportions to the behavioral intention, is shown be in Eq. 1. This implies that the attitude (AD), subjective norm (SND) and perceived behavioral control (PBCD) contribute about a third each to the sum total of Behavioral Intention (BI_{EE},), where BI_{EE} is the behavioral intention to use energy efficiently. For simplicity, only the perceived behavioral control direct controllability Mean score is used in Eq. 1, the result from using the mean score for self-efficacy is also given.

Behavioral Intention $(BI_{EE}) = 0.33(AD) + 0.33(SND) + 0.33(PBCD)$ (1)
Hence, $(BI_{EE}) = (0.33 \times 5.46) + (0.33 \times 5.40) + (0.33 \times 4.94)$
       $(BI_{EE}) = 5.21$ (or 4.94 if the self-efficacy score of 4.10 is used)

The Behavioral Intention (BI_{EE}) of 5.21 out of seven (i.e. 74% strength) calculated from Eq. 1 is also positive towards energy efficiency.

The participants show positive attitude, subjective norm and perceived behavioral control towards energy efficiency and hence a positive behavioral intention.

4. 4. The behavioral intention derived from indirect measures

The results obtained from the third and fourth subsections of the questionnaire are used to make composite measures of the attitude, subjective norm, perceived behavioral control as follows:

Attitude = Behavioral beliefs × Expected outcomes,
Subjective norm = Normative beliefs × motivation to comply, and
Perceived behavioral control = Control beliefs × influence of the control beliefs.

The predicted probability, F-statistic of 29.74, p-value less than 0.0001, the r^2 of 0.87 and the adjusted r^2 shown in table 4, are derived from the simple linear regression analysis procedure. The Mean score of attitude of 5.86 out of 7 (i.e. 84%), Subjective norm of 4.42 out of 7 (i.e. 63%) and perceived behavioral control of 4.38 out of 7 (63%) indicate favorable attitudes, subjective norm and perceived behavioral control.
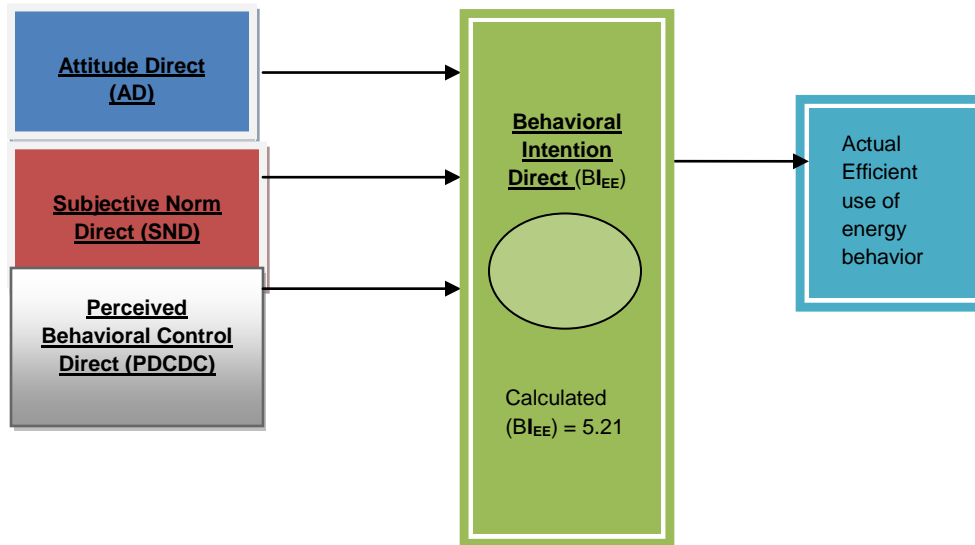
Fig. 2. Simplified graphical representation of the theory of planned behavior using direct measures only.

Table 4. Simple linear regression analysis of the energy efficiency behavior of the participants

Predictor variables	Mean (M)	Predicted Probability	F-Statistic and P-value	r^2	Adjusted r^2
Attitude (A)	5.86	0.19			
Subjective norm (SN)	4.42	0.24	29.74 <0.0001	0.87	0.79
Perceived Behavioral Control (PBC)	4.38	0.29			

The simple linear regression analysis Eq. used to calculate the Behavioral Intention to use energy efficiently (I_{EE}) is shown in Eq. 2:

$$I_{EE} = 0.3846 + 0.1897 \,(A) + 0.2415 \,(SN) + 0.2894 \,(PBC) \tag{2}$$

$I_{EE} = 3.83$

From Eq. 2 the calculated behavioral intention (I_{EE}) to use energy efficiently yields a value of 3.83 out of 7 (i.e. 55% strength) which indicates a positive behavioral intention. Although the behavioral intention is positive it is relatively weak when compared to the one obtained via the direct measures. The scores of the subjective norm (4.42 or 63%) and perceived behavioral control (4.38 or 62.5%) in table 4 are also relatively weak when compared with the attitude score of (5.86 or 84%) The graphical representation of Eq. 2 is provided in Fig. 3.
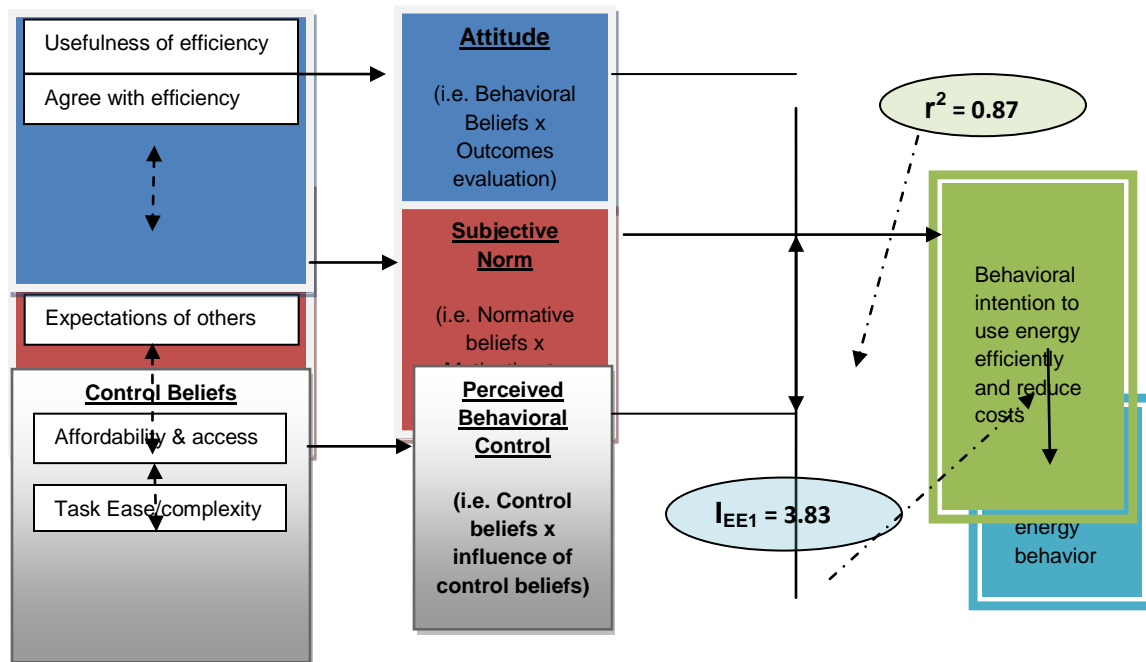

Fig. 3. graphical representation of the theory of planned behavior as used in this study.

The F-statistic of 29.74 with p value less than 0.001 and r^2 of 0.87, shown in table 4, indicates that there is significant statistical evidence for the linear relationship between the predictor variables (i.e. attitude, subjective norm and perceived behavioral control) and the response variable (i.e. behavioral intention). The r^2 value of 0.87 implies that 87% of the data points fall closely along the best-fit line and that the predictor variables are good predictors of the response or dependent variable.

4. 5. The telephone response log

The results obtained from the Telephone response log are shown in table 5. Out of the 61 participants, 42 provided responses to the telephone response log about their implementation or non-implementation of the energy efficiency they intended to implement.

Table 5. The telephone response log

Number of Participants who responded	Number of participants who intended to implement energy efficiency measures	Number of participants who implemented the intended energy efficiency measures	Number of participants who did not intend to implement the energy efficiency measures
42	42	42	0

Therefore the participants showed positive behavioral intention with their generalized behavioral intentions; their directly measured behavioral intentions and their indirectly measured intentions implemented the energy efficiency measures they intended to implement. This result is consistent with the Theory of Planned Behavior in that positive or favorable behavioral intentions resulted in the implementation of the intended behavior.

5. Discussion

In order to answer the research question: "to what extent the participants intend to use and use energy efficiency?" Participants showed positive behavioral intentions direct (BID) of implementing energy efficiency measures with a mean of 5.65 from the 12 measures that were listed in the questionnaire. Further the behavioral intention from the indirect measures of 3.83 (or 55% strength) and 5.21 (74%) from the direct measures indicates favorable behavioral intentions towards energy efficiency. However the strength of the behavioral intention from the indirect measures of 3.83 is relatively weak. The F statistic of 29.74, p value less than 0.0001 and the r^2 of 0.87 indicates the statistical significance of the linear relation between the predictor variables and the independent variable. The 42 participants listed in the Telephone response log, who had previously indicated intentions to implement energy efficiency measures, confirmed that they implemented the energy efficiency measures. As predicted by the Theory of Planned Behavior individuals who have favorable intentions are likely to implement their favorable intentions when given an opportunity to do so [23].

6. Testing the hypothesis

The null hypothesis H_0 states that the behavioral intentions of domestic electricity consumers towards energy efficiency do not affect the actual behavior. The implementation of the favorable behavioral intentions by the 42 participants who responded to the telephone response log indicates that the behavioral intentions of the domestic electricity consumers affect their actual behavior and therefore the null hypothesis is rejected.

7. Conclusion

This pilot study showed that participants have intentions of using electricity efficiently in activities such as lighting, water heating, space heating and cooling and cooking. The significance of this finding is that in all these activities there is a potential to save electricity either by changing behavior or installing energy efficient appliances. The abovementioned activities have seen significant developments and technological advances in the last 2 to 5 years that are aimed at reducing the electricity consumption of the existing devices. For example, by

just using efficient lighting devices the total electricity consumption of a household can be reduced by up to 2% (i.e. 80% reduction of about 8% of the total household consumption). As the technologies mature it is expected that the purchase prices of the new energy efficient devices. It is therefore possible that the use of these devices will then increase.

The behavioral intentions direct revealed that a high number of the participants intended to implement the kinds of measures that required little or no additional costs or extra effort. This involves activities such as switching off unused appliances; boiling the required amount of water; or cooking with the proportional size plate; and installing the Compact Fluorescent lights. It is important to notice that the participants in this study were given a "power pack" which consisted of compact fluorescent bulbs (up to 5), a geyser blanket, a low flow shower head, solar power outdoor lights (up to three). This finding is consistent with previous findings [9] that generally speaking as the kind of energy saving activity moves from being easy and inexpensive to difficult and costly the less likely it is to be performed. Further, the tasks that are perceived or considered by participants to be difficult or complex and/or expensive options such as installing low-flow shower heads, lowering the geyser temperature, were selected by fewer participants. Thus the barriers to implementing energy efficiency measures such as the complexity or costs of the task retard the implementation of energy efficiency measures.

The indication by the participants to implement various energy efficiency measures is consistent with the Theory of Planned Behavior in predicting that positive and favorable attitudes, subjective norm and perceived behavioral control towards a behavior yield positive and favorable behavioral intentions. The favorable behavioral intentions in turn lead to the implementation of the intended behavior.

8. Limitations of study

This study did not evaluate the effect of the number of people and/or children within a household and its effect on the perceived behavioral control in particular. The Theory of Planned Behavior indicates that the significant others that the participants will be required to express their normative beliefs on need to be performing the actual intended behavior for this measure to be effective. In this study the actual behavior of the significant others was not evaluated first and therefore may not have had the intended influence. Adults already know some concepts that can be used to build on and demonstrate the main principles of electricity consumption and saving. For instance they already know some concepts that can be used to demonstrate the key principles of electricity consumption, such as the effort required to ride a bicycle uphill and/or on level ground [18].

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