

CAUSAL RELATIONSHIP MODEL OF THAI STUDENT ENERGY CONSERVATION BEHAVIOUR

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Abstract: Research has proven that studying the behavior of electric energy use and conservation of university students can be a powerful predictor of future energy trends and potential problems/solutions in a nation's energy requirements as education plays a strategic role in improving energy efficiency. Therefore, a causal relationship model of Thai undergraduate student energy conservation behavior was developed in 2013 from a 15 campus survey of 1,200 undergraduate students. The instrument used for questionnaire analysis was a 5-level agreement rating scale, whose reliability was determined to range between 0.70-0.94 while construct reliability was found to be between 0.64-0.90. LISREL 9.10 analysis of undergraduate student psychological traits, situations and psychological-situational factors determined the total influences of these factors to be 0.51, 0.23 and 0.08 respectively. Additionally, the independent variables accounted for 40% of the total variance in energy conservation behavior of students.

Keywords: Energy savings, non-science disciplines, science disciplines, university students.

Introduction

Electricity is something that people cannot live without in the modern day and is used to power industrialized societies. Without electricity, it would be hard to envision how civilization could continue. In 2015, electricity consumption in Thailand rose 3.6% year-on-year (YoY) which peaked in June at 27,345.8 MW (Tunpaiboon, 2016). Business and domestic consumption grew 5.92% and 5.88% respectively. The industrial sector however, showed only a modest 1% growth due to the contraction of manufacturing activity. Since there is no domestic energy source sufficient to meet the demand, Thailand needs to import 6% of its electricity from its northern neighbor, the Lao People's Democratic Republic. It also exchanges 1% of its electricity with its southern neighbor Malaysia, accounting for 12,260 GWh (Energy Policy and Planning Office, 2015).

It has been reported that Laos exports electricity to Thailand at approximately US\$0.07 per kilowatt-hour and US\$0.06 per kilowatt-hour to Vietnam and Cambodia, while the unit price in Singapore was about US\$0.20 per kilowatt-hour (Viravong, 2016). Although energy consumption increase is normally

associated with factors such as urbanization industrialization and technological progress, other human factors are in play as well. These factors include a lack of knowledge concerning the need for conservation and knowledge of environmental issues surrounding the use of various energy forms. However, consumer awareness and education can be a powerful influence on modifying behaviour of individuals with the process beginning at the earliest stages of formal education (European Commission, 2005).

Hence, studying electric energy use and conservation behaviour of university students can be a powerful predictor of future energy trends and potential problems/solutions in a nation's energy requirements as education has a strategic role in improving energy efficiency (European Commission, 2005; Department of Energy and Climate Change, 2012; Pinta & Utama-ang, 2016).

Therefore, the researchers undertook a study which developed a causal model of energy conservation behaviour of 1,200 Thai undergraduate university students. Since the lack of research and uncertainty about student energy conservation behaviour, three parts were

investigated which included how students, their family related society developed, used and promoted energy conservation. From this study, it is hoped that the promotion of greater awareness is created, which awakens everyone to factors ensuring an efficient and stable electric grid for the future.

Literature Review

The European Union (EU) has provided an interdisciplinary, interactive perspective regarding the world economy and its environmental problems, which includes both social and physical environmental circumstances and the interaction of these 'two worlds' (Inayatullah, 2009). It was the idea of 'interaction' that paved the way for the development of four basic personality models (trait psychology, psychodynamics, situationism and interactionism) (Endler & Magnusson, 1976; Endler, 1983).

It is the interactionism model that the researchers have therefore embraced for the development of the conceptual framework of the causal variables affecting student energy saving behavior (Tett & Burnett, 2003; Walsh *et al.*, 2012).

Psychological Traits

Psychological traits are the mental characteristics resulting from the accumulation of childhood and adolescence experiences with institutions involved in influencing and shaping behaviour (Engel & Weber, 2007).

Ajzen (2002) discussed an individual's perceived behavioral control, their self-efficacy and locus of control in the Theory of Planned Behavior (TPB). Behavioral intention formation is the outgrowth from behavioural attitude, subjective norms and behavioral control perceptions.

This is also consistent with the *Ethical Tree Theory* (Bhanthumnavin, 1995) which proposes that psychological causes are divided into two parts, one being the roots and the trunk.

The trunk consists of five characteristics including achievement motive, future orientation self-control, internal locus of control, moral reason and attitude values and morals about the target behavior. Thus, the psychological traits in this study consist of achievement motive, future orientation self-control and internal locus of control. Hence, this study hypothesizes that:

H₁: Psychological traits positively affects psychological-situational.

H₂: Psychological traits positively affects student behavior.

Situations

Again, according to Bhanthumnavin (1995), psychological causes are divided into two parts, represented by the roots and trunk of a tree. The roots consist of three mental faculties, including intelligence, social skills and experience. Therefore, the situational part of this study consisted of perception from peers, media information perception, parenting and friend's peer pressure. Therefore, the researchers hypothesized the following:

H₃: Situations positively affects psychological-situational.

H₄: Situations positively affects student behavior.

Psychological-Situational

Psychological-situational states are another type of mental process (Gotyal *et al.*, 2010; Berkman & Lieberman, 2011). This is a dynamic style where there are many qualitative and/or quantitative changes resulting from the present situation combined with the nature of the individual's spirituality. This is therefore closely related to behavior. From this, the observed variables of sustainable consumption knowledge, student GPA, sustainable consumption attitude and public awareness were developed. Hence, this study hypothesizes that:

H₅: Psychological-situational positively affects student behavior.

Methodology

Student Behaviour

The scales of Thai undergraduate student energy conservation behaviour consisted of 3 observed variables including student energy savings (Y1), family energy savings (Y2) and public energy savings (Y3),

Psychological-Situational

The scales for psychological-situational were constructed using a 5-level agreement questionnaire for student opinion assessment (Likert, 1972) which measured four aspects including sustainable consumption knowledge (Y4), student GPA (Y5), sustainable consumption attitude (Y6) and public awareness (Y7).

Psychological Traits

The scales for psychological traits were constructed using a 5-level agreement questionnaire for student opinion assessment (Likert, 1972) which measured three aspects including achievement motivation (X1), internal locus of control (X2) and future orientation (X3).

Situations

The scales for situations were constructed using a 5-level agreement questionnaire for student opinion assessment (Likert, 1972) which measured four aspects including perceived norms of peers (X4), media information perception (X5), parenting (X6) and a friend's peer pressure (X7).

Questionnaire Design

A questionnaire was used as a research tool to survey 1,200 Thai undergraduate students concerning their energy conservation behavior. The 124-item questionnaire was developed from the literature review and related theory and used a five-level agreement rating scale for the 14 observed variables. Item reliability was subsequently confirmed and improved from other scholars and researchers.

Data Collection

The population for the study was 1, 328, 920 Thai undergraduate students under the auspices of the Thai Office of the Higher Education Commission who were enrolled in second semester of the 2012/2013 academic year. Using Yamane's (1967) formula for calculation of population sample size,

$$n = N / (1 + Ne^2)$$

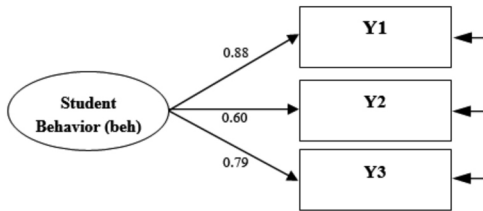
along with a 95% confidence level and $p = 0.5$, size of the sample should be where N is the population size and e is the level of precision. By using Yamane's formula along with allowance for a 3% deviation, the sample size was judged to be 1,111.

Having determined the required sample size, three steps were then utilized to generate the targeted sample size of 1, 200 students. In the first step, multistage random sampling was employed to select the universities from five regions within Thailand. In the second step, simple random sampling was used to select three universities in each of the five regions. In the third step, stratified random sampling was used to select the 80 participants from each of the 15 universities which was evenly divided by male (600) and female (600) students. To ensure survey completion, permission was obtained from the school administrators and classroom teachers for the survey team to give the questionnaires while the students were in class.

Results

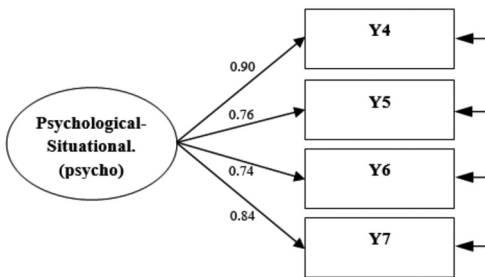
The content and construct validity of the four latent variables were generated from the 14 observed variables. The organization or grouping of the items was confirmed by using LISREL 9.10 confirmatory factor analysis (Jöreskog *et al.*, 2016) and the goodness of fit index (GFI) statistics. From this, it was determined that the value of χ^2 was not statistically significant with $p > 0.05$, root mean square error of approximation (RMSEA) < 0.05 , GFI > 0.90 , adjusted goodness of fit (AGFI) > 0.90 , root mean residual (RMR) < 0.05 and the standardized root

mean square residual (SRMR) < 0.05 (Steiger, 1990). The results of the empirical analysis from the undergraduate sample group ($n = 1,200$) showed that all latent variables had structural integrity. Detailed diagrams, component models and results of elemental analysis of each latent variable are shown in Figures 1-4 below.



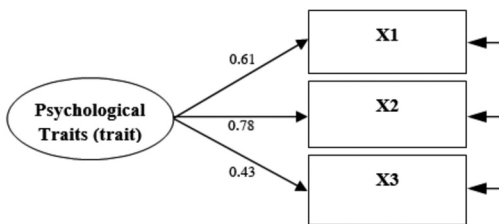
$\chi^2 = 0.00, df = 0, p = 1.00, RMSEA = 0.00$

Figure 1: CFA for student behaviour



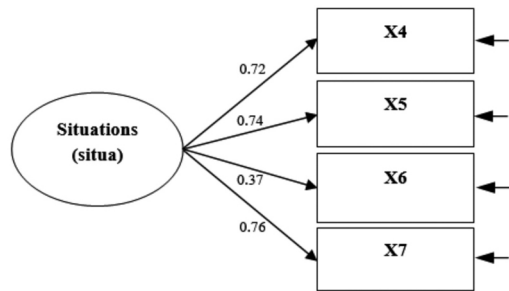
$\chi^2 = 0.00, df = 0, p = 1.00, RMSEA = 0.00$

Figure 2: CFA for psychological situational



$\chi^2 = 0.00, df = 0, p = 1.00, RMSEA = 0.00$

Figure 3. CFA for psychological traits



$\chi^2 = 0.00, df = 0, p = 1.00, RMSEA = 0.00$

Figure 4: CFA for situations

Construct Reliability

Table 1 shows the questionnaire construct reliability (r_c) results from the 1, 200 undergraduate students in their second semester of the 2012/2013 school year.

Table 1: Construct reliability of latent variables

Latent Variables	Reliability (r_c)*
Student Behavior	0.81
Psychological-Situational	0.90
Psychological Traits	0.64
Situations	0.76

* r_c should be greater than 0.60

Internal Consistency Reliability

Reliability comes from the consistency found in repeated measurements of the same phenomenon. Internal consistency refers to how much all the scale items measure the different aspects of the same attribute (Parmenter *et al.*, 2000).

Sapp and Jensen (1997) have stated that Cronbach’s alpha is frequently used in evaluating the reliability of tests for student opinion knowledge. Also, George and Mallery (2003) stated that as Cronbach’s alpha coefficient comes closer to 1.0, the greater the internal consistency of the items in the scale. They ranked the scale as ≥ 0.9 as excellent, ≥ 0.9 as good and ≥ 0.8 as acceptable. Results from the 2013 (Term 2) study’s 60 undergraduate students ‘try out’ testing is shown in Table 2.

Table 2: Internal consistency (α) reliability of the questionnaire by variable

Latent Variables	Observed Variables	Reliability (α) (n=60)	Reliability (α) (n=1,200)
Student Behavior	Student energy conservation (Y1)	0.77	0.91
	Family energy conservation (Y2)	0.75	0.83
	Public energy conservation (Y3)	0.84	0.88
Psychological-Situational	Sustainable consumption knowledge (Y4)	0.92	0.92
	Student GPA (Y5)	N/A	N/A
	Sustainable consumption attitude (Y6)	0.70	0.72
	Public awareness (Y7)	0.84	0.87
Psychological Traits	Achievement motivation (X1)	0.74	0.78
	Internal locus of control (X2)	0.70	0.75
	Future orientation (X3)	0.76	0.83
Situations	The perceived norms of peers. (X4)	0.87	0.92
	Media information perception (X5)	0.71	0.75
	Parenting (X6)	0.78	0.84
	Friend's peer pressure (X7)	0.70	0.72

Data Analysis

Structural equation modeling was employed to conduct a path analysis using LISREL 9.10 of the latent variables which tested the causal relationships among Thai undergraduate students' energy conservation behaviour. The value of c^2 was judged to be not statistically significant, $p > 0.05$, RMSEA < 0.05 , GFI > 0.90 , AGFI > 0.90 , RMR < 0.05 and SRMR < 0.05 .

The Kaiser-Meyer-Olkin (KMO) test (Table 3) was used to evaluate how appropriate the data was for factor analysis (Cerny & Kaiser, 1977). From the test result of 0.89, this is judged on the scale to be 'meritorious' which is the fifth highest ranking on the six-level scale. Furthermore, a Chi-square (χ^2) of 8393.81 was obtained (Table 3), indicating that the overall group is sufficiently relevant and appropriate to be used in the analysis.

From the results in Figure 5 and Table 4, the causal relationship model of Thai undergraduate students' energy conservation behavior was confirmed to be accurate and was consistent with the empirical data. This was also confirmed by c^2 not being statistically significant, $p = 0.892$,

RMSEA = 0.000, GFI = 0.999, AGFI = 0.993, RMR = 0.008 and SRMR = 0.008.

Table 5 shows the direct effect (DE), indirect effect (IE) and total effect (TE) of each construct with the sum of DE and IE effects being referred to as the TE (Bollen, 1987). The p value is the 'level of significance' with a $p < 0.05$ indicating that the probability that the result is observed due to chance being 5%.

All the model's causal variables have a positive effect on the Thai undergraduate students' energy conservation behavior. The results indicated that all independent variables accounted for 40% of the total variance in energy conservation behavior of students (Table 5).

The DE and IE influences on energy conservation behavior of undergraduate students consisted of two variables, psychological traits and situations, each having a TE of 0.51 and 0.23, respectively (Table 5). Psychological-situational had only a DE (0.08) on student energy conservation behavior (Table 5).

Table 3: Correlation analysis

Variable	X1	X2	X3	X4	X5	X6	X7	Y4	Y5	Y6	Y7	Y1	Y2	Y3
X1	1.00													
X2	.46**	1.00												
X3	.30**	.28**	1.00											
X4	.29**	.21**	.36**	1.00										
X5	.34**	.21**	.17**	.51**	1.00									
X6	.36**	.37**	.30**	.29**	.26**	1.00								
X7	.29**	.18**	.16**	.52**	.57**	.26**	1.00							
Y4	.55**	.42**	.25**	.52**	.52**	.43**	.50**	1.00						
Y5	.40**	.32**	.23**	.63**	.56**	.29**	.55**	.69**	1.00					
Y6	.32**	.15**	.15**	.52**	.48**	.24**	.50**	.71**	.57**	1.00				
Y7	.39**	.27**	.12**	.54**	.51**	.27**	.50**	.77**	.66**	.60**	1.00			
Y1	.35**	.39**	.44**	.21**	.19**	.36**	.12**	.36**	.26**	.13**	.17**	1.00		
Y2	.34**	.32**	.36**	.28**	.26**	.35**	.23**	.39**	.37**	.21**	.25**	.53**	1.00	
Y3	.38**	.37**	.52**	.25**	.21**	.42**	.13**	.39**	.27**	.17**	.18**	.67**	.46**	1.00
\bar{X}	3.50	3.31	3.07	14.55	3.40	3.96	3.52	3.83	3.93	3.89	3.90	3.48	3.74	3.42
S	.45	.37	.75	3.75	.43	.73	.47	.48	.51	.63	.64	.98	.71	.88

KMO: Measure of Sampling Adequacy = .89, Bartlett's Test of Sphericity: Chi-Square = 8393.81, df = 91, Sig. = .00

Table 4: Goodness-of-fit indices for the final structural equation model

	χ^2 -Sig.(p)	RMSEA	GFI	AGFI	RMR	SRMR
Recommended Values	>0.05	<0.05	>0.90	>0.90	<0.05	<0.05
Model Values	0.892	0.000	0.999	0.993	0.008	0.008

Table 5: The standard coefficients of influence

Causal Variables	Effects	Variable Effect	
		Psychological-Situational	Student Behavior
Psychological Traits (trait)	DE	0.12*	0.50**
	IE	-	0.01
	TE	0.12*	0.51**
Situation (situa)	DE	0.69**	0.18*
	IE	-	0.05
	TE	0.69**	0.23**
Psychological-Situational (psycho)	DE	-	0.08
	IE	-	-
	TE	-	0.08
R ²	-	0.55	0.40

*p < 0.05, **p < 0.01

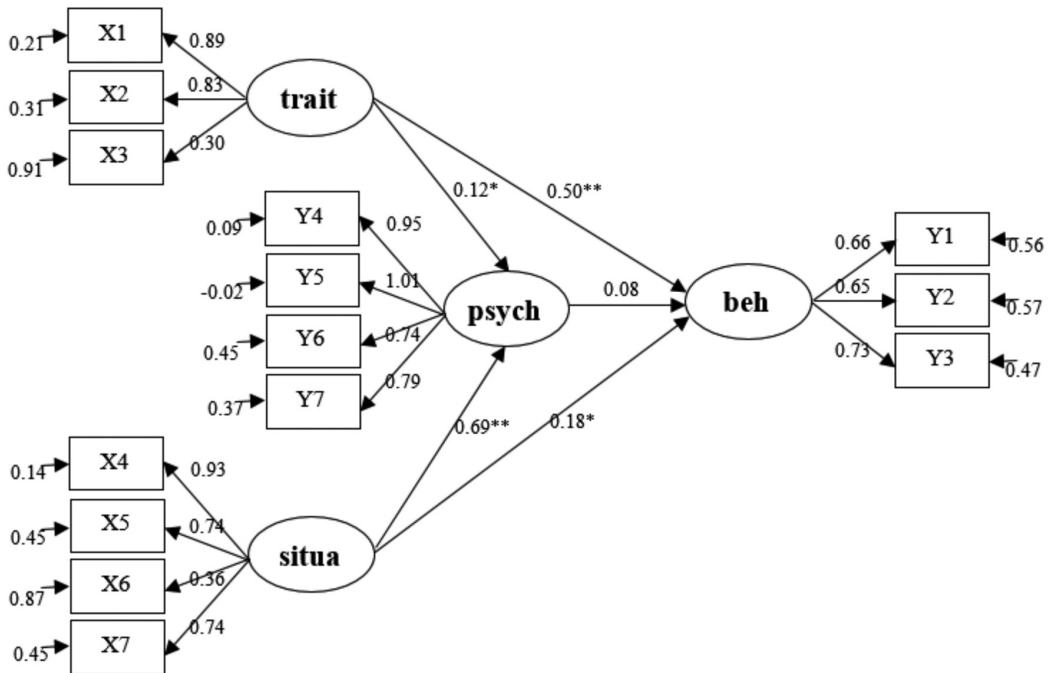


Figure 5: Structural equation model results
 Chi-Square=9.48, df=16, P-value=0.892, RMSEA=0.000

Table 6: Hypotheses testing results

Hypotheses	Coef.	t-test	Findings
H ₁ : Psychological traits (trait) positively affects psychological-situational (psych).	0.12	2.95*	Supported
H ₂ : Psychological traits (trait) positively affects student behavior (beh).	0.69	15.97**	Supported
H ₃ : Situations (situa) positively affects psychological-situational (psych).	0.50	5.58**	Supported
H ₄ : Situations (situa) positively affects student behavior (beh).	0.18	3.71*	Supported
H ₅ : Psychological-Situational (psych) positively affects student behavior (beh).	0.08	1.35	Rejected

*Sig.< .05, **Sig.<.01

Discussion and Conclusion

Malaysian consumer research from Suki (2013a) revealed that the strongest determinant of the consumer’s actual purchase behavior was the perception of the eco-label, followed by their perception of the eco-brand which had a significant influence on their actual green product purchase behavior.

Suki (2013b) in a further study also examined Generation Y (22 years old and younger) consumer conservation behaviour such as recycling, unleaded gasoline use, choosing organic vegetables and use of ozone friendly aerosols. Suki (2013b) then concluded that the strongest determinant was a young adult’s environmental knowledge on their subsequent ecological behaviour and that Generation

Y individuals tend to have more concern for green environments. Coddington (1993) also determined that these same Generation Y youth have a powerful influence on their parents when it comes to purchasing decisions.

In Thailand, previous studies of undergraduate student energy conservation were determined to be influenced most by the student's situation, followed by public awareness, psychological traits and student environmental education with environmental education having the most effect on public awareness (Pimdee *et al.*, 2012).

This is also consistent with the public educational and awareness objectives outlined in the *Thailand Energy Efficiency Development Plan (2015 – 2036)*. In this plan, an outline is suggested which will reduce energy consumption by 30% (Pichalai, 2015). The ability to do this however will come from creating greater public support for human resource energy conservation development. There will also be a need to create better public awareness, along with changing behavioral processes. Support must also be given to supporting efficient energy technology research and development.

Environmental scholars have used the previously discussed theory of planned behavior (TPB) (Ajzen, 2002) to study a wide variety of environmental behavior (Abrahamse & Steg, 2011; Harland *et al.*, 1999; Scherbaum *et al.*, 2008).

Kaiser and Gutshcer (2003) found that the TPB variables explained 81% of variance in the intention to perform conservation behaviours. Greaves *et al.* (2013) researched UK worker environmental behavioural intentions and determined that the TPB explained 61% of variance in employees' intentions to turn off their computers when leaving their desk, 46% of variance in intentions to use video-conferencing rather than travel to meetings and 53% of variance in intentions to recycle at work.

This study on Thai undergraduate student energy conservation behaviour also concluded that all the independent variables accounted

for 40% of the total variance in energy conservation behavior of students with analysis of undergraduate student psychological traits, situations and psychological-situational factors determining that the total influences of these factors to be 0.51, 0.23 and 0.08 respectively.

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