Mitigating Climate Change by Household Sector: Keys of Promoting Energy-Efficient Appliances

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Abstract
This study base on the theory of planned behavior (TPB) and introduced perceived benefit or cost as an independent variable additionally to develop the model of Efficiency action toward Climate Change (ECC model). This study conducted structural equation modeling, and found that the strategy of promoting energy-efficient appliances should emphasize on global warming with the concept of perceived benefit or cost. This study suggested to the industrial sector should provide the energy consumption information of all their appliances to the public; it could raise the intention of household sector to purchase energy-efficient appliances.

Keywords: global warming; climate change; theory of planned behavior; energy-efficient appliances.

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1. Introduction

The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to stabilize GHGs concentration in the atmosphere at a level, which should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change. Most mitigation or adaptation strategies for climate change have been directed toward long-term options such as inducing new low-carbon technologies or creating cap-and-trade regimes for emissions. However, Dietz et al. (2009) emphasized that household sector is one of the major emitters of GHG. The goal of this study was to find out the factors which influenced the intention of household sector to purchase energy-efficient appliances, and gave some suggestions to the industrial sector.

2. Theoretical Framework

2.1 Literature Review

The theory of planned behavior (TPB; Ajzen and Fishbein, 1986) and the modification models were often used to examine various proenvironmental behaviors. TPB is an extension of the theory of reasoned action (TRA; Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). In the theory, attitudes toward the behavior, subjective norms with respect to the behavior, and perceived behavioral control are usually found to predict behavioral intentions. TPB model has been applied successfully to a wide range of human behaviors (Brown et al. 2010).

2.2 Research Model

This study based on TPB and oriented from mitigating global warming to develop the model of Efficiency action toward Climate Change (ECC model). The ECC model comprehends all the independent variables of TPB, additionally introduced perceived benefit or cost as an independent variable, and assumed it can predict the intention of actions as well.

3. Methods

3.1 Research Variables

Environmental Attitude (EA)

As a general rule, the more favorable the attitude with respect to a behavior, the stronger should be an individual intention to perform the behavior under consideration (Ajzen et al., 1986). General behavior should be more closely related to general environmental attitudes (Klöckner and Blöbaum, 2010). In order to find out the key predictors of purchasing energy-efficient appliances, ECC model identified the attitude of the individual to purchase energy-efficient appliances.

Subjective Norm (SN)

Subjective norm is the perceived social pressure, and based on individuals' perception of other important people in their life would want them to perform or not to perform the behaviors. Subjective norm can predict intention significantly in the study of voting behavior (Fishbein and Ajzen, 1981). The ECC model followed most of the studies, and identified subjective norm as: the person who the individual concerned will remind the individual to purchase energy-efficient appliances.

Perceived Behavioral Control (PBC)

The role of perceived behavioral control in TPB is the non-volitional elements which can predict the behavioral intention, can nevertheless be considered a unitary latent variable in a hierarchical factor model (Ajzen, 2002). The ECC model followed the studies of Abrahamse and Steg (2009), Lam (2006), and identified perceived behavioral control as: It is convenient for individual to buy energy-efficient appliances.

Perceived Benefit or Cost (BOC)

The performances of environmental behaviors similar to the other behaviors were influenced by the perceived of benefit or cost of individuals, the less benefit or the more cost would restrict the individual to perform the environmental behaviors (Patchen, 2006). The ECC model followed the studies of Loureiro et al. (2002), Dalton et al. (2008), and Ward et al. (2011), identified perceived benefit or cost as: Usually the energy-efficient appliances are more expensive than traditional ones, but the reduction of energy bills by using energy-efficient appliances were more than the premium price.

Intention of Efficiency Actions (IEA)

The ideas of this study are going to find out the key factors which influence the intentions of individual to purchase energy-efficient appliances. This study considered the appliances of citizens were still in use, so followed the studies of Lam (2006), Clark et al. (2007), Chen and Chao (2011) identified intention of efficiency actions as: When replacing the appliances, the individual may willing to purchase the energy saving ones.

3.2 Research Design

Kaohsiung is the most important industrial metropolis in Taiwan. Annual average per capita emission of CO_2 in Kaohsiung is 26.3 t (Environmental Protection Bureau of Kaohsiung City Government, 2009). This study aimed to develop the model of Efficiency action toward Climate Change (ECC model), and applied the structural equation modeling (SEM) to confirm the model by the sample of Kaohsiung residents.

4. Results and Discussion

4.1 Reality Analysis

The Cronbach's alpha value of each constructs in ECC model are above 0.7, which comply with the suggestion of Hair et al. (2006), the consistency of the constructs were acceptable.

4.2 Confirmatory Factor Analysis

A confirmatory factor analysis was conducted. Hair et al. (2006) suggest that a critical ratio (C.R.) of 0.7 and above indicates good composite reliability; they also suggest that average variance extracted (AVE) value of 0.5 and above indicates a good convergent validity. Doll et al. (1994) suggest that goodness-of-fit (GFI) values of 0.8 and above indicate a reasonable fit. Byrne (2001) suggests that a comparative fit index (CFI) value of 0.9 and above indicated a well-fitting model, and a Tucker-Lewis index (TLI) value close to 1 showed good fit to the model. Byrne (2001) also suggests that a root–mean–square error of approximation (RMSEA) value below 0.08 indicated a comparatively good fit. Joreskog and Sorbom (1993) suggests that a x^2/df value below 5 indicates that the model is acceptable. A structural equation modeling was conducted, most of the indicators in this study showed a well fit to the corresponding constructs of ECC model; and squared multiple correlations (SMCs) showed that all of the observed variables reflected the constructs (latent variables) effectively.

4.3 Model Test

A confirmatory factor analysis to whole model was conducted. Kline (2005) argued if the correlation coefficient is more than 0.85, it shows multicollinearity between the variables. The correlation coefficients between the latent variables of ECC model are about 0.132 to 0.627, represented there were low or medium correlation between the latent variables of ECC model. To go further, this study conducted the structural equation modeling (SEM) to test the ECC model at the second step, the value of the indicators showed well fit to the model with $x^2[160]=3.093$, GFI value of 0.811, CFI value of 0.922, TLI value of 0.908, and RMSEA value of 0.095.

4.4 Path Analysis

This study conducted the path analysis in the ECC model, it showed that environmental attitude can predict the intention of efficiency actions ($p<.01$); on the other hand, subjective norm, perceived behavioral control and perceived benefit or cost can predict the intention of efficiency actions better ($p<.001$); this study concluded that all the independent variables can influence the dependent variable significantly in the ECC model.

4.5 The comparison of TPB and ECC model

ECC model base on TPB and introduced perceived benefit or cost as an independent variable additionally. Byrne (2001) argued that the parsimony goodness-of-fit index (PGFI) under the value of 0.5 represents un-expectable to the model. The PGFI value

of ECC model was 0.618, which means the parsimony of the ECC model was acceptable. On the other hand the explained variation of ECC model was 61.9%, more than TPB (58.4%). This study concluded that, the explained variation of intention to purchase energy-efficient appliances, ECC model showed superior to TPB.

5. Conclusion and Suggestion

5.1 Conclusion

All the independent variables of the ECC model (environmental attitude, subjective norm, perceived behavioral control, and perceived benefit or cost) could influence the dependent variable (intention of purchasing energy-efficient appliances) significantly.
This study concluded that the promoting of energy-efficient appliances should not only appeal for global warming or climate change, because the effect of proenvironmental attitude to the intention of purchasing energy-efficient appliances was not enough. The strategic of promoting should emphasize on global warming and go along with the concept of subjective norm, perceived behavioral control, and perceived benefit or cost.
This study found that the opinion of the person who the individual concerned may influence the intention of the individual of purchasing energy-efficient appliances.This study also found that, usually the energy-efficient appliances were more expensive than traditional ones, if the individual perceived the reduction of energy bills by using energy-efficient appliances, could raise the intention of individual to purchase the energy-efficient appliances.

5.2 Suggestion

This study suggested the industrial sector should provide the energy consumption information of all their appliances, and made a comparison list for salespeople or retailers to introduce these appliances. The households can compare the energy consumption and the cost of the appliances immediately. It is more possible for the households to purchase the level one (the most energy efficient) appliances.

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