Analysis of Energy-saving Behavior among University Students in Vietnam

Naohiro Goto¹, Shota Tokunaga¹, Dinh Thi Nga² and Van Ho Thi Thanh²
1. Department of Environmental and Life Sciences, Toyohashi University of Technology, Toyohashi 441-8580, Japan
2. Faculty of Environment, Hochiminh City University of Natural Resources and Environment, Hochiminh City 800010, Vietnam

Abstract: Currently, in the course of serious environmental problems where the cause is anthropogenic, such as global warming, not only the technology and policies but also the promotions of pro-environmental behavior are required. However, previous studies reported a gap between high environmental awareness and behavior. So to promote this practice, it is necessary to clarify the determinants that lead to practice. Because of the rapid economic growth in developing countries, including Vietnam, pollution problems and energy consumption are of major importance. This study aims to propose methods to promote pro-environmental practices based on a questionnaire and statistical analysis that investigated university students in Vietnam’s Ho Chi Minh city. From the factor analysis, in actions to do with the power-saving behavior of standby power and home electronics, and the use of air conditioning, four evaluation criteria including effectiveness, cost feasibility, convenience, and social norms are extracted. The covariance structure analysis showed that the evaluation of convenience represented the strongest causal relation to a given power-saving action, and the action, in turn, can lead to improvements in most practical activities so as to enhance their convenience. Finally, several methods to save energy are proposed based on the results of the questionnaire.

Key words: Environmental behavior, intention, factor analysis, questionnaire investigation, covariance structure analysis.

1. Introduction

Final energy consumption of Vietnam has increased in all sectors since 1990, particularly in industry, the household, and the transportation sector. The reasons are related to a shift in the main industry from agriculture to manufacturing, and the spread of energy consumption equipment due to the rise of living standards. With increasing energy expenditure, there are various approaches such as technological and administrative ones although various environmental problems are concerned. In particular, to implement measures in the household sector, people’s consciousness of the problem is essential. It requires an interest in environmental issues and environmental awareness to take action against them.

However, even though many people have high environmental awareness, most cannot undertake environmental measures easily. Filling the resource gap increases the number of individuals who can practice environmental action and leads to the solutions of environmental problems.

1.1 Pro-environmental Behavior Model

There have been many studies showing the relationship between environmental awareness and pro-environmental behavior. Ajzen [1] modeled one of the major theories dealing with the relevance of attitude to behavior. In the planned-behavior theory model, “attitude toward the behavior”, “subjective norms” and “perceived behavioral control” are supposed to be the determinants that form intentions and transform behavior.

Hirose [2] developed the framework of the theory and described a psychological process which occurs in the mismatch by using the “two-stage model of environmentally friendly behavior”.

Tsukawaki et al. [3] addressed three environmental issues and five corresponding pro-environmental behaviors, and analyzed the influence of explanatory
power and determinants in Hirose’s model.

The pro-environmental behavior determinant model suggested that behavioral determinants such as attitudes and evaluation form behavioral intentions and lead to the practice of the behavior. In this research, Hirose’s model [2] can be adapted to a variety of pro-environmental behaviors compared with other models.

1.2 Determinants of Awareness and Behavior

Ono et al. [4] analyzed determinants of pro-environmental behavior classified by burdens such as effort and expense. They proposed countermeasures which promote behaviors according to environmental behaviors because the criteria of this behavior depend on evaluation, cognition and individual characteristics affecting the behavioral intention and behavior.

Matsumoto et al. [5] clarified the differences in the impact of people’s social nature on pro-environmental behavior. They showed that cost-benefit evaluation had an influence on actions that had a ‘low’ social nature (saving power and waste reduction), and evaluation of social norms had an influence on actions of a ‘high’ social nature (behavior in a given region). In addition, they discussed how behavior was affected by the social situation.

Aoki et al. [6] researched regional differences in pro-environmental behavior. Their results showed that there is a difference between North and South, city and rural area, but it depends on the type of behavior. Simple behavior, such as power saving, does not depend on the region.

1.3 Objective of the Study

Currently, researches to promote pro-environmental behavior and to analyze behavioral determinants in a developing country are relatively few although there are many in developed countries. Thus, this study focuses on Vietnamese young people because their ratio in the population is high and they will be the group responsible for the society in the future. This research aims to analyze the determinants of pro-environmental behavior using statistical analysis, and to propose methods to promote this behavior.

2. Methods and Data

2.1 Investigation about Pro-environmental Behavior

A questionnaire investigation concerning pro-environmental behavior was implemented at Ho Chi Minh city University of Natural Resources and Environment by a collective investigation method in lectures on March 16-17, 2015.

2.1.1 Hypothesis Model

The hypothesis model is shown in Fig. 1. The model of the hypothesis in this study is made with reference to Hirose’s model. It leads from “determinants to intention” which then is supposed to extend to “practice”. The “determinants to intention” are defined according to each evaluation made by participants in the study.

2.1.2 Subjective Behavior

Electricity consumption per capita tends to increase from 1995 because of economic growth [7]; as the ownership of home electronics is growing, the authors selected the power saving of standby power (SB) and power saving of home electronics (HE) as target behaviors.

Dang et al. [8] estimated that cooling (fan and air conditioning) were main sources of energy consumption. The authors also avoided the use of air conditioning (AC) as an environmental behavior.

Fig. 1 Model of hypothesis relating environmental determinants to practice.
2.1.3 Question for Evaluation

Evaluation items correspond to the determinants that lead to the intention in the hypothetical model is shown in Fig. 1. Based on previous studies, feasibility, costs and benefits, social norms and effectiveness were identified. For each variable, the authors conducted a questionnaire with responses on a 6-point scale.

2.2 Statistical Analysis

To clarify the causal relationship among the variables, a covariance structure analysis was carried out (AMOS22.0). Before the covariance structure analysis, factor analysis was carried out to extract the determinants that lead to the intention of each pro-environmental behavior (SPSS22.0). The determinant extraction method is the method of maximum likelihood and the rotation method was pro max rotation. A covariance structure analysis was carried out by the estimation method adopted as the maximum likelihood method.

3. Results

3.1 Pro-environmental Behavior

3.1.1 Intention and Practice Items

Intention items related to pro-environmental behavior are shown in Fig. 2. A high proportion of answers about intention for the effort made in each power-saving action is 90% or greater. The results of SB saving and energy saving of HE were almost the same.

Practice items related to pro-environmental behaviors are shown in Fig. 3. The proportion of each action is very high and is similar to that found in the intention items.

3.1.2 Evaluation Items

Evaluations of the power saving involved in SB and HE are shown in Table 2. CO₂ reduction, power reduction and environmental conservation show a high percentage of respondents who rated these items as somewhat true or very true.

As with the actions to avoid AC use, power saving, CO₂ reduction, power reduction and environmental conservation in the “somewhat true”, “very true” category show that a large percentage of respondents have evaluated them highly; a large proportion agreeing strongly with the statements is also shown even at the level of economic and household contributions.

3.3 Factor Analysis

3.3.1 Power Saving

Results of the factor analysis in saving power in SB and HE are shown in Table 4. The numerical value of the table represents the related strength of each determinant and each observed variable (factor loadings).

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Question</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility</td>
<td>I am in a situation where it is possible to save power</td>
<td>Situation</td>
</tr>
<tr>
<td></td>
<td>I know how to save power</td>
<td>Knowledge</td>
</tr>
<tr>
<td></td>
<td>I think it is cumbersome to evaluate power saving</td>
<td>Cumbersome</td>
</tr>
<tr>
<td></td>
<td>I think conserving power is inconvenient</td>
<td>Inconvenience</td>
</tr>
<tr>
<td>Benefit costs</td>
<td>I think saving power is saving money</td>
<td>Economic</td>
</tr>
<tr>
<td></td>
<td>I think power saving contributes to the household</td>
<td>Household contribution</td>
</tr>
<tr>
<td></td>
<td>I am anxious about the community if I do not save power</td>
<td>Eyes of community</td>
</tr>
<tr>
<td>Social norm</td>
<td>I think people in the community do actively save power</td>
<td>Around actively</td>
</tr>
<tr>
<td></td>
<td>I think people in the community expect me to save power</td>
<td>Around expectation</td>
</tr>
<tr>
<td></td>
<td>I have the feeling I am reducing CO₂ emissions by saving power</td>
<td>CO₂ reduction</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>I have the feeling I am reducing power use by saving power</td>
<td>Power reduction</td>
</tr>
<tr>
<td></td>
<td>I have the feeling I am conserving the environment by saving power</td>
<td>Environmental conservation</td>
</tr>
</tbody>
</table>
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Fig. 2 Intention items related to pro-environmental behavior (n = 131).
Note: (1 wanted very much, 2 wanted, 3 wanted a little, 4 not wanted, 5 not wanted very much, 6 not wanted at all).

Fig. 3 Practice items related to pro-environmental behavior (n = 131).
Note: (1 very committed, 2 committed, 3 a little committed, 4 not committed, 5 not committed very much, 6 not committed at all).

Table 2 Evaluation items in standby power saving and home electronics (n = 131).

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Situation</td>
<td>18</td>
<td>37</td>
<td>24</td>
<td>11</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Knowledge</td>
<td>22</td>
<td>45</td>
<td>21</td>
<td>3</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Cumbersome</td>
<td>2</td>
<td>8</td>
<td>13</td>
<td>19</td>
<td>44</td>
<td>14</td>
</tr>
<tr>
<td>Inconvenience</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>19</td>
<td>43</td>
<td>27</td>
</tr>
<tr>
<td>Economic</td>
<td>64</td>
<td>27</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Household contributions</td>
<td>53</td>
<td>31</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Eyes of community</td>
<td>6</td>
<td>24</td>
<td>40</td>
<td>19</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Around actively</td>
<td>5</td>
<td>20</td>
<td>47</td>
<td>19</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Around expected</td>
<td>9</td>
<td>26</td>
<td>44</td>
<td>11</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>CO₂ reduction</td>
<td>52</td>
<td>32</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Power reduction</td>
<td>72</td>
<td>18</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Environmental conservation</td>
<td>56</td>
<td>31</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

Notes: 1 very true, 2 true, 3 somewhat true, just a little true, 5 mostly untrue, 6 completely untrue; unit = %.

Table 4 Factor analysis of power saving for standby power and home electronics.

<table>
<thead>
<tr>
<th>Determinants</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental conservation</td>
<td>.911</td>
<td>.031</td>
<td>-.072</td>
<td>.032</td>
</tr>
<tr>
<td>CO₂ reduction</td>
<td>.832</td>
<td>-.091</td>
<td>.033</td>
<td>.079</td>
</tr>
<tr>
<td>Power reduction</td>
<td>.819</td>
<td>.188</td>
<td>.023</td>
<td>-.047</td>
</tr>
<tr>
<td>Household contributions</td>
<td>.103</td>
<td>.911</td>
<td>-.004</td>
<td>-.088</td>
</tr>
<tr>
<td>Economic</td>
<td>.107</td>
<td>.851</td>
<td>.008</td>
<td>-.015</td>
</tr>
<tr>
<td>knowledge</td>
<td>-.093</td>
<td>.730</td>
<td>-.010</td>
<td>.163</td>
</tr>
<tr>
<td>Cumbersome (R)</td>
<td>.080</td>
<td>.029</td>
<td>1.015</td>
<td>-.098</td>
</tr>
<tr>
<td>Inconvenience (R)</td>
<td>-.110</td>
<td>-.041</td>
<td>.697</td>
<td>.156</td>
</tr>
<tr>
<td>Situation</td>
<td>.048</td>
<td>.124</td>
<td>.001</td>
<td>.737</td>
</tr>
<tr>
<td>Eyes of community</td>
<td>.039</td>
<td>-.050</td>
<td>.036</td>
<td>.689</td>
</tr>
</tbody>
</table>

Concerning each determinant, a large value in the factor loadings leads to behavioral intentions, which then classified the first determinant as effectiveness, the second as cost feasibility, the third as convenience, and the fourth as social norms. Two variables on experience rating are reversed and (R) added to understand the interpretation of the analysis more easily. The correlation among the determinants is that
convenience has a low correlation coefficient with other determinants and it was found to have a weak correlation.

3.3.2 Avoiding the Use of AC
As for factor analysis in actions that avoid AC use, determinants which have a large value that leads to intentions where the value of the load amount is large for each determinant were: first, effectiveness, followed by cost feasibility, social norms and convenience. Like other pro-environmental behaviors, convenience has a low correlation coefficient with other determinants, where it was found to have a weak correlation.

3.4 Covariance Structure Analysis

3.4.1 Power Saving
The results of the covariance structure analysis in power saving of SB and HE is shown in Fig. 5. Each indicator shows a certain goodness of fit of the model (GFI = 890, AGFI = 839, CFI = 958 and RMSEA = 068). Intention is in a strong causal relationship to practice. This means that practice can be improved by increasing intention. Among the significant evaluation items that constitute intention, convenience shows the strongest causal relationship followed by social norms. Therefore, an increase in social norms and convenience will lead to an improvement of practice.

In addition, for effectiveness and intention, the path coefficient showed a negative value at -0.21. Because cost feasibility is a significant probability for intentions of 0.5 or more, it did not meet the criterion for showing a causal relationship.

3.4.2 Avoiding the Use of AC
The results of the covariance structure analysis of actions to avoid AC use are shown in Fig. 7. Each indicator shows a certain goodness of fit, GFI = 899, AGFI = 852, CFI = 957 and RMSEA = 065. Intention has a strong causal relationship to practice. Among the significant evaluation items for intention, convenience is the strongest one, followed by social norms. Therefore, the increase of social norms and convenience will lead to improving practice. Moreover, effectiveness was not significantly related to intention and practice.

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Fig. 5  A result of covariance structure analysis in standby power saving and home electronics.
Square: actually observed variable; Ellipse: calculated variable determinant; Arrow: direction on the cause-and-effect relationship; Bi-directional arrow: correlation; Number (path coefficients): degree of relationship, standardized solution.
4. Discussion

4.1 Analysis of the Results

4.1.1 Factor Analysis

From the results of the factor analysis in SB power saving and HE, four determinants including effectiveness, cost feasibility, convenience and social norms were extracted. In particular, a strong correlation was observed between effectiveness and cost feasibility. This is because when the electricity tariff is cheaper than a reduction in the power use, correlations to cost can then be considered stronger. These are the same as the determinant analysis in action to avoid AC use.

4.1.2 Covariance Structure Analysis

From the results of the covariance structure analysis in saving power through SB and HE, practice had a strong causal relationship to intention. In the significance path for intention, convenience shows the strongest causal relationship, followed by social norms. Therefore, the increase of social norms and convenience will lead to improved practice. The reason why convenience shows a strong relationship with intention is that people have less knowledge about the means of power saving, and feel it is cumbersome and inconvenient to take action. The reason why social norms had a strong relationship is that the Vietnamese have a high community awareness and frequent exchanges with neighbors [8, 9].

Because Vietnamese are susceptible to social trends, social norms are thought to have a strong causal relationship with intentions. Effectiveness concerning the reduction of environmental loads for intention showed a negative value at -0.21. This means that people think a power-saving action does not contribute to reducing environmental impacts. However, the intention of saving power is high owing to determinants other than effectiveness, where the action is easy to implement. Also, effectiveness in previous research shows that the value path coefficient is positive for intentions, unlike in this study, which shows the effectiveness of an intention depends on the action.

The significance level for intention for cost feasibility was 0.5 or better, thus it did not meet the criterion.

Fig. 7 Result of covariance structure analysis in action to avoid the use of AC. Square: actually observed variable; Ellipse: calculated variable determinant; Arrow: direction on the cause-and-effect relationship; Bi-directional arrow: correlation; Number (path coefficients): degree of relationship, standardized solution.
From the results of covariance structure analysis in actions to avoid AC use, practice had a strong causal relationship with intention. In the paths with significance concerning intention, convenience is the strongest causal relationship followed by social norms. Therefore increasing social norms and convenience will lead to the improvement of practice. The reason why convenience shows a strong causal relationship with intention is that people have little knowledge of how to avoid AC use and regard methods that they know as cumbersome and inconvenient.

Another reason why social norms show a strong causal relationship with intention as well as with power-saving behavior is high community awareness and exchanges with neighbors [8, 9]. Moreover, effectiveness was not significantly related to intention. This is because, as mentioned in the cross-tabulation, they recognize that among the environmental issues, the pollution problem is the one to be solved, and that in contributing action to global environmental problems, such as action to avoid AC use, the relationship between effectiveness and intention is thought to be weakened.

4.2 How to Promote Each Pro-environmental Behavior

4.2.1 Power-saving Behavior of Standby Power and Home Electronics

To facilitate power saving actions and enhance convenience is optimal. People who think it is troublesome to conserve power and undertake power saving see life as inconvenient; this shows the high value of convenience. In recent years, HE is popular. Moreover, many people have little knowledge about the means of saving power and feel that saving power is troublesome and inconvenient.

Therefore, teaching a variety of methods for each type of HE equipment is considered necessary to reduce the feelings that they are cumbersome and inconvenient, and to promote power-saving actions. As many students possess fans, rice cookers, TVs, fridges, PCs and ACs, teaching methods of power saving about these HE can be very effective.

Facilitate saving power when using SB and HE, and it is effective to increase social norms regarding these. Social norms increase as people evaluate their neighbors as those who are expected to save power. As a result of their life conditions and degree of knowledge, practice of pro-environmental behavior among university students is clear, and being informed of these results encourages people to undertake concrete practices and implement actions to change. Therefore, providing an aggregate result of power-saving actions is proposed so that students can know and practice effective behaviors.

4.2.2 Action to Avoid the Use of AC

To promote the action to avoid AC use, enhancing convenience is very important. In Ho Chi Minh city, there are high temperatures throughout the year, and AC use is regarded as essential for citizens; life without AC is considered to be inconvenient. However, CO2 emissions can be reduced when the temperature of AC is set to be increased by 1 °C. There are many methods to implement pro-environmental behavior without inconvenience. Social norms also promote the actions involved in avoiding AC use. Some responses such as “using conditioning at low temperature” and “using fans instead of AC” can be considered practical. Thus life with less AC can be promoted by knowing not only power-saving activities but also the actions of one’s neighbors. Thus it is useful to share ideas about AC use that students have already known or practiced.

5. Conclusion

This study clarified the determinants of pro-environmental behavior among university students in Ho Chi Minh city and proposed a method for promoting pro-environmental activities. A hypothetical model based on related research was established, and a questionnaire investigation was carried out. Factor analysis and covariance structure
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Analysis were undertaken to understand that increasing convenience leads to promoting power-saving actions for SB and HE. Behaviors to avoid using AC were also found to lead to an improvement in convenience.

When measures to save energy are proposed, they should be related to equipment that many people have. Moreover, they should be those which not so many people know about, because people feel measures which they do know well as cumbersome and inconvenient.

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References


