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**Research Article**

# Factors Influencing Energy-saving Behavior of Air-conditioner Usage in Sanam Chandra Palace Campus, Silpakorn University

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**Abstract:** This research was aimed at identifying the individual factor, level of knowledge and attitude towards the energy saving on the air conditioner which affected behavior in using the air conditioner of students and staff in Silpakorn University, Sanam Chandra Palace campus. The research conducted the survey research and the findings was as follows: 1) The factors affecting the using behavior in energy saving of staff and students in Silpakorn university, Sanam Chandra Palace campus were gender, age, educational background, marital status, monthly income, function, and number of members in residence while the factors not affecting energy saving behavior was information awareness in energy saving 2) the level of knowledge and attitude in energy saving had relation to energy saving at statistical level of significance and 3) university student and staff had the high level of knowledge in energy saving intervention on air conditioner but had level of behavior at medium level.

**Keywords:** Behavior of Air-conditioner, Energy-saving, Energy conservation measures.

## 1. Introduction

According to the Energy Situation of Thailand issued by Department of Alternative Energy Development and Efficiency, it was found that the area of using the highest volume of final energy consumption during Jan – Nov 2018 was ranked by housing area as No. 3 (10,1025 ktoe or 13.2%) following the industry and transportation. In addition, as for the summary of final energy consumption in 2017 categorized by economic field, it could be seen that the volume of energy consumption in housing area was gradually decreased from that in 2015 and 2016 respectively. Therefore, it could be concluded that the people tend to use less energy consumption (Energy situation of Thailand, 2018). On the other hand, referring to summary of energy consumption by Ministry of Energy Thailand, it indicated that due to climate change, the people who live in residential area has used more air conditioner, as shown by the air conditioning system consumed the highest volume (66%) in compared with the others – lighting system and other systems.

(Azizi et al., 2015) studied strategies for improving energy saving behavior in commercial buildings in Malaysia and concluded that those who lived in Green buildings demonstrated more energy saving behaviors than those who live in other types of buildings. (Ornetzedera et al., 2016)investigated user satisfaction and well-being in energy efficient office buildings: Evidence from cutting-edge projects in Austria and indicated that there was low energy consumption in office building which is in line with the finding that the well-being, the living, and energy consuming in office buildings were from the intricated processes of all key elements including the social one. (Nisiforou et al., 2012) examined Behavior, attitudes and opinion regarding to their energy usage habits and adoption of energy saving measures in large enterprise employees and found that most employees acknowledged on the fact of useless energy consumption and agreed to take interventions to save energy. Moreover, they suggested that the executive should set up the intervention to save energy to build the expected behaviors toward energy saving to employees. (Hori et al., 2013) studied the determinants of household energy-saving behavior: Survey and comparison in five major Asian cities and proposed the finding that the community activities significantly affected the energy saving behavior and social interaction had significant relation to energy saving behavior. (Ma et al., 2013) concluded that the citizens in Chongqing, China were not provided the instruction on energy saving in household electrical appliances and had a limited level of knowledge even though most of them were willing to save energy if the intervention do not negatively affect to their well-being. Also, they tended to quickly respond to the economic

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motives e.g. high electrical fee, discount on electrical appliances. (Paço and Varejão, 2010) explored factors affecting energy saving behavior: a prospective research and found that female demonstrated the energy saving behavior more than male did. (Zhuang and Wu, 2014) investigated saving energy when using air conditioners in offices – Behavioral pattern and design indications and found that the suitable temperature for setting the air conditioner was between 26 - 28 ˚C. Nevertheless, since the employees had understanding on setting the air conditioner at low level, half of them did not follow the setting. Moreover, they always set up the very low temperature when entering to the office.

For Silpakorn University, it was found that the air conditioner was promptly set up in classroom, working rooms, and activity rooms to facilitate the studying and working activities. In this study, the researcher focused on studying the using behavior in air conditioner which affected the energy saving behavior of university students and staff in Silpakorn University, Sanam Chandra Palace Campus in order to identify the individual factors and supporting factors which affected the using behavior in air conditioner and propose the approach to reduce energy consumption which would be applied in housing area later on.

## 2. Research Methodology

### 2.1 Conceptual Framework

In this study, the researcher set up the independent variables into two main items 1) individual factors 2) supporting factors which covered variables affecting the using behavior in air conditioner of university students and staff in Silpakorn university as shown in Figure. 1.

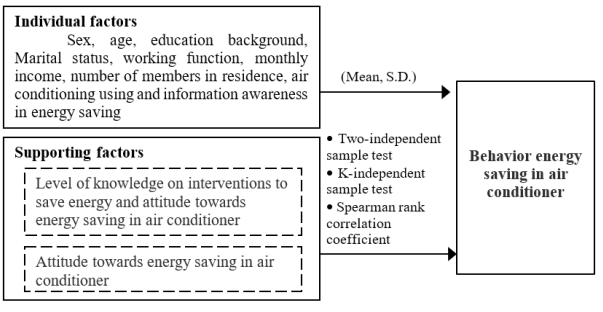


**Figure 1** Research Framework

1) Independent variables consist of individual factor including gender, age, educational background, marital status, working function, monthly income, number of members in residence, air conditioner using, information awareness in energy saving while supporting including level of knowledge on interventions to save energy and attitude towards energy saving in air conditioner.

2) Dependent variable refers to behaviors in using air conditioner which affected energy saving.

### 2.2 Research Hypothesis

Hypothesis 1: The difference in individual factors including gender, age, educational background, marital status, working function, monthly income, number of members in residence, and air conditioner using, significantly affected the behavior in using the air conditioner or not.
Hypothesis 2: The level of knowledge on interventions to save energy on energy saving in air conditioner had relation to the behavior in using the air conditioner or not.
Hypothesis 3: Attitude towards energy saving to the air conditioner had relation to the behavior in using the air conditioner or not.

### 2.3 Research Method

The researcher conducted the research by firstly collecting the information from the related studies as reference and conceptual framework, following by studying for research analysis and questionnaire design. The questionnaire was drafted and applied to the pilot of 30 sample to ensure validity of questionnaire by Cronbach's analysis. After being confirmed, the questionnaire was applied to 400 students and staff in Silpakorn University, Sanam Chandra Palace campus [9]. The result was analyzed by statistical tools two-independent sample test, K-independent sample test and Spearman rank correlation coefficient as following findings:

Spearman rank correlation coefficient (Zhuang and Wu, 2014) (two type of coefficient)

1) If all n ranks are distinct integers, it can be computed using the formula

$$r_s = 1 - \frac{6\sum_{i=1}^{N} D_i^2}{N(N^2-1)} \qquad (1)$$

where refer to the number of cases and refer to difference in paired ranks

2) where there are tied rank is:

$$r_s = \frac{(N^3-N) - 6\sum_{i=1}^{N} D_i^2 - \frac{(T_x+T_y)}{2}}{\sqrt{(N^3-N)^2 - (T_x+T_y)(N^3-N) + T_x T_y}} \qquad (2)$$

## 3. Research Findings

### 3.1 General information of sample group

According to the sample group, it could be found that most respondents were female in a range of 21 – 30 years old (60%), undergraduate students (93.75%), and studying in the faculty of Engineering and Industrial Technology (28.50%). In addition, it was seen that almost all respondents had experience in using the air conditioner and was given the information on energy saving (97%) by television channels (72.25%).

### 3.2 Result analysis on knowledge and understanding on interventions to save energy on the air conditioner

In this research, the knowledge and understanding on interventions to save energy on the air conditioner refers to using the air conditioner appropriately which helps save the energy and increases efficiency of air conditioner with maintenance and care. The result was shown as Table 1.

| Knowledge and understanding in interventions to save energy in air conditioner | Understand Frequency (%) | Not understand Frequency (%) |
|---|---|---|
| Intervention to use air conditioner appropriately | 268 (66.92) | 132 (33.08) |
| Intervention for maintenance and care | 262 (65.54) | 138 (34.46) |

**Table 1** Result of analysis on knowlesge and understanding in interventions to save energy air conditioner

### 3.3 Result analysis on attitude towards the energy saving to the air conditioner

Referring to the research findings, it was found that the sample group had "agreed" to all three main attitudes towards energy saving to the air conditioner as Table 2.

| Attitude | $\bar{X}$ | S.D. | Interpretation* |
|---|---|---|---|
| Attitude on using the air conditioner which helps save energy | 3.25 | 0.29 | Agree |
| Attitude on using the air conditioner which helps save energy for the whole | 3.09 | 0.25 | Agree |
| Attitude on using the air conditioner which supports the governmental policy | 3.18 | 0.25 | Agree |

* Criteria on interpretation to the average refers to 5 – totally agree; 4 – mostly agree; 3 – agree; 2 – partially agree; 1 – mildly agree

**Table 2** Result of analysis on attitude towards energy saving to air conditioner

### 3.4 Result analysis on behavior in using the air conditioner which affected the energy saving

Referring to the analysis on behavior in using air conditioner which affected the energy saving, as illustrated in table 3, it was found that the sample group demonstrated the behavior in using the air conditioner appropriately by following the energy saving interventions as "Sometimes" (4-6 out of 10 times) as well as behaviors in maintenance and care.

Referring to table 4 which shows the analysis on difference in individual factors of respondents and behavior which affected the energy saving to the air conditioner, it was found that the individual factors which affected the behavior which affected the energy saving to the air conditioner were gender, age, educational background, marital status, working function, monthly income, and number of members in residence while the factors which did not affect energy saving behavior was information awareness in energy saving factors at level of statistical significance ($P < 0.05$).

| Two-independent sample test by Mann-Whitney U | | | | |
|---|---|---|---|---|
| Individual factor | | Behavior in using the air conditioner helping save energy | | |
| | | *N* | *Z* | *P* |
| Gender | Male | 140 | -2.64 | 0.01* |
| | Female | 260 | | |
| Information awareness on energy saving | Ever | 388 | -1.38 | 0.17 |
| | Never | 12 | | |

| Individual factor K-independent sample test by Kruskal-Wallis H | | | |
|---|---|---|---|
| Individual factor | Behavior in using the air conditioner helping save energy | | |
| | Chi-Square | *df* | *P* |
| Age | 36.19 | 4 | 0.00* |
| Educational background | 30.79 | 3 | 0.00* |
| Marital status | 45.66 | 4 | 0.00* |
| Monthly income | 44.77 | 6 | 0.00* |
| Working function | 57.42 | 13 | 0.00* |
| Number of members in residence | 18.63 | 3 | 0.00* |

* 0.05 level of statistical significance

**Table 4** Result of analysis on Hypothesis 1: Individual factors affected behavior in using the air conditioner which helps save energy

### 3.5 Result of Hypothesis Analysis

Hypothesis 1: The difference in individual factors significantly affected the behavior in using the air conditioner.

Hypothesis 2: The level of knowledge on interventions to save energy on energy saving in air conditioner had relation to the behavior in using the air conditioner.

Referring to the relation coefficient analysis, it was seen that the level of knowledge on interventions to save energy on energy saving in air conditioner had relation to the behavior in using the air conditioner at statistical level of significance ($P < 0.5$; Sig.=0.00) in the opposite way ($r = -0.29$) as table 5.

| Knowledge and understanding/ attitude | Attitude towards the energy saving on the air conditioner | | |
|---|---|---|---|
| | Spearman's rho (*r*) | Sig (2-tailed) | Direction |
| Knowledge and understanding in interventions to save energy in air conditioner | -0.29 | 0.00* | Opposite |
| Attitude towards the energy saving on the air conditioner | 0.40 | 0.00* | Aligned |

* 0.05 level of statistical significance

**Table 5.** Correlation between knowledge and understanding in interventions to save energy in air conditioner and attitude towards the energy saving on the air conditioner

Hypothesis 3: Attitude towards energy saving to the air conditioner had relation to the behavior in using the air conditioner.

Referring to the relation coefficient analysis, it was found that the attitude towards energy saving to the air conditioner had relation to the behavior in using the air conditioner. at statistical level of significance ($P < 0.5$; Sig. = 0.00) in the same way ($r = 0.40$) as Table 5.

## 4. Conclusion

According to research findings, it could be concluded as follows:

1. The individual factors which affected the behavior which affected the energy saving to the air conditioner were gender, age, educational background, marital status, working function, monthly income, and number of members in residence.

However, the factors which did not affect energy saving behavior was information awareness in energy saving factors.

| Behavior | $\bar{X}$ | S.D. | Interpretation |
|---|---|---|---|
| Behavior in using air conditioner appropriately | 3.13 | 0.07 | Sometimes (4-6/ 10) |
| Behavior in maintaining and caring air conditioner | 3.34 | 0.20 | Sometimes (4-6/ 10) |

**Table 3** Result of analysis on behavioral factor in using air conditioner which helps save the energy

2. As for supporting factors which affected the behavior in using the air conditioner, it could be concluded as follows:

2.1) The level of knowledge or understanding in interventions to save energy on air conditioner had a correlation to behavior in using air conditioner at low level ($r < 0.5$) in the opposite way. It could be implied that those who have knowledge or understanding in interventions to save energy on air conditioner in the high level would demonstrate the behavior in saving air conditioner in the low level.

2.2) The attitude towards energy saving in the air conditioner had a correlation to behavior in using air conditioner in the low level ($r < 0.5$) and in the same way. It could be implied that those who have knowledge or understanding in interventions to save energy on air conditioner in the high level would demonstrate the behavior in saving air conditioner in the high level.

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