

Factors Affecting Residential Energy Consumption from the Viewpoint of People's Lifestyle and Quality of Life: Case Studies of Thailand and Vietnam

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Abstract

In 2016, we conducted a field study on residential energy consumption in Thailand, Vietnam to indicate how people's lifestyle and quality of life result in energy consumption in these countries. In this first part of the questionnaire, energy consumption data as well as differences in household, housing, penetration rate of electronic products and lifestyle was included. Meanwhile, in order to find how people rate their quality of life, various indexes, such as general degree of satisfaction and happiness, income, education, religion, health, work, living standard, neighborhood, community were gathered. Eventually, this study utilized structural equation modeling (SEM) to explore the correlation between energy consumption, household characteristic, housing characteristic and people's quality of life.

Keywords: affecting factors, residential energy consumption, lifestyle, quality of life, structural equation modeling, Southeast Asian country

Introduction

Considering implementing an energy efficiency measure has a possibility to affect people's general Quality of Life (QOL), it is necessary to suggest and verify the effectiveness of policies and measures on energy saving without decreasing the level of people's QOL. Therefore, it is important to identify the factors that may influence consumers' QOL.

QOL defined as the quality of contents on individual life and quality of life that seen socially, more precisely, QOL is a measure to capture how much one individual enjoys life as a human being and how much the individual finds happiness in its life.

Moreover, happiness in QOL measured in the various aspects such as physical and mental health, good human relationship, meaningful work, comfortable living environment, adequate education, recreation activities and leisure. QOL indicators have subjective and objective dimensions, and subjective QOL generally get more attentions.

In the process from factor analysis to structural equation modeling (Fig. 1), impact on subjective QOL analyzed from the viewpoint of life satisfaction and degree of happiness. The purpose of this research is to examine correlations among household attributes, housing attributes, variety of home electronics and energy consumption.

In terms of categories on subjective QOL, following categories are examined; overall satisfaction and happiness, daily habitat, economic affordability, health status, education level, human relationship,

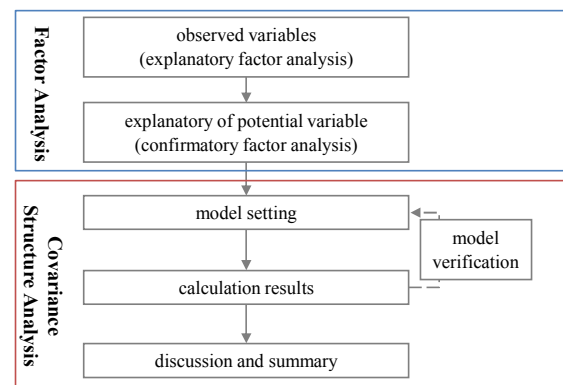


Fig 1. Conceptual flow chart of the statistical analysis

spare time and leisure, anxiety after retirement, awareness on energy saving, neighbor relationship, as shown in Fig. 2. Each category is evaluated based on the consumers' current situation by 4 point scales (very unsatisfied, unsatisfied, satisfied, and very satisfied) from very unsatisfied (1 point) to very satisfied (4 point).

Methodology

(1) Factor Analysis

In order to look for impact factors on QOL indicators, basic characteristics and energy consumption, this research searches QOL indicators (observed variables) with use of SPSS. As the next step, several observed variables that have a common factor with following same meaning defined as one

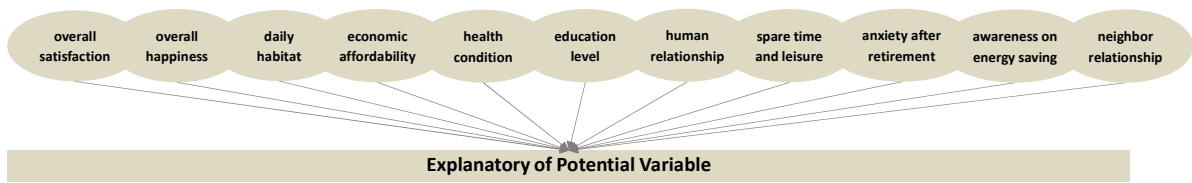


Fig 2. Image of explanatory of potential variable from observed variables

potential variables. With implementation of factor analysis on observed variables and potential variables, this research defines observed variables and potential variables that should be applied on a modeling. The advantage of this procedure on this research is that it is more efficient to examine causal connection among potential variables than the direct application of variety of variables. Moreover, another advantage is to be understood as common factor that hides behind on variety of observed variables. In the case of deciding the number of factors, difference of characteristic value between front factor and back factor made sure to look at initial characteristic value explained dispersion. In addition, a method of factor extraction is maximum-likelihood method. A standard for factor extraction is that the lowest characteristic value is set as 1.0 (based on the characteristic value), and use promax rotation (oblique rotation).

This research examines commonality among observed variables taking out from exploratory factor analysis, and highlights particular items that show extremely low commonality. On the other hand, with looking at lines, this research makes sure loadings fulfill the basic criteria (0.4), and the factor that meet the basic criteria is decided as observed variables that are included in a model. Moreover, It is necessary to examine consistency and applicability of the variables (examination of scale reliability in SPSS), so that this research extracts observed variables that are below 0.7 in α coefficient in crontach, and implemented reexamination. Finally, the process of inversion items are implemented in the factors that show negative loading.

(2) Covariance Structure Analysis

In order to define causal correlation between potential variable and observed variables, this research implements covariance structure analysis by SPSS Amos (structural equation modeling: SEM).

Hypothesized relationship between the amount of energy consumption and several potential variables from the result of factor analysis is proposed, and explained with path diagram. In addition, this research shows several models that have different path, and delete unreliable path (probability based on the statistical amount of verification in point estimate factors from output of Amos). As a result, this research

improve degree of adaptation, and establish the most appropriate model in adaptation though the process of modeling innovation. In addition, the adaptation of model is finally decided by evaluate the value of comparative fit index (CFI), root mean square error of approximation (RMSEA), akaike's information criterion (AIC).

Outline

This survey covered urban areas and suburban areas, composed into two parts: basic attributions from responded households and subjective evaluation about QOL.

- Thailand (urban area): Bangkok (100 samples)
- Thailand (suburban area): Ang Thong (104 samples)
- Vietnam (urban area): Hanoi (84 samples)
- Vietnam (urban area): Ho Chi Minh (75 samples)
- Vietnam (suburban area): Mê Linh (70 samples)

Part 1 shows interview survey on basic attributions including responded households and housing, penetration rate of home electronics, the amount of energy consumption, living situation in a house,

Table 1. Survey items of Part 1

Part	Items
Part 1: Identification of Household	number of household members, age, gender, occupation, the days that people usually at home during the daytime on weekdays, annual income of all family members
Part 2: Housing Characteristics	building type, structure type of building, number of floors, gross floor area, established year, ownership, number of rooms
Part 3: Energy Consumption and Energy Bills	monthly energy use by fuel type, monthly energy bills by fuel type
Part 4: Home Appliances and Electronics	space cooling (room air-conditioning, fan, etc.), space heating (room air-conditioning, heaters, etc.), home appliances (16 items), lighting, cooking equipment (IH), energy efficiency labels of 4 items
Part 5: Hot Water	type and number of water heating equipment, hours of use, bathing habits
Part 6: Vehicles	type and number and frequency of use of automobiles and motorbikes/scooters
Part 7: Lifestyle and Behavior	ways of keeping home cool, satisfaction with the indoor environment, willingness to buy energy-efficient home appliances in the future and problems when buying energy-efficient home appliances, energy saving behaviors

activities for adjustment in environment, environment of heating inside house and comfortability.

Part 2 shows detailed data about satisfaction and happiness about current individual lives, daily habit, health condition, human relationship, spare time and leisure, anxiety after retirement, awareness on energy saving, hope for future, satisfaction on current housing, neighbor relationship are collected as individual indicators of respondents and QOL indicators (Fig. 2).

Moreover, this research aims to examine influence factors and relationship among basic characteristics, energy consumption from households and OOL.

Results

As shown in Fig. 5, the overall satisfaction degree on daily lives shows that suburban areas are relatively higher than urban areas. In general, residents' comfort get higher under the situation that the level of public facilities about infrastructure and basic life component are high. Eventually, it is followed the situation that residents' comfort get higher on daily lives. On the other hand, urban lives with high population density, there is a possibility that the residents' comfort get lower due to the increase of residences' stress.

1) Correlation among QOL indicators

- "Satisfaction on living environment" is the most significant factor to have influence on "satisfaction and happiness" in most of the regions. In addition, "high priority on spare time" and "joining events" have direct effect or indirect effect though "satisfaction on living environment" in some regions.

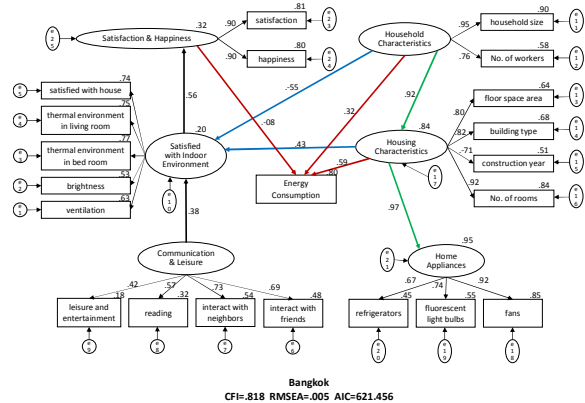


Fig 3. Correlation between QOL, basic characteristics and energy consumption (Bangkok)

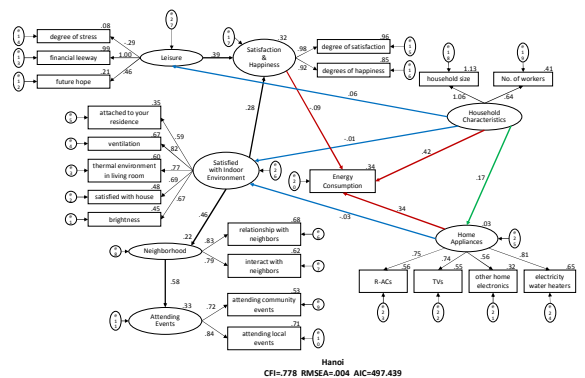


Fig 4. Correlation between QOL, basic characteristics and energy consumption (Hanoi)

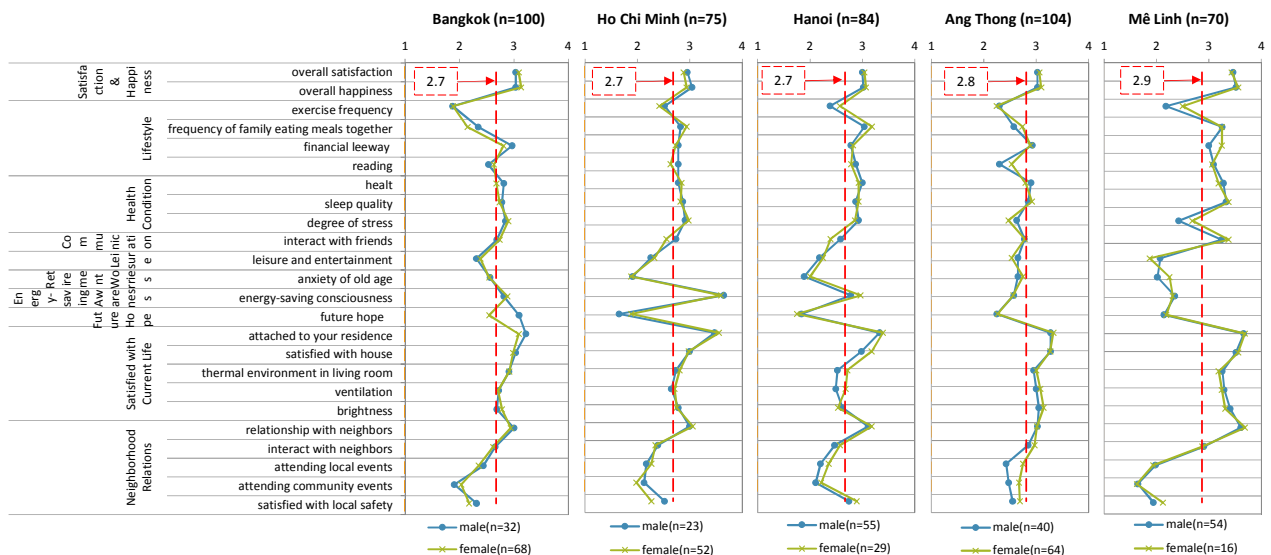


Fig 5. Impact of gender on life satisfaction by region

- Bangkok: The people in “high concern of human relationship and spare time” show high level on “satisfaction on living environment”, and the people who show high “satisfaction on living environment” tend to indicate higher comfort and happiness.
- Hanoi: The people in “high concern of spare time” or high “satisfaction in living environment” indicate high comfort and happiness. In addition, the people in high “satisfaction in living environment” join neighborhood meetings and community events with higher frequency.
- Ho Chi Minh: The people who join neighborhood meetings and community events frequently show higher “satisfaction on living environment” and feel high comfort and happiness. Moreover, the people who show high satisfaction on living environment maintain high quality of sleeping and they are satisfied with their health status.
- Ang Thong: “satisfaction and happiness” is influenced by “satisfaction on living environment” as same as Bangkok.
- Mê Linh: It is indicate that higher household income shows relatively lower satisfaction on living environment.

2) Correlation between basic attribution and energy consumption

- The correlation between “household attribution” and “residence attribution” is remarkably high. In addition, “household attribution and residential attribution” and “the number of home electronics” shows a high correlation in many regions.
- Bangkok: The targeted households in Bangkok show that the most important factor on energy consumption is “household attribution” and the next factor is “residence attribution”.
- Hanoi: “energy consumption” affected at 0.47 from “household attribution” (including both direct and indirect effects), 0.34 from “the number of home electronics”. There is relatively weak correlation between basic attribution and energy consumption.
- Ho Chi Minh: The targeted households in Ho Chi Minh show that the most important factor on energy consumption is “household attribution” and the next factor is “residence attribution”, but the second factor does not have that big influence.
- Ang Thong: suburban areas in Thailand show the most significant factors on energy consumption are “household attribution” and “the number of home electronics”.
- Mê Linh: Suburban areas in Hanoi show that “household attribution” and the number of “air

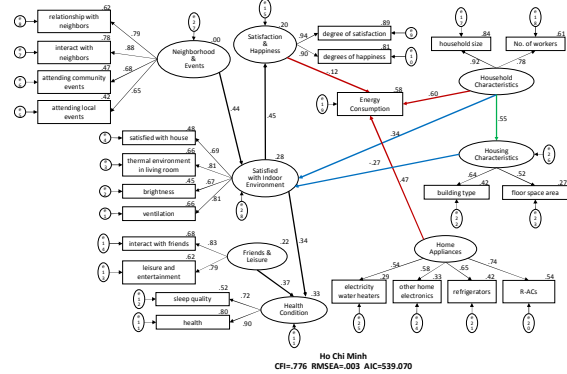


Fig 6. Correlation between QOL, basic characteristics and energy consumption (Ho Chi Minh)

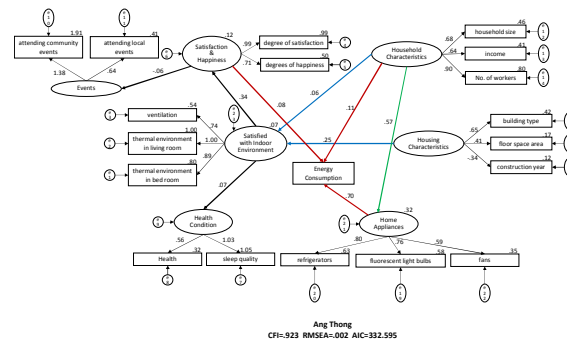


Fig 7. Correlation between QOL, basic characteristics and energy consumption (Ang Thong)

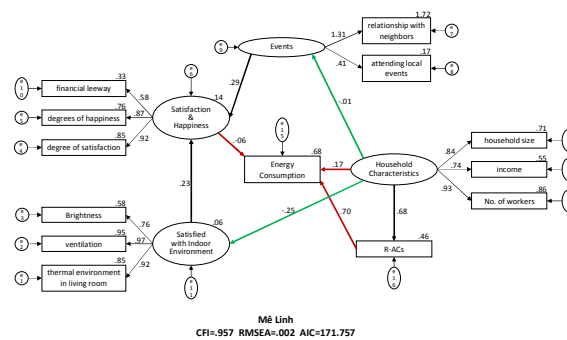


Fig 8. Correlation between QOL, basic characteristics and energy consumption (Mê Linh)

conditioner” have significant influence on energy consumption.

3) Correlation among QOL indicators, Basic attribution and energy consumption

- Although significant path between QOL indicators and energy consumption are not obvious in any region, basic characteristic and

QOL indicators shows a significant path. Details are as below.

- Bangkok: People who live in new and big detached houses show higher satisfaction on living environment, that suggest a possibility of higher overall satisfaction and happiness.
- Hanoi: The correlation between QOL indicators and energy consumption, as well as basic attribution do not reveal a positive correlation in Hanoi.
- Ho Chi Minh: There is a possibility that people who live in apartment with relatively higher income can improve QOL without dramatic increase of energy consumption, and they tend to show higher overall satisfaction and happiness.
- Ang Thong: People who live in big and new detached houses or own houses show higher satisfaction on living environment as same as Bangkok. Moreover, there is a possibility that they show higher overall satisfaction and happiness.
- Mê Linh: It is indicate that the higher household income households relatively show lower satisfaction on living environment in suburban areas of Hanoi.

Conclusions

Residential energy use in Southeast Asia is expected to increase with future improvements in living standards. Moreover, achieving and maintaining a continuous energy efficiency improvement without affecting residents' comfort levels is very essential. Taking the above into consideration, this survey aims to seek for the factors that influenced on residents' QOL in order to propose policies and measures on electricity conservation.

Therefore, in order to explore correlation between the three parties, such as QOL indicators, basic attribution as well as energy consumption, this research examined scenarios that influenced each other through structure equation modeling.

The result of covariance structure analysis indicates that "satisfaction on living environment" has the most significant correlation with "satisfaction and happiness" in the most of the regions. In addition, sufficient spare time and leisure has significant correlation with "satisfaction and happiness" in some regions. The correlation between "household attribution" and "residence attribution" is remarkably high, and the correlation between "the number of home electronics" and "household attributions and residence attributions" in many regions.

"Satisfaction and happiness" shows significant relationship with "satisfaction on living environment", but does not show influence on "energy consumption".

On the other hand, "basic attribution" of housing has influence on "satisfaction and happiness" relatively. For example, the people living in big and new detached houses or town houses that have many rooms show higher satisfaction on living environment in both two regions in Thailand, and they tend to show higher overall satisfaction and happiness. In Ho Chi Minh, the people living in apartment tend to show higher satisfaction on living environment, and show higher overall satisfaction and happiness. Based on these results, people's QOL level is able to be improved without dramatic increase of energy consumption, when living environment is improved.

This research mainly uses the degree of happiness and satisfaction as indicators to show people's subjective happiness, and these indicators are the measures to estimate living condition. Activities that meet on daily lives at high level are not influenced by objective factors such as income and family structure, but influenced by subjective factors such as value judgement, hobby, preferences toward human relationship, attitude. There is mutual interaction between activities on daily lives and energy consumption. Therefore, the future research is to contribute for policy making and implications following the context of countries with effective use from information provided from such indicators.

Acknowledgement

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