Identifying Factors Affecting Implemention of Green IT Practices Using Structural Equation Modeling

Kritiya Rangsom[1]

[1]Assistant Professor: dept. of Information Systems
Faculty of Business Administration, RMUTT
Pathum Thani, Thailand
e-mail: gritiya_r@rmutt.ac.th

บทคัดย่อ—บทความนี้นำเสนอการประยุกต์ใช้ โมเดล สมการโครงสร้าง (เอสอีเอ็ม) เพื่อระบุปัจจัยที่ส่งผลต่อการ ปฏิบัติตามแนวปฏิบัติกรีนไอทีของบุคลากรในองค์กรภาครัฐใน จังหวัดปทุมธานี จำนวน 71,005 คน กลุ่มตัวอย่างที่ใช้ใน งานวิจัยสุ่มเลือกมาจากเจ้าหน้าที่ของหน่วยงานภาครัฐในจังหวัด ปทุมธานีจำนวน 200 คน จากสมการโครงสร้างที่ได้พัฒนาขึ้น พบว่า ปัจจัยที่ส่งผลต่อการปฏิบัติตามแนวปฏิบัติกรีนไอทีได้แก่ การรับรู้แนวปฏิบัติกรีนไอที การคล้อยตามกลุ่มของแนวปฏิบัติ กรีนไอที ด้วยค่า R^2 เท่ากับ 0.341

คำสำคัญ: กรีนไอที, การอนุรักษ์สิ่งแวดล้อม, การอนุรักษ์ พลังงาน

Abstract—this paper applies the structural equation modeling (SEM) to identify factors that influence the implementation of Green IT practices in public sector in Pathum Thani province, 71,005 people. Samples were drawn from government officers who work in Pathum Thani province at their office. The sample size is 200. According to identical SEM model, those factors affecting Green IT practices were: the perception of green IT guideline, the subjective norm of Green IT guideline practices with $R^2 = 0.341$

Keywords-component; Green IT; Green Environment; Energy saving

I. INTRODUCTION

A. Background

Green IT guideline is defined for every organization, both in public and private sector; and create a good practice on global saving such as reduce carbon footprint, energy saving and etc. Due to the global warming problem, all firms and organizations should present their own responsibility and have a cooperation. Electronical industrial especially computer manufacturer, and computer users need to involve and follow Green IT guidelines. Under this believed and good attitude toward helping global, all of them should be in.

In Thailand, the Ministry of Information and Communication Technology (MICT) has developed the ICT2020 Policy Framework for the next 10 years. This policy aims to up Thai technology achievement index rank, develop Thai knowledge workers, develop Thai industry toward knowledge-based industry. The one content of this policy is the "sufficiency economy" philosophy and Green ICT concept. The major implemented unit of this plan should be public sector including government offices and organization. But the private sector such as computer part manufacturers or large firms should not to be ignored. Since the government unit, especially science and technology organization, promote and launch a lot of campaign about Green IT and Energy saving such as training courses for high administrative, and take them to visit foreign countries under green IT practical topic.

According to previous information, the big question are "under the situation of a lot of investment, promoting and advertising about Green IT guideline, how much do people perceive and what are factors affecting practice a Green IT guideline? With those questions, the research has been conducted to answer those.

B. Objective

1. To study the level of Green IT guideline perception under the government officers perspective.

2. To study the level of practice on Green IT guideline of people who work for government officers

3. To analyze the factors affecting energy saving according to practices Green IT guideline

II. LITERATURE REVIEW

This research examines an individual behavior of government officer who use a computer as a part of his/her daily work. The main idea of this research is based on the theory of reasoned action (TRA). By using Green IT

guideline perception as an independent variable, this research adapt both of subjective norm and attitude as a mediator in a purposed model.

A. Green IT concept [1]

In modern management, Internet and Communication Technology will play a role in the management of both proactively and reactively. Due to the application of green IT, it has become a tool for creation of ecological balance in the range of natural and the environment. All about those are integrated security, energy, and food production. The disposal of waste, pollution, and waste itself are effect the climate change and global warming.

B. Green IT guidelines

San [2] indicated a holistic approach to Green IT including Green use, Green disposal, Green design, and Green manufacturing.

Green IT using [2-3] means reducing energy consumption by PCs and equipment, reducing use paper or paperless such as two-sided printer, reuse paper, replace fax with e-mail; virtualizing servers, web/video conferencing, purchasing of energy-saving IT products, two-sided printed.

C. Theory of reasoned action

Theory of reasoned action, TRA, is a one of phycology theory. This theory is a prediction model and use to predict behavioral intention of individual. The theory expands a prediction of attitude and behavior and separate intention out of behavior and tries to define an attitude toward intention [4]. This theory was developed by Martin Fishbein and Ajzen Icek [4] base on theory about attitude toward behavior. The last finding before this theories are: a weaken relationship between attitude scale and willingness behavior [5].

In TRA, Ajzen and Fishbein [4], [6] present their theory with three components of theory.
1. Behavioral Intention: BI
2. Attribute: A
3. Subjective Norm: SN

In this theory, a relationship among those variables shows as this equation:

$$BI = A + SN \qquad (1)$$

The equation shows Behavioral Intention equals Attitude toward Behavior plus Subjective Norm of Behavior.

D. Factor Analysis [7]-[8]

Factor analysis is a technique for analyzing the covariation among the observed variables. This technique uses to reduce unimportant observed variable and integrate associated observe variable together as a new component or factor. There are several methods, such as Principle Component Analysis: PCA, Maximum Likelihood: MLE, and etc., is employed by this technique.

In factor analysis, factor is an underlying or latent construct that 'causes' the observed variables. It is estimated by a linear combination of observed variables. Factor loading is the degree to those variables are 'driven' or 'caused' by factor. The loadings are u_i and v_i in next equation

$$X_i = u_i F1 + v_i F2 + e_i \qquad (2)$$

E. Structure Equation Model [8-9]

Structure Equation Model, SEM, is an approach applying confirmatory factor analysis for analyzing a user's purposed model and their factor relationships is goodness of fit or not? Generally, there are a lot of estimation methods of SEM. This research use a Maximum Likelihood Estimation: ML. The result model of SEM have to be complied Goodness of fit by Chi-square (χ^2) (not significant, p-value greater .05), Goodness of Fit Index: GFI (greater than .9) Adjusted Goodness of Fit Index: AGFI (greater than .9), Root Mean Square Error of Approximation: RMSEA(less than .05).

III. RESEARCH METHODOLOGY

A. Research Framework

The research framework was developed by using three things as:
1. Using concept of TRA as a base theory.
2. Add Green IT guideline perception as an independent variable.
3. Replace behavioral intention with practices of green IT guideline.

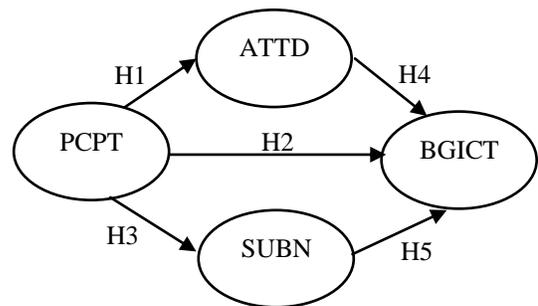The purposed model shows in the next figure.

Figure 1. Research framework model – user model

Where:
ATTD   stands for Attitude
PCPT   stands for Perception of Green IT
BGICT   stands for Behavior of Green IT
SUBN   stands for Subjective Norm

B. Hypothesis

From a research framework, the hypothesis was set up as follow:

1. Perceive Green IT guideline influences attitude toward Green IT concept for people who works in government sector.
2. Perceive Green IT guideline influences Green IT practice for people who works in government sector.
3. Perceive Green IT guideline influences subjective norm of Green IT concept for people who works in government sector.
4. Attitude toward Green IT concept influences Green IT practice for people who works in government sector.

Subjective norm of green IT is a concept of green IT practice for people who works in government section including civil office and government employee; non-profit organization, and authority .

C. Research Design

This research is quantitative in nature with the research instruments of questionnaire using ordinary, interval, and rating scale measurement. The study was designed as a survey field study, a scientific with experimental study that investigates relationship among perception, attitude, subjective norm, and practice green IT guideline.

D. Population and Sample

The population of this research are Pathum Thani citizen who are in working capability state and already have job. A number of this population was 71,005 people [10]. The sample technique used was non probability sample, purposive sampling in particular. The sample size is suitable for analysis is 200 samples.

E. Research Instrument and Data Collection

The main research instrument employed in this research is a questionnaire which is adapted from Fishbein and Ajzen[6] including: attitude measurement, and subjective norm measurement; demography of respondent, saving energy guideline, and Green IT guidelines.

The questionnaire were administer from people works for government such as civil officer, government employee, university employee. moreover, the data collecting was conduct from people who work for non-profit organization and organization of government which are in public section such as electric authority, water authority.

F. Data Analysis

After data collection, the questionnaires were analyzed using descriptive statistics, hypothesis test and Structural Equation Model.

IV. RESULT

The results are divided into three parts including: demographic and perception of green IT guideline descriptive, factor analysis, and casual model analysis.

A. Demographic

The descriptive result of demographic of respondents, attitude toward green IT guideline, perceive green IT concept, and practice green IT guideline are presented in the following table.

TABLE I.   RESPONDENT DEMOGRAPHY

Characteristic	Value	Number	Percent
Gender	Male	79	39.5
	Female	121	60.5
Age	below 20 yrs.	13	6.5
	21 – 30 yrs.	78	39.0
	31 – 45 yrs.	76	38.0
	above 46 yrs.	33	16.5
Average family income per month	below 20,000 bht.	66	33.0
	20,000 – 39,999 bht.	83	41.5
	40,000 – 59,999 bht.	39	19.5
	60,000 – 79,999 bht.	8	4.0
	80,000 – 99,999 bht.	4	2.0
Status	Single	93	46.5
	Has spouse no children	52	26.0
	No spouse has children	18	9.0
	Has both of spouse and children	37	18.5

According to table I, the demographic description are shown most of the respondent were female (60.5%), aged between 21 and 45 years (77%), average income per month under 40000 (41.5%), and marital status is single (46.5).

B. Perception of green IT guideline

The descriptive result of Green IT guideline perception of respondent is presented in the next table below.

TABLE II.   PERCEPTION OF GREEN IT GUIDELINE

Green IT guideline	Full score	Mean	S.D.
Using computer	3	2.715	.570
Reduce paper usage	4	3.095	.985
Selected product	5	3.550	1.574

Referring table II, most of the respondents perceived and understood in energy saving by Green IT guideline as follow:

- The mean value of using computer aspect is at high level (2.715)
- The mean value of reduce paper usage aspect is at high level (3.095)and
- The mean value of selected product aspect is at moderate level (3.550).

C. Factor Analysis

The Explored Factor Analysis (EFA) was use as a tools to reduce observed variable to meaningful latent variable

the following table is a result of using EFA for analyze attitude toward green IT concept.

TABLE III.   EFA OF ATTITUDE TOWARD GREEN IT CONCEPT

Variable name	loading factor value
attr1	.856
attr2	.910
attr3	.901
attr4	.290

KMO = .721 Chi-Square 327.636 df=6 Sig.=.000

With regard to table III, the loading factor of observed variable *attr4* is under 0.6 and need to delete out of component *Attitude toward Green IT concept*. According to this reason, the latent variable named ATTD is setup, and is composed with three observed variable are: *attr1, attr2,* and *attr3*.

The next table presents EFA of *Subject Norm of Green IT guideline*

TABLE IV.   EFA OF SUBJECTIVE NORM

Variable	Loading factor
sn1	.716
sn2	.811
sn3	.811
sn4	.727

KMO = .842 Chi-Square 481.854 df=6 Sig.=.000

Cause by all loading factor values of each observed variable in above table IV are greater than 0.6 then a *Subjective Norm of green IT guideline* latent variable is consisted of all observed variables in table above as *sn1, sn2, sn3,* and *sn4*.

TABLE V.   EFA OF PRACTICING GREEN IT GUIDELINE

Variable	Component 1	Component 2
ii1	.	.823
ii2		.803
ii3		.730
ii4	.462	.393
ii5	.801	
ii6	.866	
ii7	.727	
ii8	.662	
ii9	.626	

KMO = .813 Chi-Square 746.386 df=36 Sig.=.000

In table V, there is two components is created by this factor analysis as:
- The first component, called F1, composes with observed variable as: *ii1, ii2,* and *ii3*;
- Second component, called F2, composes with observed variable as: *ii5, ii6, ii7, ii8,* and *ii9*.

However, the loading factor of observed variable *ii4* below 0.6 and need to be eliminated from those two components. The next table describes mean and standard deviation of the latent variable F1, and F2.

TABLE VI.   DESCRIPTIVE PRACTICING GREEN IT GUIDELINE

Variable	Mean	SD.
F1 using computer	3.942	.828
F2 reduce paper usage	3.882	.755

In table VI, both of practicing Green IT guideline, such as F1 and F2, are at high level (value almost 4) and distribution of variables are not too much (value below 1).

D. Casual Model

The casual model is built from all variables which are defined in the above section and initialized model. The next table shows a fitted model statistics. Then the next figure presents the fitted model figure.
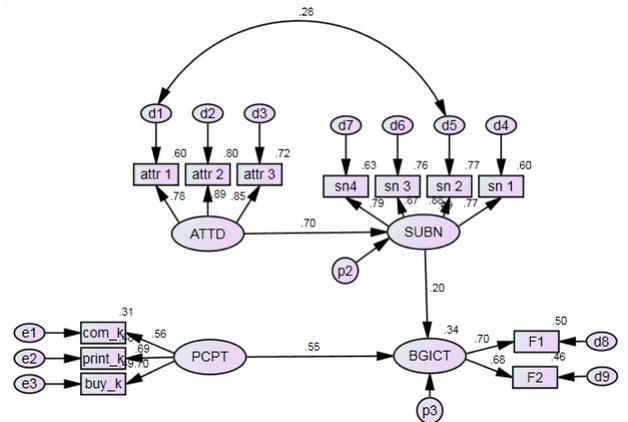

Figure 2.   Casual Model

TABLE VII.   FITTED MODEL STATISTICS

Statistics Name	criteria	Statistics Value
χ^2	-	61.474
Degree of freedom	-	50
Probability value	>.05	.128
χ^2/DF	< 2	1.229
RMR	< .05	.109
GFI	> .95	.951
AGFI	> .95	.924
RMSEA	< .05	.034
HOELTER	-	247

In table VII, the most statistical values of identical model pass a standard criteria except Adjust Goodness of Fit Index (AGFI).

In the identified model, there are four latent variable as initialize model and fitted statistics as a caption of each line. The coefficient of latent variable of fitted model presents in next table.

TABLE VIII.   COEFFICIENT OF VARIABLE

Dependent variable	Independent variable	coefficient	p-value(t-test)
SUBN	ATTD	.699	.001**
BGICT	PCPT	.549	.001**
	SUBN	.200	.033*

* significant .05, ** significant .01

In the table of coefficient, all factors compile with the determined hypothesis, and describe as the follow:

1. Perception of Green IT has influents to practice green IT guideline at significant level 0.01
2. Subject Norm of Green IT guideline has influent to practice green IT guideline at significant level 0.05
3. Attitude toward Green IT guideline has influent to Subject Norm of green IT guideline at significant level 0.01

Referring the fitted model, the next table presents direct, indirect, and total influent of each independent latent on dependent latent.

TABLE IX.   INFLUENT ON LATENT VARIABLE IN FITTED MODEL

dependent variable	Independent variable	Directed influent	Indirect influent	Total Influent
SUBN	ATTD	.699	-	.699
BGICT	PCPT	.549	-	.549
	SUBN	.200	-	.200
	ATTD	-	.104	-

In table IX, the almost influent among variables in this table are direct influent except attitude toward Green IT guideline which has only indirect influent via subject norm of Green IT guideline and has no direct influent.

In fitted model and its' coefficient, I can draw an equation with standardize coefficient as:

$$BGICT = .2\ SUBN + .549\ PCPT \qquad (3)$$
$$SUBN = .699 ATTD \qquad (4)$$

The last table presents an R-square, standardize, of all dependent variables in model.

TABLE X.   SQUARED MULTIPLE CORRELATION

Dependent Variable Name	value
SUBN	.448
BGICT	.341

The predicted value of subject norm in Green IT guideline and practical on Green IT guideline are 44.8 and 34.1 percent respectively

V. CONCLUSION AND RECOMMANDATIONS

A. Conclusion

Most of respondents were female, their age ware between 21 and 45 year old, had average income below 40,000 baht per month, and had a single status.

Regarding the fitted Structure Equation Model, the factors influences on practice of Green IT guideline are: perception of Green IT guideline, subjective norm of Green IT guideline, less indirect affecting from attitude toward Green IT guideline. These predictors are able to predict practice Green IT guideline with accuracy percentage 34.1.

B. Recommandations

With regard to the finding, respondent who come from government section have a saving energy concept at level much, But they perceived a practice green IT guideline in purchasing IT product aspect at level moderate. In identical model, the coefficient of perceived practice green IT guideline is greater than the other. The suggestion from this finding is government agent should enhance obtaining knowledge about purchasing IT product. This knowledge are going to enable those people do a better work in saving energy with IT peripheral purchasing. Poster attach in board will stimulate perception of those people too. Public relation about green IT is another way to help those people to ease of perception and practices.

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