Causal Relationship Model of Ecological Footprint Integrated with Environmental Education

Puripat Mukpradab[1], Nongnapas Thiengkamol[2], Tanarat Khoowaranyoo Thiengkamol[3]

Received: 30 December 2015; Accepted: 17 March 2016

Abstract

This research was quantitative research with a survey approach. A questionnaire was used as an instrument for gathering data from a population of 36,009 upper secondary school students under Secondary Service Area Office 28 (Sisaket-Yasothon) in academic year 2014. Cluster Random Sampling technique was implemented to collect 400 upper secondary school students as the sample group. Structural Equation model (SEM) was used for model confirmation. Research results demonstrated that Ecological Footprint (EF), Environmental Education (EE), and Environmental Conservation Inspiration (INS) were able to explicate the variation of cause Environmental Conservation Behavior for Global Warming Alleviation (EnB) with 92.00 percent. EF had the most effect to EnB with 0.69, Subsequences were EE, and INS with 0.48 and 0.40. Additionally, EF and EE were able to explicate the variation of INS with 78.00 percent, and EF had the most effect to INS with 0.36. Subsequence was EE with 0.30. The causal relationship model of EF and EE influencing EnB through INS was confirmed the proposed model and it was fitted with all observed variables in line with criteria of Chi-Square/df value with less or equal to 1.647 and it was less than or equaled to 5.00 ($\chi^2/df \leq 500$). RMSEA (Root Mean Square Error Approximation) equaled to 0.045 (RMSEA <0.05) and RMR (Root Mean Square Residual) equaled to 0.047 (RMR <0.05) including index level of model congruent value of Goodness of Fit Index (GFI) equaled to 0.94, and Adjust Goodness of Fit Index (AGFI) equaled to 0.91 which are between 0.90-1.00.

Keywords: model, ecological footprint, environmental education

Introduction

Ecological Footprint (EF) is a measurement of humanities reliance on natural resources. Moreover, EF measures the amount of productive land and water necessary for the production of goods including waste accumulation from the population's activity. EF is a distinctive group of uniqueness, actions, etc., that leave a trace and serve as methods of classification, such as the quantity of productive land suited for average of each person (in the world, a country, etc) for food, water, transport, housing, waste management, and other purposes. The simplest way to define ecological footprint would be classify it as the impact of human activities measured in terms of the area of biologically productive land and water requisite to produce the goods consumed and to absorb the wastes produced. Basically, it is the quantity of the environment required to produce the goods and services needed to maintain a particular lifestyle.[8,22]

The EF is rooted in the fact that all renewable resources come from the earth. It accounts for the flows of energy and matter to and from any defined economy and converts these into the corresponding land/water area

[1] *Department of Environmental Education Faculty of Environment and Resource Studies Mahasarakham University, Mahasarakham, 44150, Thailand. Tel: 6-681-878-3497 Email: tu_g1960@hotmail.com.*

[2] *Department of Environmental Education Faculty of Environment and Resource Studies Mahasarakham University, Mahasarakham 44150, Thailand Email:mahidol@gmail.com*

[3] *Co-Advisor, School of Management, Assumption University, HuaMak Campus, 592/3 Ramkhamhaeng 24, HuaMak, Bangkok 10240, Thailand*

required for nature to support these flows. The Ecological Footprint is defined as “the area of productive land and water ecosystems required producing the resources that the population consumes and assimilate the wastes that the population produces, wherever on Earth the land and water is located.”1 It compares actual throughput of renewable resources relative to what is annually renewed. Non-renewable resources are not assessed, as by definition their use is not sustainable.

Environmental Education of The Intergovernmental Conference highlighted the Environmental Education functions on preservation and improvement the global environment and required to supply the agenda and directions for environmental education. Environmental education is a learning process that makes human gain more awareness and knowledge on the environment, developing the essential skills and expertise, and cultivating attitudes, and promise for decision making and taking responsibility. Environmental education covers the fundamental component of environmental, knowledge and understanding, awareness for environmental problems, having proper attitude for performing appropriate behavior through repeated practice for environmental conservation with skill and correct decision making with responsibility and participation in environment projects and activities.[25]

Thiengkamol affirmed that the inspiration of public consciousness or public mind requires no admiration or complement or incentive. Particularly in natural resources and environment conservation, it happens from insight of someone, whilst its occurrence might come from the pleasure in a person as role model or idle, events, situation, environment, media perceiving such movie watching, book and magazine reading, and internet using. In addition, several researches were carried out by her and her colleagues, these have also proved that inspiration of public consciousness or public mind are a critical factor for environmental conservation in diverse environmental management with the integration of the environmental education concept.[2,3]

The goal of this study was to apply the EF knowledge and EE for the students to conserve the natural resources and environment via inspiration of public consciousness or public mind. Knowledge and understanding of EF and EE would lead them to be concerned that the ecological capacity has limitations whilst the population growth has increased rapidly because various factors support this growth. A factor such as better medical technology is progress, thus the people have better health. However, there is the problem of a new disease arising from the environmental problems of pollutions. Therefore, understanding the EF would help younger generations to realize the importance of ecological balance and to challenge them to change their environmental behavior of consumption, energy conservation, waste management, recycling, traveling and environmental knowledge transferring. The new generations would be our hope to cure and maintain the ecological system with their public consciousness to meet sustainable development.

Objective

The objective of this research was to develop a causal relationship model of an ecological footprint and environmental education of upper secondary school students under Secondary Service Area Office 28 (Sisaket-Yasothon) in the Northeastern region, Thailand.

Methodology

The research method was conducted following these steps:

1. Population and Sample

Population was 36,009 upper secondary school students under Secondary Service Area Office 28 (Sisaket-Yasothon) of Northeastern region of Thailand in second semester of academic year 2014.

Sample was 400 upper secondary school students that gathered with Cluster Random Sampling technique.

2. Research tool

The content and structural validity of a questionnaire were proved by Item Objective Congruent (IOC) from 5 experts in the fields of ecology, environmental education, social science and social research methodology.

The reliability was tried out by conducting a sample group from 40 upper secondary school students who had the same characteristics with sample group. The reliability was determined by Cronbach's Alpha formula: the ecological footprint composing 42 items, environmental education composing 42 items, environmental conservation inspiration composing 35 items, and environmental conservation behavior for global warming alleviation composing 42 items. The whole questionnaire consisted 161items. Their reliabilities were 0.816, 0.804, 0.954, 0.957 and 0.938 respectively.

3. Data Collection

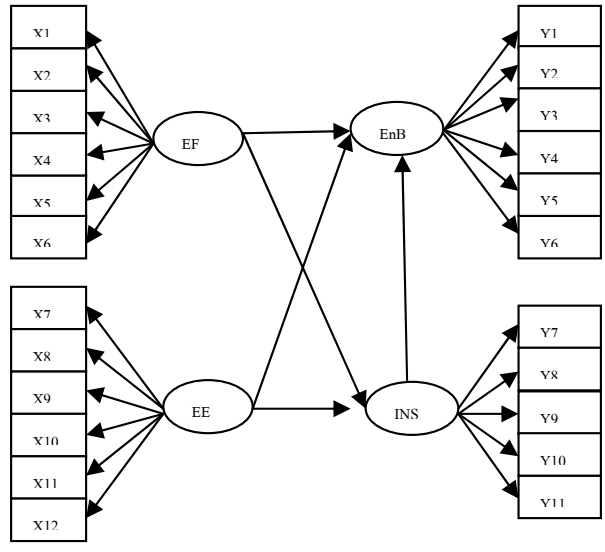
The Cluster Random Sampling technique was employed for data collecting of 400 upper secondary school students under Secondary Service Area Office 28 (Sisaket-Yasothon) of Northeastern region of Thailand. The research instrument was a questionnaire, and it was used for data gathering.

4. Data Analysis

The descriptive statistics were frequency, percentage, mean and standard deviation. Structural Equation Model (SEM) was used for model confirmation with LISREL version 8.30 by considering on Chi- Square value had no statistically significant at level of 0.01 or Chi-Square/df value with less or equal to 5, RMSEA (Root Mean Square Error Approximation) and RMR (Root Mean Square Residual) values with less than 0.05 including index level of model congruent value, GFI (Goodness of Fit Index) and index level of model congruent value, AGFI (Adjust Goodness of Fit Index) between 0.9-1.00.

Conceptual Framework

The exogenous latent variables of Ecological Footprint (EF) and Environmental Education (EE) had direct and indirect effects to Environmental Conservation Inspiration (INS) and Environmental Conservation Behavior for Global Warming Alleviation (EnB). EF was measured by Ecological Footprint for Shelter (X1), Ecological Footprint for Food (X2), Ecological Footprint for Transportation (X3), Ecological Footprint for Cloth (X4), Ecological Footprint for Medicine (X5), and Ecological Footprint for Housing (X6). EE was measured by Environmental Awareness (X7), Environmental Attitude (X8), Environmental Skill (X9), Environmental Participation (X10), Environmental Responsibility (X11) and Environmental Decision (X12). The endogenous latent variable of EnB was measured by Consumption Behavior (Y1), Energy Conservation Behavior (Y2), Waste Management Behavior (Y3), Recycling Behavior (Y4), Traveling Behavior (Y5), Environmental Knowledge Transferring Behavior (Y6) and INS was measured by Self-Public Mind (Y7), Role Model Impression (Y8), Event Impression (Y9), Environment Impression (Y10), and Media Reception (Y11).



Results

1. Results of Effect among Variables in the Model in Terms of Direct and Indirect Effect

Ecological Footprint (EF), Environmental Education (EE) and Environmental Conservation Inspiration (INS) had effect on Environmental Conservation Behavior for Global Warming Alleviation (EnB) as follows.

1) Confirmatory factors of EF had direct effect on INS with statistically significant at level of 0.05 with effect of 0.36. EF had direct effect on EnB with statistically significance at a level of 0.01 with effect of 0.69 and indirect effect on EnB with statistical significant at level of 0.05 with effect of 0.14.

2) Confirmatory factors of EE had direct effect on INS with statistical significant at level of 0.05 with effect of 0.33. EE had direct effect on EnB with

statistical significant at level of 0.01 with an effect of 0.48 and indirect effect to EnB with statistical significant at level of 0.05 with effect of 0.13.

3) Confirmatory factors of INS had direct effect on EnB with statistical significant at level of 0.01 with effect of 0.40.

Considering on structural model confirmatory factors of component analysis of EF, EE and INS had effect to EnB with effect of 92.00 %. The structural equation can be written as the following in equation (1).

$$EnB = 0.40*INS + 0.69*EF + 0.48*EE \quad (1)$$
$$(R^2 = 0.92)$$

Equation (1) factors that had the most effect to EnB was EF with 0.69, subsequences were EE, and INS with effect of 0.48 and 0.40, these were able to explicate the variation of EnB with 92.00 percent.

Considering on confirmatory factors INS of upper secondary school students, it demonstrated that EF had the most effect on INS with 0.36. Subsequence was EE with 0.33, these were able to explicate the variation of INS with 78.00%. The structural equation can be written as follows.

$$INS=0.36*EF + 0.33*EE \quad (2)$$
$$(R^2 = 0.78)$$

Equation (2) factors that had the most effect to INS were EF, and subsequence was EE, these were able to explain the variation of Environmental Conservation Inspiration (INS) with 78.00 percent.

The results of exogenous variables had effect to endogenous variables with direct and indirect effects were demonstrated in (Figure 1) and (Table 1).

Discussion

The results indicated that understanding the concept of Ecological Footprint (EF) was predicted by 6 observed variables of Ecological Footprint for Cloth (X4), Ecological Footprint for Transportation (X3), Ecological Footprint for Shelter (X1), Ecological Footprint for Medicine (X5), Ecological Footprint for Housing (X6) and Ecological Footprint for Food (X2) with predicting power of 0.83, 0.74, 0.65, 0.64, 0.60, and 0.28 respectively. Moreover, it also had direct effect to Environmental Conservation Behavior for Global Warming Alleviation (EnB) with effect of 0.69, which is a rather high effect, thus it is obviously seen that EF plays an important role to change the environmental conservation behaviors for global warming alleviation that was predicted by Environmental Knowledge Transferring Behavior (Y6), Energy Conservation Behavior (Y2), Waste Management Behavior (Y3), Traveling Behavior (Y5), Recycling Behavior (Y4), and Consumption Behavior (Y1) with prediction power of 0.71, 0.62, 0.62, 0.61, 0.56, and 0.51 respectively. Another essential exogenous variable was Environmental Education (EE) which had direct and indirect effects on EnB with 0.48 and 0.13 and it also was predicted by observed variables of Environmental Skill (X9), Environmental Decision (X12), Environmental Awareness (X7), Environmental Responsibility (X11), Environmental Attitude (X8) and Environmental Participation (X10) with prediction power of 0.89, 0.60, 0.48, 0.47, 0.37 and 0.32 respectively. The findings verified that EF and EE are vital factors that are able to be applied for challenging pro-environmental behaviors of upper secondary school students to act as critical change agents to transfer their environmental knowledge to their friends, family members, and others in society as well including explicit their Energy Conservation Behavior, Waste Management Behavior, Traveling Behavior, Recycling Behavior, and Consumption Behavior as good role model for others too. The results were in the line with Thiengkamol and her colleagues that EE had direct and indirect effect to environmental conservation behaviors for global warming alleviation.

Additionally, Environmental Conservation Inspiration (INS) had direct effect to EnB with effect of 0.40 whereas considering on prediction of correlation of observed variables of Event Impression (Y9), Media Reception (Y11), Environment Impression (Y10), Role Model Impression (Y8), and Self-Public Mind (Y7). These were congruent to different studies of Thiengkamol and her colleagues that the results illustrated that Inspiration of Public Consciousness or public mind influencing pro-environmental

behaviors whether consumption behavior, energy conservation, waste management behavior, recycling behavior, traveling behavior and knowledge transferring and supporting for environmental conservation and so on.

Thus, this research results should be established to inspire upper secondary school students to take action in playing a role as environmental educators to transfer their environmental knowledge and understanding with public mind to devote for environmental conservation behavior as new generations who take care for ecological balance and maintain environmental quality to meet life quality for achieving sustainable development based on EF and EE concept considerations.

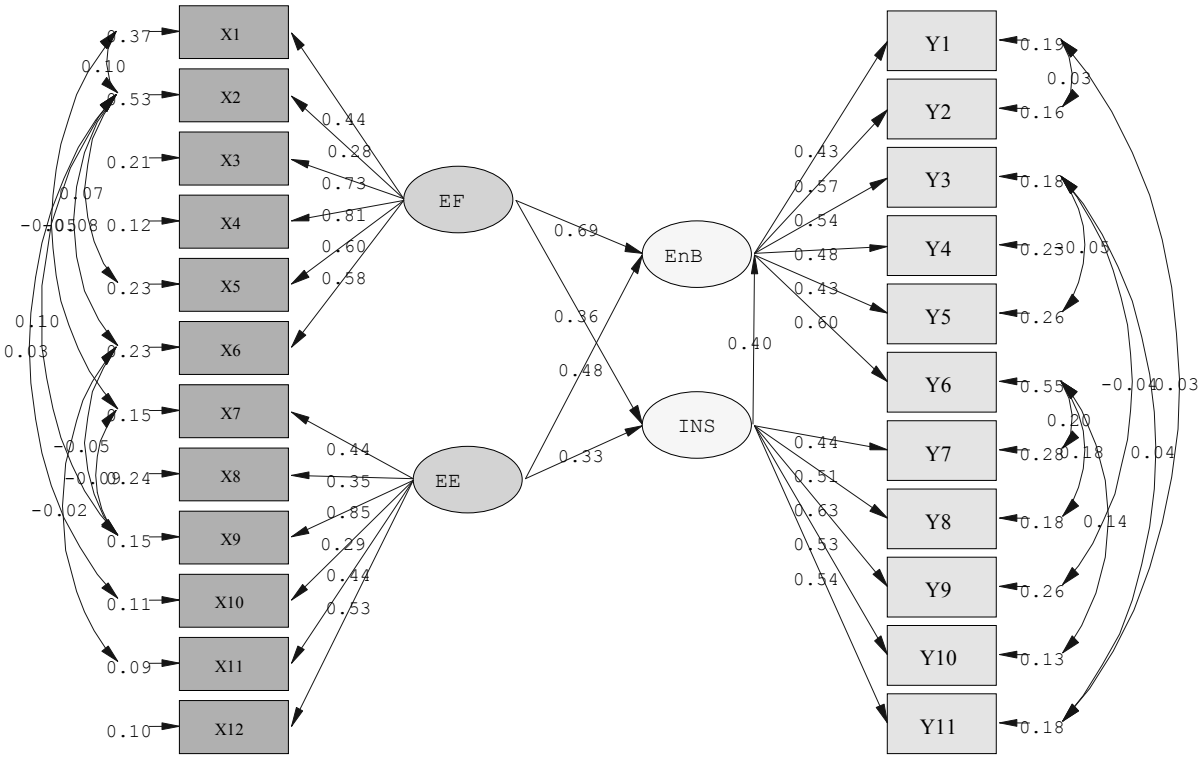


Figure 1 Model of Direct and Indirect Effect of EF and EE Affecting EnB through INS

Table 1 Direct and Indirect Effect of EF and EE Affecting EnB through INS

Causal variable	Result variables					
	INS			EnB		
	TE	IE	DE	TE	IE	DE
EF	0.36* (0.059)	-	0.36* (0.059)	0.83** (0.075)	0.14* (0.033)	0.69** (0.074)
EE	0.33* (0.059)	-	0.33* (0.16)	0.61** (0.065)	0.13* (0.013)	0.48** (0.069)
INS	-	-	-	0.40** (0.043)	-	0.40** (0.043)
χ^2= 263.50; df = 160			CN = 234.28		χ^2/df= 1.647	
GFI = 0.94; AGFI = 0.91			RMSEA = 0.045		RMR = 0.047	

TE: Total Effect, IE: Indirect Effect, DE: Direct Effect

Conclusion

Nevertheless, it might be summarized that latent variables that can be observed from observed variables are influenced through Environmental Conservation Inspiration (INS) composed of Self-Public Mind (Y7), Role Model Impression (Y8), Event Impression (Y9), Environment Impression (Y10), Media Reception (Y11) to Environmental Conservation Behavior for Global Warming Alleviation (EnB) that included behavior of appropriate consumption, energy conservation, waste management, recycling, travelling and knowledge transferring. Thus, the model of EF and EE influencing via INS to cause EnB was verified the proposed model was fitted with all observed variables according to criteria of Chi-Square/df value with less or equal to 5 ( ). RMSEA (Root Mean Square Error Approximation) equaled to 0.049 (RMSEA < 0.05) and RMR (Root Mean Square Residual) equaled to 0.017 (RMR < 0.05) including index level of model congruent value of Goodness of Fit Index (GFI) equaled to 0.95, and Adjust Goodness of Fit Index (AGFI) equaled to 0.92 which are between 0.90-1.00.

References

[1] Artwanichakul, K. and Thiengkamol, N. and Thiengkamol, T., Structural Model of Dengue Fever Prevention and Control Behavior, European Journal of Social Sciences, Vol.32, No.4, pp.485-497, 1992.

[2] Chomputawat, S. and Thiengkamol, N. and Thiengkamol, K .T., Causal Relationship Model of Environmental Conservation for Agriculturist, European Journal of Scientific Research, Vol.104, No.3, pp. 504-518, 2013.

[3] Donkonchum, S. and Thiengkamol, N. and Thiengkamol, C., Causal Relationship Model of Environmental Conservation Behavior Integrated with LCA Knowledge, European Journal of Social Sciences, Vol.33, No.1, pp.5-16, 2012.

[4] Gonggool, D. and Thiengkamol, N. and Thiengkamol, C., Development of Environmental Education Volunteer Model through Inspiration of Public Consciousness for Sustainable Development, European Journal of Social Sciences, Vol.32, No.1, pp.303-310, 2012.

[5] Jongwutiwet, N. and Thiengkamol, N. and Thiengkamol, T., Causal Relationship Model of Hospital Environmental Management, Mediterranean Journal of Social Sciences, Vol.3, No.11, pp.303-310, 2012.

[6] Koonboonchan, A. and Thiengkamol, N. and Thiengkamol, K.T., Causal Relationship Model of Global Warming Alleviation Integrated with Four Noble Truths and Psychological State, European Journal of Scientific Research, Vol.104, No.3, pp.418-433, 2013.

[7] Kotchachote, Y. and Thiengkamol, N. and Thiengkamol, K.T., Casual Relationship Model of Forest Fire Prevention, European Journal of Scientific Research, Vol.104, No.3, pp.519-532, 2013.

[8] Monfreda, C. and Wackernagel, M. and Deumling, D., Establishing national natural capital accounts based on detailed ecological footprint and biological capacity assessments, Land Use Policy, Vol.21, No.3, pp.231–246, 2004.

[9] Morrasri, P. and Thiengkamol, N. and Thiengkamol, K.T., Causal Relationship Model of Little Green Child with Environmental Behavior, European Journal of Social Sciences, Vol.34, No.2, pp.177-189, 2012.

[10] Phinnarach, K. and Thiengkamol, N. and Thiengkamol, C., Causal Relationship Model of Community Strength, European Journal of Social Sciences, Vol.34, No.3, pp.379-392. 2012.

[11] Pimdee, P. and Thiengkamol, N. and Thiengkamol, K.T., Causal Relationship Model of Electrical Energy Conservation, European Journal of Social Sciences, Vol.32, No.3, pp.306-315, 2012.

[12] Ruboon, O. and Thiengkamol, N. and Thiengkamol, K.T. and Kurokodt, J., Model of Environmental Education Teacher with Inspiration of Environmental Conservation for Global Warming Alleviation, European Journal of Social Sciences, Vol.31, No.1, pp.92-102, 2012.

[13] Saisunantharom, S. and Thiengkamol, N. and Thiengkamol, C., Casual Relationship Model of Biodiversity Conservation, European Journal of Scientific Research, Vol.104, No.3, pp.460-474, 2013.

[14] Suebsing, S. and Thiengkamol, N. and Thiengkamol, C., Causal Relationship Model of Forest Conserva-

tion, European Journal of Scientific Research, Vol.115, No.2, pp.292-304, 2013.

[15] Thiengkamol, N., Nurture Children to be Doctors, Intelluals, Bangkok, 2011.

[16] Thiengkamol, N., Development of Model of Environmental Education and Inspiration of Public Consciousness Influencing to Global Warming Alleviation, European Journal of Social Sciences, Vol.25, No.4, pp.506-514, 2011.

[17] Thiengkamol, N., Causal Relationship Model of Environmental Education and Psychological Trait, Mediterranean Journal of Social Sciences, Vol.3, No.11, pp.263-272, 2012.

[18] Thiengkamol, N., Model of Environmental Education and Psychological Factors Based on Inspiration of Public Consciousness Affecting to Global Warming Alleviation, Mediterranean Journal of Social Sciences, Vol.3, No.11, pp.435-444, 2012.

[19] Thiengkamol, N., Model of Environmental Education and Psychological Factors Affecting to Global Warming Alleviation, Mediterranean Journal of Social Sciences, Vol.3, No.11, pp.427-434, 2012.

[20] Tumpracha, K. and Thiengkamol, N. and Thiengkamol, C., Causal Relationship Model of Food Security Management, Mediterranean Journal of Social Sciences, Vol.3, No.11, pp.639-650, 2012.

[21] Udonboon, C. and Thiengkamol, N. and Thiengkamol, C., Causal Relationship Model of Water Conservation Behavior, Mediterranean Journal of Social Sciences, Vol.3, No.11, pp.599-611, 2012.

[22] Wackernagel, M. and Rees, W. E., Our Ecological Footprint: Reducing Human Impact on the Earth, New Society Publisher: Gabriola Island, British Columbia, 1996.

[23] Wackernagel, M. and Monfreda, C. and Moran, D. and Wermer, P. and Goldfinger, S. and Deumling, D. and Murray, M., National Footprint and Biocapacity Accounts 2005: the Underlying Calculation Method, Global Footprint Network, Oakland, 2005.

[24] Waewthaisong, S. and Thiengkamol, N. and Thiengkamol, C., Causal Relation Model of Environmental Traveling Behavior, European Journal of Social Sciences, Vol.33, No.2, pp.184-195, 2012.

[25] Wong, K. K., The Environmental Awareness of University Students in Beijing, China.Journal of Contemporary China, Vol.12, No.36, pp.519-536, 2003.

[26] World Wide Fund for Nature (WWF)., Europe 2005 The Ecological Footprint. World Wide Fund for Nature (WWF) European Policy Office, Brussels, 2005.