Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 March 2018 doi:10.20944/preprints201803.0127.v1

Article

Development of a Causal Relationship Model of Behavior in Household Disposal of Used Batteries in a Rural Community Banpru Town Municipality, Hatyai District, Songkhla Province

Montee Pruekparichart [1] and Kuaanan Techato [1,2,*]

[1] Environmental Assessment and Technology for Hazardous Waste Management Research Center, Faculty of Environmental Management, Prince of Songkla University, Songkhla, Thailand; 5610930023@email.psu.ac.th
[2] Research Program of Municipal Solid Waste and Hazardous Waste Management, Center of Excellence on Hazardous Substance Management (HSM), Bangkok, Thailand; kuaanan.t@psu.ac.th
* Correspondence: kuaanan.t@psu.ac.th; Tel.: +66 74-426843

Abstract: This research aimed to develop a causal relationship model of the behavior of a Thai rural community in disposing of used batteries. The variables studied were 1) the household latent variable (three observable variables); 2) the social latent variable (six observable variables); 3) the intention latent variable (three observable variable); and 4) the behavior latent variable (three observable variables). Six hundred households were surveyed using a questionnaire. The questionnaire developed was validated by seven experts and its reliability was established by testing it with a sample group. Results showed that the modified model do present a good overall level of fit. The House and social positively and directly influenced intention. Intention positively and directly influenced behavior. The theoretical and practical implications relating specifically to intention to the behavior in disposing of used dry batteries by households are emphasized. The modified model indicated eighty-nine percent of the variance in the behavior in disposing of used dry batteries by households was explained by the intention factors. The most direct effect on behavior was the intention factors with 0.89 of effect size. The factors with indirect effects on behavior were household and social factors with an effect size of 0.52 and 0.35.

Keywords: causal relationship model; disposing of used batteries; households

1. Introduction

There is an upward trend in the amount of hazardous waste in Thailand with an annual rate of increase of 10% [1] and electronics waste is the most common type of hazardous waste [2]. Proper management of hazardous waste can, however, reduce contamination and its health impact [3]. In an assessment of threats to the community the danger presented by household waste was ranked as the fifth highest by the Ministry of Natural Resources and Environment [4] and used dry batteries are a significant part of household hazardous waste. However, the management of household behavior can achieve a reduction in unexpected environmental problems either by reusing or treating waste [5].

The behavior of households in disposing of used dry batteries waste are influenced by three types of factors: awareness factors, social factors, and intentional factors. [6,7,8,9,10,11,12].

This research aimed to develop a causal relationship model of the behavior of households in Banpru Municipality, Hatyai District, Songkhla Province, in disposing of used dry batteries. There were four latent variables and eleven observed variables:

 doi:10.20944/preprints201803.0127.v1

1) The household (HOUSE) latent variable via three observable variables: perception (HPCT), visible opportunities (HOV) and social Influence (HSIF).

2) The social (SOCIAL) latent variable via four observable variables: information source include member of the press (SISM), personal (SISP) and internet (SISI), information type (SIT), reinforcement (SRFM) and experience (SEPR).

3) The intention to act (INTANT) latent variable via three observable variable: separating intention (INTS), collecting intention (INTC) and disposing intention (INTD)

4) The actual behavior (BEHAVIOR) latent variable via three observable variables: separating behavior (BHS), collecting behavior (BHC) and disposing behavior (BHD).

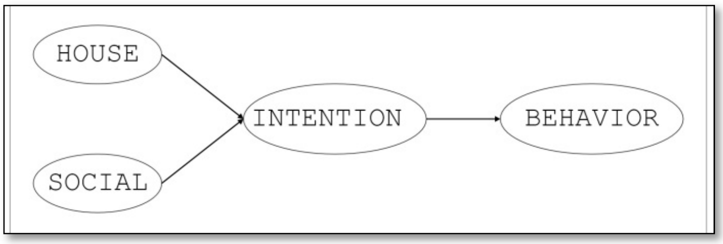

Figure 1. Relationship between Variables Influencing the Disposing of Used Dry Batteries

The household latent variable relates to the attitudes manifested within the household. The social latent variable relates to external factors, arising outside of the household, which may serve either a supporting or prohibiting function. The intention latent variable in the context of this study represents an intermediary variable between the household latent variable and the social latent variable and the actual behavior is the final result of the intention.

2. Materials and Methods

2.1. Population and Sampling Size

The study was conducted in the Banpru town municipality, Had-Yai district, Songkhla province, Thailand. Population for this research is the household of Banpru town municipality, amount to 20,388 formal households. The number of samples in this study were 600 households which calculated the proportion of the hypothesis test formula and based on the quantification of sample size for SEM suggested by Bollen [13]. Sampling technique with multistage random sampling. The survey was administered in person through door-to-door. The data were collected via an on-site self-administered questionnaire during august and September 2017.

2.2. Validity and Reliability Test

A questionnaire was used to collect data in this study and the validity of the items composing the questionnaire was established by an index of item congruence (IOC) based on the opinions of seven experts for content validity test in behavior, environmental management waste and qualitative research. At the first time, the questionnaire has 189 indicators. The IOCs of the items were found to range between 0.29 and 1.00 from 189 indicators and those items with an IOC lower than 0.50 were deleted. Based on the IOC score, IOC score or have less than 0.50 must be removed for the question of validity [14].

Considering form IOC scale, all the items in the questionnaire were based on a 5-point Likert scale and after deleting the items which did not meet the IOC criterion based on the experts'opinions, and rechecking with formal officer, the indicators in the questionnaire remains 165 indicators. the reliability test of the questionnaire based on the Cronbach's Alpha coefficient was found to range between 0.583 and 0.987 from 165 indicators (0.987 in all indicators) based on a pilot sample of 30 households, and removed low correlation of indicators. It remains 142 indicators, was ranged between 0.749 and 0.990 (0.987 in all indicators). The result of Cronbach's Alpha coefficient of this

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 March 2018 doi:10.20944/preprints201803.0127.v1

research showed good reliability [14]. A Cronbach's alpha that stayed above 0.749 indicates good internal reliability [14]. Therefore, all the items are reliable and usable. A further investigation using Structural Equation Modelling (SEM) techniques to examine the fitness of the model.

2.3. Instrument

The questionnaire was based on pro-environmental behavior literature and information obtained from the elicitation interviews. A set of questionnaire with 148 items was used as the instrument the study. The questionnaire consisted of two parts; the first part related to the respondent's demographic information and existing practices in the use and disposal of dry used batteries, which are gender, age, education level, occupation, household status, and city status obtained. The second part related to the respondent's perception of the contamination hazards from the disposal of dry batteries, their understanding of the perception (13 items), visible opportunities (10 items), social Influence on disposal practices (10 items), knowledge (5 items), information source and type about separating and disposing hazardous waste management (10 and 27 items), and their experience of the activity of various organizations relating to the disposal of used dry batteries, which consist of the experience (20 items), reinforcement (20 items), intention to act (10 items) and separating and disposing behavior (10 and 7 items). Each item was constructed on a five point Likert scale ranging from 1 (not at all) to 5 (very much).

2.4. Software

The descriptive statistics is analyzed using the SPSS statistics 17.0 for Windows software. The structural equation modeling (SEM), which is used to analyze for model fit (Goodness of fit index), predictive power (regression) and significance of paths for the specified model proposed, is analyzed using the LISREL 9.2 for Windows software.

3. Results

A completely questionnaire of 600 respondents from household in the Banpru town municipality in this study. More than 60% of the respondents were female campers (67.20%). The average age of the participants was 39 years old (SD = 13 years). Almost half of the sample were Undergraduate degree (45.50%). The respondents had a household head (32%). Most of the respondents are an officer/employees (25.30%). This area research was hometown of the respondents in 72.80%.

All skewness values lie between -1.0 and 1.0 in the data mining process. Data is considered normally distributed and is therefore acceptable to proceed with the parametric analysis procedure. The Kaiser- Meyer-Oikin (KMO) measure of sampling adequacy for all constructs are 0.878, close to 1.0. Furthermore, the Bartletts test significance value is close to 0.000 [15]. Therefore, it is appropriate to proceed with data reduction procedure or a factor analysis procedure.

In table 1 shows the correlation between the observe variables based on Pearson Product Moment correlations, mean values and standard deviation for measures of an observe variables of the household, social, intention to act and actual behavior latent variables. This result of correlation matrix test in this table showed that the range of observe variables between -0.323 and 0.884, almost all variables observed were statistically significant at 0.01 and 0.05, the direction of observe variables relationship were both direct (positive value) and opposite (negative value). In technical term, we found that the HKL factor only is a problem of this model because it is a negative value and non-significant with other factors.

Table 1. Means, SD and correlations of relationships between variables in the model (unmodified)

	HPCT	HOV	HSIF	HKL	SISM	SISP	SISI	SIT	SRFM	SEPR	INTS	INTC	INTD	BHS	BHC	BHD
HPCT	1															
HOV	.728**	1														
HSIF	.758**	.720**	1													

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 March 2018 doi:10.20944/preprints201803.0127.v1

HKL	.257**	.200**	.077	1												
SISM	.212**	.174**	.268**	-.137**	1											
SISP	.144**	.141**	.259**	-.214**	.758**	1										
SISI	.135**	.111**	.193**	-.126**	.607**	.602**	1									
SIT	.303**	.265**	.334**	-.104*	.564**	.547**	.437**	1								
SRFM	.217**	.282**	.342**	-.323**	.435**	.525**	.394**	.436**	1							
SEPR	.328**	.390**	.455**	-.222**	.469**	.508**	.359**	.475**	.759**	1						
INTS	.382**	.346**	.445**	.004	.272**	.272**	.170**	.358**	.278**	.388**	1					
INTC	.379**	.360**	.437**	-.014	.270**	.259**	.208**	.300**	.306**	.365**	.719**	1				
INTD	.419**	.375**	.460**	.020	.280**	.282**	.231**	.331**	.293**	.378**	.840**	.884**	1			
BHS	.432**	.384**	.520**	.001	.317**	.325**	.214**	.421**	.323**	.434**	.661**	.569**	.639**	1		
BHC	.381**	.350**	.467**	-.081*	.392**	.378**	.289**	.401**	.477**	.516**	.535**	.512**	.559**	.743**	1	
BHD	.384**	.311**	.436**	-.121**	.410**	.419**	.334**	.433**	.532**	.547**	.526**	.508**	.543**	.687**	.774**	1
Mean	3.30	3.24	3.07	3.88	2.30	2.07	2.12	2.63	1.82	2.07	2.79	2.68	2.79	2.63	2.32	2.11
SD	0.85	0.91	0.96	1.05	0.79	0.79	0.99	0.91	0.99	0.96	1.10	1.21	1.10	1.24	1.05	0.99
N	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600

SD = standard deviation, N = sampling group and *p < .05, **p < .001

In table 2, when considering the correlation value of each variable, the knowledge observable variable was weak from the correlation matrix table and had negative relationship with another factor. So, the researchers consider deleted it from the household latent variable. This result of correlation matrix test in the table 2 showed that the range of observe variables between 0.111 and 0.884. All of the variables observed were statistically significant at the 0.01 level, the direction of observe variables relationship were the positive direct.

Table 2. Means, SD and correlations of relationships between variables in the model (modified)

	HPCT	HOV	HSIF	SISM	SISP	SISI	SIT	SRFM	SEPR	INTS	INTC	INTD	BHS	BHC	BHD
HPCT	1														
HOV	.728**	1													
HSIF	.758**	.720**	1												
SISM	.212**	.174**	.268**	1											
SISP	.144**	.141**	.259**	.758**	1										
SISI	.135**	.111**	.193**	.607**	.602**	1									
SIT	.303**	.265**	.334**	.564**	.547**	.437**	1								
SRFM	.217**	.282**	.342**	.435**	.525**	.394**	.436**	1							
SEPR	.328**	.390**	.455**	.469**	.508**	.359**	.475**	.759**	1						
INTS	.382**	.346**	.445**	.272**	.272**	.170**	.358**	.278**	.388**	1					
INTC	.379**	.360**	.437**	.270**	.259**	.208**	.300**	.306**	.365**	.719**	1				
INTD	.419**	.375**	.460**	.280**	.282**	.231**	.331**	.293**	.378**	.840**	.884**	1			
BHS	.432**	.384**	.520**	.317**	.325**	.214**	.421**	.323**	.434**	.661**	.569**	.639**	1		
BHC	.381**	.350**	.467**	.392**	.378**	.289**	.401**	.477**	.516**	.535**	.512**	.559**	.743**	1	
BHD	.384**	.311**	.436**	.410**	.419**	.334**	.433**	.532**	.547**	.526**	.508**	.543**	.687**	.774**	1
Mean	3.30	3.24	3.07	2.30	2.07	2.12	2.63	1.82	2.07	2.79	2.68	2.79	2.63	2.32	2.11
SD	0.85	0.91	0.96	0.79	0.79	0.99	0.91	0.99	0.96	1.10	1.21	1.10	1.24	1.05	0.99
N	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600

SD = standard deviation, N = sampling group and *p < .05, **p < .001

3.1. Structural Model

Measures of overall model fit indices showed that the hypothesized model did not fit the data well (Chi-square = 893.94, df = 86, relative chi-square = 10.395, p-value = 0.000). Another measures of overall model fit indices below a recommended in criteria of table.3 (RMSEA = 0.110, CFI = 0.879, GFI = 0.830, SRMR = 0.0561 and AGFI = 0.857) (See Table 3 below for definitions of indices and criteria).) So the hypothetical model in figure.2 was not statistically significant. Therefore, the modified model was adopted in this study. The modified model exceeded the recommended acceptance levels, not only for the relative chi-square value but also for the remaining measures, suggesting a good incremental and parsimonious fit, as described below (figure.2)

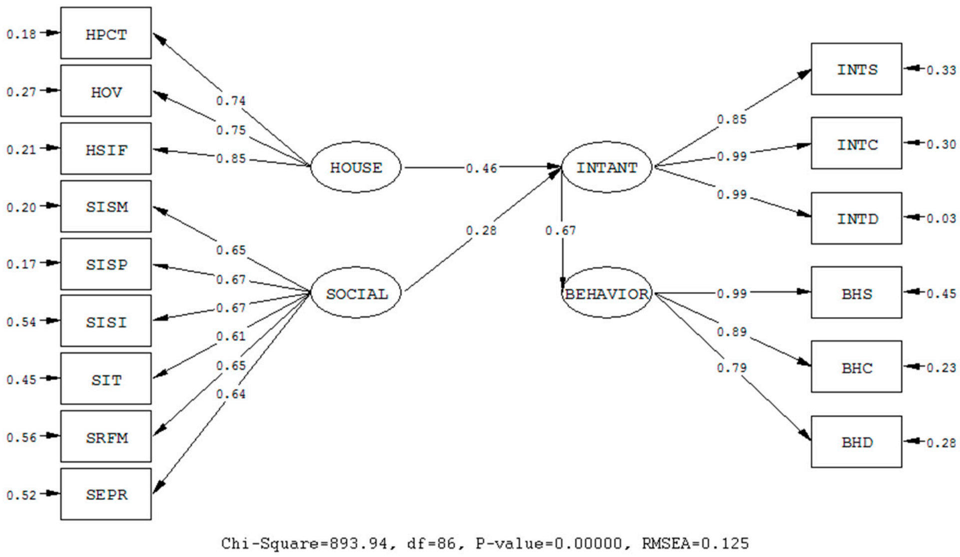

Figure 2. The hypothetical model

The modified model results, showed sufficient conformity between the conceptual models with data obtained from the study as shown in Table 3, consisted of the same variables is shown in figure. 3, explained the data well: Chi-square = 397.90, df = 80, relative chi-square = 4.97, p-value = 0.000, RMSEA = 0.81, CFI = 0.95, GFI = 0.92, SRMR = 0.08 and AGFI = 0.88. Value of relative chi-square was 4.97 was obtained slightly above the criteria value recommended, the absolute measure of the fit index parameters or RMSEA, equal to 0.81 and SRMR, equal to 0.08 within the tolerance limit of 0.08. The value of goodness of fit index, CFI, GFI and AGFI equal to 0.95, 0.92 and 0.88 indicating acceptance within the tolerance limit of 0.90 [15].

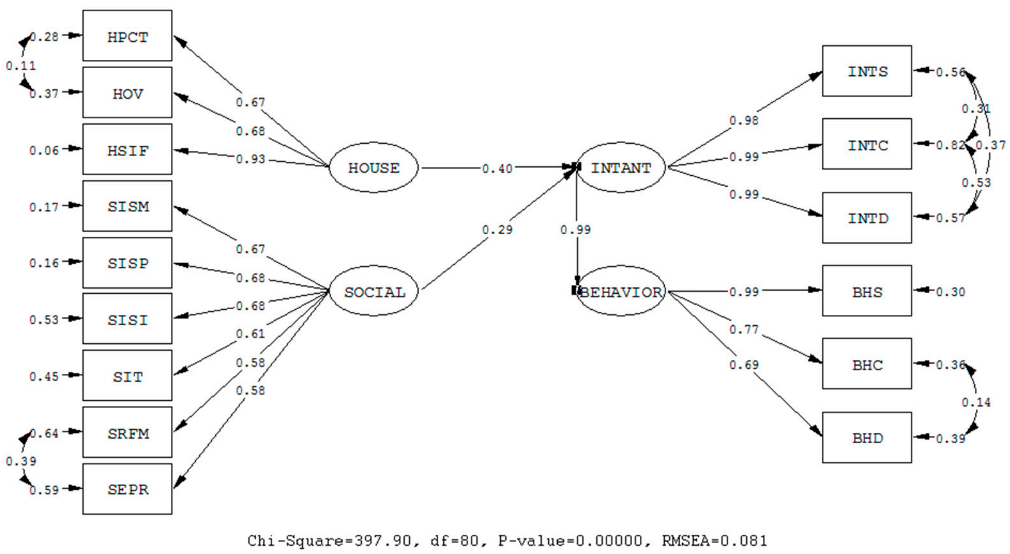

Figure 3. The modified model

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 March 2018 doi:10.20944/preprints201803.0127.v1

Almost all of Statistics Values of The modified model had significant effects on behavior in disposing of used dry batteries. In technical terms, these results suggest that there are no problems with the structural model. This means that this model can explain the behavior in disposing of used dry batteries by households. (Table 3)

Table 3. Statistical comparison of the model before and after adjustment.

Statistics		Criteria	Value of Model	
			Hypothesized	Modified
Absolute Fit Indices				
	Chi-square Test		615.85	397.90
df	Degree of Freedom		85	80
Chi-square/df	Relative chi-square	Not less 5	7.25	4.97
Sig.	P-Value for Test of Close Fit	More than.05	0.00	0.00
RMSEA	Root mean square error of approximation	0.05-0.08	0.10	0.81
SRMR	Standardized root mean square residual	0.05-0.08	0.13	0.08
Comparative Fit Indices				
CFI	Comparative fit index	More than 0.90	0.92	0.95
GFI	Goodness-of-fit index	More than 0.90	0.88	0.92
AGFI	Adjusted Goodness-of-fit index	More than 0.90	0.83	0.88

Source: [13, 15, 16, 17, 18]

As can be seen, the household latent variable has a significant and positive influence on the intention latent variable (P< 0.01, Path Coefficient = 0.52), the social latent variable has a significant positive influence on the intention latent variable (P < 0.01, Path Coefficient = 0.35) and the intention latent variable has a significant positive influence on the behavior latent variable (P < 0.01, Path Coefficient = 0.89).

Based on the path factor analysis shown in table 5, the most influential factor on behavior is the intention of the user.

Table 4. Path Factor Analysis

Latent Variables	Effect	Latent Variables		
		HOUSE	SOCIAL	INTENT
INTENTION	Direct Effect	0.52**	0.35**	
	Total Effect	0.52**	0.35**	
BEHAVIOR	Direct Effect			0.89**
	Total Effect			0.89**

** P < 0.01

The relationships between the observable variables and the latent variables based on the squared correlations (R^2) and the completely standardized solution statistics are shown in Table 5. All observable variables pass the standard completely standardized solution score (>0.30) and are the middle and high reliable or square multiple correlation scores (0.34 - 0.92) [19]. The highest R^2, 0.92 for the household latent variables shows a social influence. The highest R^2, 0.75 from the social latent variables is information source from personal, the highest R^2, 0.65 from the intention latent variables is disposing intention and the highest R^2, 0.77 from the behavior latent variables is separating behavior.

 doi:10.20944/preprints201803.0127.v1

Table 5. Influence of each observable variable

Variable	Completely Standardized Solution	Square Multiple Correlation (R^2)
HOUSE		
HPCT	0.79**	0.62
HOV	0.75**	0.56
HSIF	0.96**	0.92
SOCIAL		
SISM	0.85**	0.73
SISP	0.87**	0.75
SISI	0.69**	0.47
SIT	0.67**	0.45
SRFM	0.59**	0.34
SEPR	0.60**	0.36
INTANT		
INTS	0.78**	0.61
INTC	0.74**	0.54
INTD	0.80**	0.65
BEHAVIOR		
BHS	0.88**	0.77
BHC	0.82**	0.68
BHD	0.77**	0.60

**.P < 0.01

4. Discussion and Conclusions

There are several factors that influence our decisions towards the behavior in disposing of used dry batteries by households that we have not research on. This study examines the relation between household factor, social factor and behavior in disposing of used dry batteries of the households in urban areas, with intention factor as the mediator.

The causal relationship model of the behavior of households in Banpru Municipality in disposing of used batteries established in this research based on the collection of data with a questionnaire, considered the CFI, GFI, AGFI, SRMR, and RMSEA and the Chi-square coefficient, and all the coefficients were transformed to a normal distribution by the normal scores method. The interactions in the model explain that the behavior of the people in the households is influenced by four factors consisting of external situation, internal mental constructs, the mechanical interaction between the external situation and internal mental constructs, and the human organic interactions between the internal situation and the internal mental constructs

Social influence and social experience are the key factors which policy makers need to consider in seeking to increase the rate of appropriate disposal of used dry batteries. The means by which social influence can be brought to bear on households include the use of a variety of media (e.g. billboard advertising, social media etc.) whereas the influence of social experience requires the user to be involved in some form of community activity aimed at appropriate separation and disposal. Thus there needs to be suitable and convenient facilities available for collecting used dry batteries from households.

Acknowledgments: This study was supported in part by grants from the Research Program of Municipal Solid Waste and Hazardous Waste Management, Center of Excellence on Hazardous Substance Management (HSM), Bangkok, Thailand and the Environmental Evaluation and Technology of Hazardous Substance Management Research Center, Faculty of Environmental Management, Prince of Songkla University, Songkhla, Thailand.

References

1. ASTV Online manager. *Crisis! Thai Electronic Waste.* Available online: http://www.manager.co.th/iBizChannel/ViewNews.aspx?NewsID=9570000113873 (accessed on 26 December, 2014).
2. ASTV Online manager. *Pollution Control Department to tackle the problem of garbage revealed "Songkhla model" is a model of all provinces.* Available online: http://www.manager.co.th/South/ViewNews.aspx?NewsID=9570000037736 (accessed on 15 October, 2015).
3. Department of Labour Protection and Welfare, Ministry of Labour. *Manual for hazardous waste sorting in the office.* Bangkok: Rumthaipress. N.d.
4. Ayutthaya, A. I. *Project for Prioritization of Natural Resources and Environmental Issues.* Available online: http://tdri.or.th/publications/wb43/ (accessed on 4 January, 2016).
5. Department of Environmental Quality Promotion (DEQP). *Discipline Guide Sustainable waste management.* 2nd ed., Bangkok: Department of Environmental Quality Promotion (DEQP), 2015.
6. Fishbein, M. & Ajzen I. *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research.* MA: Addison-Wesley. 1975.
7. Magnusson, D. & Endler, N. S. *Interactional psychology and personality.* New York, NY: John Wiley & Sons. 1977.
8. Hines, J. M., Hungerford, H. R. & Tomera, A. N. Analysis and Synthesis of Research on Responsible Environmental Behavior: A Meta-Analysis. *The Journal of Environmental Education*, Volume 18, 1987. Pages 1–8.
9. Ajzen, I. *Attitudes Personality and Behavior.* Chicago: Dorsey. 1988.
10. Burgess, J., Harrison, C. & Fillius, P. Environmental communication and the cultural politics of environmental citizenship. *A Environment and Planning*, Volume 30, 1998. Pages 1445–1460.
11. Hansmann, R., Bernasconi, P., Smieszek, T., Loukopoulos, P. & Scholz, R. W. Justifications and self-organization as determinants of recycling behavior: The case of used batteries. *Resources, Conservation and Recycling*, Volume 47, 2006. Pages 133–159.
12. Latif, S. A., Omar, M. S., Bidin, Y. H. & Awang, Z. Role of Environmental Knowledge in Creating Pro-Environmental Residents. *Procedia - Social and Behavioral Sciences*, Volume 105, 2013. Pages 866 – 874, (AicE-Bs2013London: Asia Pacific International Conference on Environment-Behaviour Studies). doi: 10.1016/j.sbspro.2013.11.088
13. Bollen, K. A. *Structural Equations with Latent Variables.* New York: John Wiley & Sons. 1989.
14. Cronbach, L.J. Coefficient alpha and the internal structure of tests. *Psychometrika*, Volume 16(3), 1951 , 297–334. https://doi.org/10.1007/BF02310555
15. Hair, J. F., Jr., Black, B., Babin, B., Anderson, R., & Tatham, R. *Multivariate data analysis.* 6th ed., New Jersey: Prentice-Hall. 2006.
16. Jöreskog, K. G. and Sörbom, D. *LISREL 8 : user's reference guide.* Chicago, IL : Scientific Software International. 1996.
17. Tabachnick, B. G. & Fidell, L. S. (2000). Using multivariate statistics. 4th Edition, Massachusetts: Pearson Education. 2000.
18. Schumacker, R. E. & Lomax, R. G. *Structural Equation Modeling.* 3rd ed., New York: Routledge. 2010.
19. Mueller, R. O. *Basic principles of structural equation modeling: An introduction to LISREL and EQS.* New York: Springer-Verlag. 1996.