第 XI 部

タイの環境経済評価
および
環境政策に関する
実証研究

プロジェクト代表者
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第 12 章

Understanding Factors Influence Household Waste Recycling Behaviour in Thailand. Case Study: Bangkok

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Abstract

A success of recycling programs depends largely on the active and sustained involvement of people. To examine factors that influence households' decision to participate in recycling programs, this research applied directed interviews, observations, and questionnaire surveys to study the behavior toward recycling of the 381 random selected individuals in Bangkok. This study employed the theory of planed behavior as the main framework and injected socio-demographic, economic, and situational factors into the model to examine how these factors integrate to either stimulate or restrain recycling involvement of people. The results of the estimated logistic regression models suggested that the adequacy of information regarding recycling and resident period in the current place directly predicted recycling behavior, whereas the condition of recycling facility and personal recycling skill provided both direct effect on the actual behavior and indirect effect via recycling intention. In contrast, the psychological factors; attitude toward recycling, subjective norm, and awareness of recycling benefit, only indirectly influenced recycling behavior through the intention. The economic incentive, perceived efforts on time and space, and other demographic variables were not found significant in both levels.
Keywords: Thailand, recycling, waste, logistic regression, theory of planed behavior.

12.1 Introduction

The solid waste generation in Thailand has increased extensively along with population growths, economic expansions, as well as changing in consumption patterns. Pollution Control Department[1] reported that the amount of generated waste had risen from 30,640 tons per day in 1993 to 41,023 tons per day in 2008. The excessive solid waste generation with-

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out proper treatments caused environmental effluences and has become an emerging concern. Recycling has been broadly promoted as one of the waste management strategies to reduce materials that need to be disposed as well as to utilize valuable waste. Still, the recycling participation rate is rather low. Only approximately 20% of over 15 million tons of annual generated waste is being recycled, whereas it is estimated that the potential recyclable waste in Thailand is as high as 40-60%[2].

To encourage people to co-operate in recycling programs, it is important to understand the factors that influence people's behavior toward recycling. Despite its necessity, researches on understanding mechanism of recycling decision of households in Thailand are critically rare. In response to the need, this research aims to investigate the role of socio-demographic factors, psychological factors, economic factors, and situational factors in influencing recycling behavior of Thai people in an integrated perspective.

12.2 Theoretical framework

Theory of reasoned action (TRA) and theory of planed behavior (TPB) have been well comprehended as models that provide a framework to explain the determinants of behavior in social and psychological perspective. The TRA suggests that behavior is a direct function of intention which is formed by attitude toward that behavior and subjective norm. When one has high intention, it is likely that he or she will perform the behavior [3]. The TPB is an extension of TRA, proposed by Ajzen *et al* [4]. In addition to the attitude and subjective norm, TPB adds the concept of perceived behavioral control (PBC) which is developed from self-efficacy theory originated by Bandura [5, 6] into the model. The PBC not only influences intention but also directly influences behavior. The TRA and TPB have been extensively applied to predict recycling behavior in many occasions [7-13]. However, many researchers supported that there are other variables besides elements of TRA and TPB that predict environmental behaviors [7-8, 12-20]. This study considered relevant factors in accordance with previous studies and employed the TPB as the critical framework of the research.

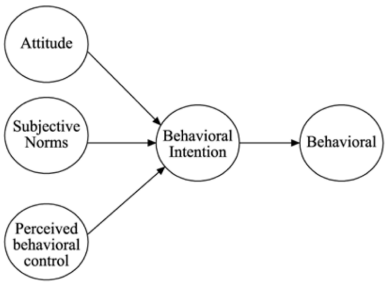

Figure 1: Theory of planed behavior [4].

12.3 Research design

12.3.1 Instrument development

The data of this research were obtained from personal interviews based on a structured questionnaire, designed follow the previous literatures [10-13, 15, 21]. Pre-tests were hold

two times prior to the main survey to examine the quality of the questionnaire items. Participants in the pre-tests were 80 Thai citizens who have been dwelled in Bangkok at least 90 days. In addition to the close-ended questionnaire, an open interview was also applied to acquire personal opinions. The internal consistency of question dimensions was measured by Conbach's alpha coefficient which indicates the degree to which a set of items measures a single unidimensional latent construct, values from 0 to 1. Values above 0.7 indicate a good internal consistency [22]. The results of the second pre-test were satisfied in every question, with the alpha coefficients ranged from 0.71 to 0.88. The verified questionnaire survey consisted with 3 parts; 1) questions regarding socio-demographic information, 2) questions regarding recycling behavior and intention, and 3) six-point scales question items on psychological, situational, and economic factors (strongly disagree=1 to strongly agree=6).

12.3.2 Sampling and data collection

Bangkok was selected for the study area. The target population was individuals who have been lived in Bangkok not less than 90 days. Multi-stages sampling method was applied to gather research samples. The information of total fifty districts in Bangkok was firstly examined. Inner-Bangkok, which is classified as residential and business area [23], was selected as the interest group. Pathumwan district was randomly selected from 21 districts in the next stage by drawing lots. In the third stage, the number of sample required was calculated by using Krejcie and Morgen's formula [24].

$$n = \frac{\chi^2 NP(1-P)}{d^2(N-1) + \chi^2 P(1-P)}$$

Where n =required sample size, χ^2=table value of chi-square for 1 degree of freedom at the 95% confidence level (3.841), N =population size, P =population proportion (assumed to be .50 since this would provide the maximum sample size), and d =degree of accuracy expressed as a proportion .05 or 5% margin error.

According to the population and housing statistic provided by Department of Provincial Administration [25], Pathumwan district has a population of 58,858 people (male 27,463; female 31,395) as of 2009. Based on the sampling formula, 381 samples were required at 5% margin error. In the last stage, the number of sample required for each sub-district in Pathumwan ward was calculated by the ratio-sampling method as below;

1. Roungmuan = (381 × 20,031) / 58,858 = 130 samples
2. Wangmai = (381 × 10,905) / 58,858 = 70 samples
3. Pathumwan = (381 × 7,644) / 58,858 = 50 samples
4. Lumphinee = (381 × 20,278) / 58,858 = 131 samples

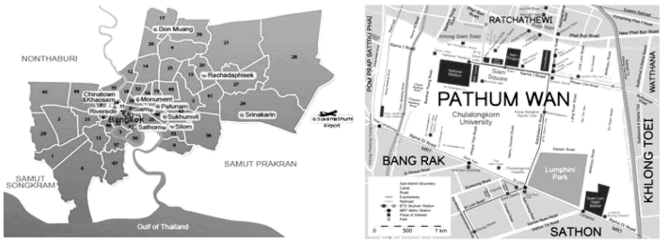

Figure 2: Maps of Bangkok metropolitan (left) and Pathumwan district (right)

12.3.3 Analysis methodology

Logistic regression analysis was employed to estimate significant effects of explanatory variables in the study. The logistic regression works with odds which refer to the ratio of proportions for the two possible outcomes [26-28]. If the probability of $Y = 1$ is P, then $1 - P$ is the probability when $Y = 0$. The odds can be written as eqn.(1).

$$\text{Odds} = \frac{P}{1-P} = e^{(\alpha+\beta_1 X_1+\beta_2 X_2+\cdots+\beta_k X_k)} \tag{1}$$

Hence, the odds, or the ratio of the probability of $Y = 1$ to its complement could be defined as eqn. (2).

$$P[Y = 1 \mid X_i] = \frac{e^{(\alpha+\beta_1 X_1+\beta_2 X_2+\cdots+\beta_k X_k)}}{1 + e^{(\alpha+\beta_1 X_1+\beta_2 X_2+\cdots+\beta_k X_k)}} \tag{2}$$

Where X refers to explanatory variables 1 to k and i refers to samples 1 to n. Since the odds can take any positive values and so have no ceiling restriction, a logistic transformation is applied to remove the floor restriction. A multiple logistic regression model is abbreviated as eqn.(3)

$$\text{logit}(Y = 1 \mid X_i) = \log\left[\frac{P(Y=1)}{1-P(Y=1)}\right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k \tag{3}$$

Parameters in logistic regression model are estimated by maximum likelihood method [26]. The statistical significance of each coefficient is evaluated using the Wald test.

$$w_i = \left(\frac{\beta_i}{\text{S.E}_{\beta_i}}\right)^2 \quad \text{where } i = 1, 2, \cdots, n. \tag{4}$$

The regression coefficient β represents the change in the logit of the probability from a unit change in the associated predictor, holding other factors constant. The log-odds coefficients can also be interpreted after anti-log by exponentiating, as the change in the ratio of probability of outcome $Y = 1$ over $Y = 0$ for a unit change in the associated explanatory factor, ceteris paribus [27-29]. The goodness-of-fit of the logistic regression models in this study was analyzed using a) the -2 log-likelihood statistic, or the deviance, which measures unexplained variation in the model. The larger the value expresses the less accurate the predictions of the model; b) the Omnibus test which is a likelihood-ratio chi- square test whether the coefficients of the variables in the model are all jointly equal to zero; c) the Hosmer & Lemeshow goodness of fit test which examines the null hypothesis that the model adjust well to the data; and d) the Nagelkerke R^2 which reveals the amount of variation in the outcome variable that is explained by the model, having maximum value equal to 1.

12.4 Data analysis

12.4.1 Descriptive analysis

The median age of the respondents was 28 years old. Most of the respondents were female (56.7%), completed undergraduate school (63.3%), single (70.9%), living in a single house (55.9%), and having personal monthly income 10,001 to 20,000 Thai baht (41.7%). Of total 381 samples, 217 respondents (57%) reported that they involve in recycling activities while 231 respondents (60.6%) reported that they have intentions to recycle. The samples demonstrated appropriate representatives of Bangkok population which 52.4% is female, median age is a range of 20 to 34 years old, per capita income on average equal to 11,284 Baht [30]. However, the sample group was better educated than the populations which have average years of educational attainment at 12 years [31].

Table 1: Characteristics of the sample

Demographics		Frequency	% of responses
Gender	Male	165	43.3
	Female	216	56.7
Marital Status	Single	270	70.9
	Married	109	28.6
	Divorce	2	0.5
Education	Junior High school or lower	17	4.5
	High school	79	20.7
	Undergraduate	241	63.3
	Graduated or higher	44	11.5
Income	Less than 10000	95	24.9
	10000-20000	159	41.7
	20001-30000	56	14.7
	30001-40000	22	5.8
	40001-50000	16	4.2
	More than 50000	33	8.7
House type	Single house	213	55.9
	Room	168	44.1

12.4.2 Principal component analysis

Principal component analysis (PCA) was carried out prior to construct the logistic regression model to examine the empirical dimensions of questionnaire data measured on ordinal scales [32-33]. To measure the competence of PCA to the initial variables, the Kaiser-Meyer-Olkin (KMO) statistic and the Bartlett's test was performed. The KMO measure of sampling adequacy provides an index ranges from 0 to 1. A value close to 1 indicates that patterns of correlations are relatively compact and so factor analysis should yield distinct and reliable factors. The Bartlett's test evaluates whether the correlation matrix of initial variables is significantly different from the identity matrix. The PCA can be applied if the hypothesis that these matrixes are equal is rejected [34-35]. The results of the PCA performed with twenty-seven items on psychological, situational, and economic factors, obtained from the third part of the questionnaire survey, were summarized in table.3. No problematic collinearity across dimensions was found. The factor loadings demonstrated 10 dimensions. All components in

aggregate explained 92.76% of the total variance in the data. KMO=0.73 showed a modest sampling adequacy of factor analysis. The Bartlett's test is highly significant at *p*-value equal to .00, approved that the PCA is applicable.

The seven non-scaled socio-demographic variables and ten scaled variables after performing PCA were double examined for multicollinearity problem by testing the Variance Inflation Factor (VIF) which measures the impact of collinearity among the independent variables in a regression model. As a rule of thumb, VIF of a variable above 10 indicates a multicollinearity problem [26]. The value of examined VIF ranged from 1.147 to 2.181, confirmed that there was no multicollinearity problem among seventeen explanatory variables.

Table 2: Summary of the Variance Inflation Factor of predictors in the model

Variables		Collinearity Statistics	
		Tolerance	VIF
1.	Attitude toward recycling	.872	1.147
2.	Internal Subjective Norm	.780	1.282
3.	External Subjective Norm	.756	1.323
4.	Awareness of recycling benefit	.848	1.179
5.	Economic Incentive	.803	1.245
6.	Perceived space needed for recycling	.774	1.292
7.	Perceived time needed for recycling	.625	1.599
8.	Perceived facility condition	.627	1.594
9.	Perceived recycling skill	.698	1.433
10.	Adequacy of recycling information	.727	1.376
11.	Gender	.857	1.168
12.	Age	.458	2.181
13.	Marital status	.500	1.998
14.	House type	.775	1.290
15.	Income	.529	1.892
16.	Education level	.665	1.504
17.	Resident years	.754	1.326

Table 3: Results of the principal component analysis

Items	Loadings[a]	% of Variance explained[b]
Component 1: Perceived space needed for recycling		
I feel that recycling waste is space consuming	+0.947	
I feel that storing recycle waste affects using space in my house	+0.924	21.33
I feel that recycling waste is inconvenience in term of space	+0.938	
Component 2: Perceived facility condition		
I feel that it is easy for me to find recycling service	+0.915	
I agree that I am provided good recycling facility	+0.941	17.66
I feel that recycling service is convenient to access.	+0.930	
Component 3: Economic incentive		
Economic intensive is a factor persuading me to recycle waste	+0.927	
I feel that economic returns from recycling waste make me want to recycle	+0.957	9.56
I agree that economic rewards affect my recycling behavior	+0.955	
Component 4: Adequacy of recycling information		
I feel that am well provided information about recycling	+0.946	
I often find recycling information commonly	+0.903	9.09
I agree that I am accessible to information regarding recycling	+0.937	
Component 5: Perceived recycling skill		
I feel that I have ability to recycle waste properly	+0.906	
I agree that it is not troublesome for me to sort recyclable waste	+0.912	8.32
I think that I know well the process of recycling household waste	+0.892	
Component 6: Perceived time needed for recycling		
I feel that recycling waste is time consuming	+0.821	
I feel that it takes times to separating recyclable waste from others	+0.914	7.33
I feel that recycling waste is inconvenience in term of time	+0.923	
Component 7: Attitude toward recycling		
I feel that recycling waste is beneficial	+0.903	
I feel that recycling waste is valuable	+0.924	5.80
I feel that recycling waste is good	+0.881	
Component 8: Internal subjective Norm		
Recycling behavior of household members has impact on my recycling behavior	+0.934	5.38
Recycling behavior of people who are living with me affects my recycling behavior	+0.945	
Component 9: External subjective Norm		
Recycling behavior of friends or colleagues has impact on my recycling behavior	+0.934	4.48
Recycling behavior of people who are close to me but not living together affects my recycling behavior	+0.950	
Component 10: Awareness of recycling benefit on waste problem		
I agree that recycling helps utilizing valuable waste	+0.955	3.82
I agree that recycling is a solution for reducing waste problem	+0.948	

[a] After Varimax rotation with Kaiser Normalization.
[b] Extraction Method: Principal Component Analysis.

12.4.3 Logistic regression analysis

The capability of variables at each level to predict relevant variables at subsequent levels was examined by hierarchical logistic regression analyses. To test whether the factors present direct effects on recycling behavior or indirect effects via the intention, explanatory variables in the study were estimated in two stages; first stage with recycling intention as the dependent variable, second stage with recycling behavior as the dependent variable. Both intention to recycle and recycling behavior measured by self-report binary scale; 1=yes and 0=no.

To measure the predictors of intention to recycle in the first stage, a two-step hierarchical logistic regression analysis was applied. The socio-demographic variables which are classified as the factors at the lowest level were entered on the first step. The seven variables together provided a model that correctly classified 64% of the sample (82.3% of sample with

intention to recycle; 36% of sample with no intention to recycle). Hosmer and Lemeshow test was significant demonstrated that the model with only demographic variables did not adjust well to the data. Entering the rest ten variables on the next step amplified the percentage of respondents correctly classified to 90% (92.2% of sample with intention to recycle; 86.7% of sample with no intention). Hosmer and Lemeshow test become insignificant. Nagelkerke R^2 improved from .116 to .738. The value of the -2log-likelihood also decreased from 476.680 to 210.823 presented more accurate the predictions of the model. The attitude toward recycling, external subjective norm, awareness of recycling benefit, perceived facility condition, and perceived personal recycling skill were significant predictors of recycling intention, table.4.

In the second stage, a three-step hierarchical logistic regression analysis was employed to measure the predictors of recycling behavior. The recycling intention was entered into the model on the third step. The socio-demographic variables entered on the first step provided a model that correctly classified 63.3% of the sample (74.2% of recycler; 48.8% of non-recycler). Hosmer and Lemeshow test was significant demonstrates that the model with only demographic variables did not adjust well to the data. Entering psychological, situational, and economic variables on the second step increased the percentage of respondents correctly classified to 89% (90.3% of recycler; 87.2% of non- recycler). The resident year, perceived facility condition, perceived personal recycling skill, and perception of having adequacy recycling information significantly predicted recycling behavior in this level. Hosmer and Lemeshow test became insignificant. Nagelkerke R^2 increased from .141 to .731. The -2 log- likelihood decreased from 478.459 to 221.105. The entry of the recycling intention variable on the last step improved model substantially. The percentage of respondents correctly classified increased to 94.5% (96.3% of recycler; 92.1% of non-recycler). Hosmer and Lemeshow test was not significant. Nagelkerke R^2 improved to .878. The value of the -2 log-likelihood decreased to 116.357. The resident year, perceived facility condition, perceived personal recycling skill, perception of having adequacy of recycling information, and recycling intention significantly predicted recycling behavior, table.5.

Table 4: Estimated regression coefficients of the logistic regression model predicting recycling intention

Predictors	Step 1		Step 2	
	β	exp(β)	β	exp(β)
Gender	-.437	.646	.089	1.094
Single				
Married	.129	1.137	1.214	3.366
Divorce	-1.080	.340	-.839	.432
House type	-.272	.762	-.831	.436
Income less than 10000 Thai baht				
Income 10001-20000 Thai baht	-.324	.723	-.899	.407
Income 20001-30000 That baht	-.401	.669	.122	1.130
Income 30001-40000 Thai baht	-1.104	.332	-.552	.576
Income 40001-50000 Thai baht	-.417	.659	-1.560	.210
Income more than 50000 Thai baht	-.219	.803	.607	1.835
Junior high school or lower				
High school	-.863	.422	-1.531	.216
Undergraduate	-.700	.497	-1.825	.161
Graduate or higher	-1.165	.312	-1.176	.309
Age	.028	1.028	-.028	.972
Resident year	.040*	1.041	.013	1.014
Attitude toward recycling			1.109**	3.032
Internal subjective Norm			-.117	.889
External subjective Norm			.496*	1.642
Awareness of recycling benefit			.465*	1.592
Economic incentive			-.151	.860
Perceived space needed for recycling			-.188	.829
Perceived time needed for recycling			.141	1.151
Perceived facility condition			1.777**	5.910
Perceived recycling skill			1.324**	3.758
Adequacy of recycling information			.232	1.261

Dependent variable = Recycling intention (1=have intention,0=do not have intention)
exp(β) = Exponent of β
Statistically significant at the *0.05 and **0.01 level.

Table 5: Estimated regression coefficients of the logistic regression model predicting recycling behavior

Predictors	Step1		Step2		Step3	
	β	exp(β)	β	exp(β)	β	exp(β)
Gender	-.412	.662	.370	1.448	.562	1.755
Single						
Married	-.034	.966	1.076	2.932	.313	1.367
Divorce	-1.054	.349	-.662	.516	-.230	.794
House type	-.302	.739	-.293	.746	.027	1.027
Income less than 10000 Thai baht						
Income 10001-20000 Thai baht	-.115	.891	-.266	.766	.819	2.268
Income 20001-30000 Thai baht	-.222	.801	.762	2.142	1.461	4.312
Income 30001-40000 Thai baht	-.763	.466	.805	2.236	2.383	10.832
Income 40001-50000 Thai baht	-.001	.999	-.519	.595	1.319	3.738
Income more than 50000 Thai baht	.169	1.184	1.482	4.402	1.743	5.713
Junior high school or lower						
High school	-.370	.690	-1.316	.268	-1.272	.280
Undergraduate	-.373	.689	-1.808	.164	-2.177	.113
Graduate or higher	-1.010	.364	-1.678	.187	-2.343	.096
Age	.032	1.032	-.032	.969	-.021	.980
Resident year	.052**	1.053	.049*	1.051	.070*	1.073
Attitude toward recycling			.309	1.362	-.728	.483
Internal subjective norm			.333	1.395	.504	1.656
External subjective norm			.328	1.388	.110	1.117
Awareness of recycling benefit			.226	1.254	-.069	.933
Economic incentive			-.316	.729	-.353	.702
Perceived space needed for recycling			-.020	.980	.370	1.448
Perceived time needed for recycling			.221	1.247	.099	1.104
Perceived facility condition			1.653**	5.220	.840**	2.317
Perceived recycling skill			1.491**	4.441	1.302*	3.677
Adequacy of recycling information			.850*	2.339	1.391*	4.018
Intention to recycle					5.486**	241.280

Dependent variable = Recycling intention (1=have intention,0=do not have intention)
exp(β) = Exponent of β
Statistically significant at the *0.05 and **0.01 level.

12.5 Conclusions and discussions

This research aimed to acquire insights into household waste recycling behavior in Thailand by gaining an understanding of what factors influence households' decision to participate in recycling programs. The results demonstrated that the resident year and perceived adequacy of recycling information were direct predictors of recycling behavior, whereas the perceived facility condition and perceived personal recycling skill both directly influenced recycling behavior and indirectly influenced the behavior via the intention. On the other hand, the psychological factors; attitude toward recycling, external subjective norm, and awareness of recycling benefit, only provided indirect effect on recycling behavior. The results on subjective norm intensely suggested that recycling behavior of people in Bangkok were likely to be influenced by norm of the involving societies than norm of household's members. The economic incentive, perceived efforts on time and space, and socio-demographic variables besides resident year were neither direct nor indirect predictors of recycling behavior. The reason why time and space were insignificant might be because people did not recycle to the rate that high efforts on time and storing space were needed.

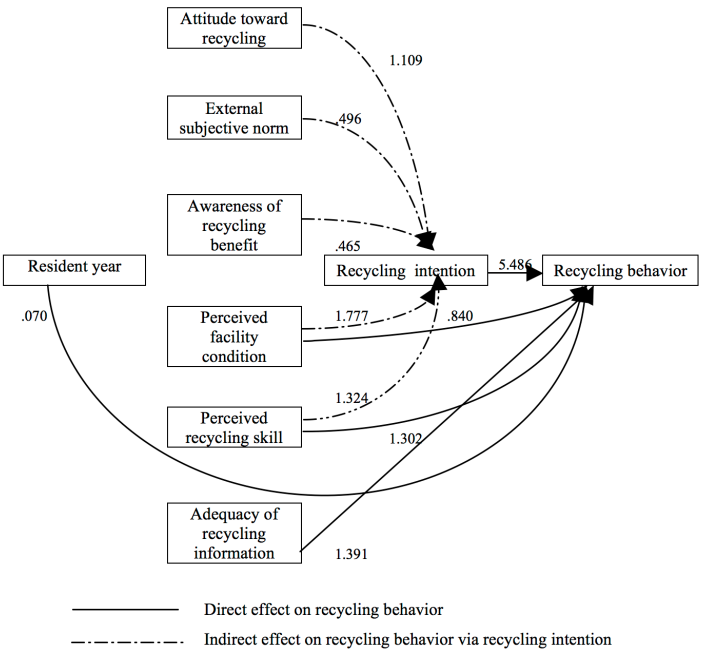

Figure 3: Path diagram of direct and indirect predictors of recycling behavior

The outcomes of the study suggest some directions for improving recycling participation. First, recycling facilities, services and other support systems should be expressly concerned. An insufficiency and inferiority of the system could largely demotivate willingness to recycle as well as hinder actual recycling behavior. Extensive attentions should be paid on the service accessibility and standard of disposal containers. The facility and service should be comfortable to get access. A universal standard of classification of separation container as well as sorting criteria should be clearly specified. Moreover, the actual installed facility must be steadied with information provided to people; otherwise it would cause further confusion and raise more perceived complexity of the recycling system. The significant impact of resident year, which in part reflected degrees of expertise in the facilities and services in the community, supported that more understanding in the recycling system tended to positively affect recycling involvement. In addition, perceived lack of recycling skills could be a significant barrier to recycling participation. Hence, people should be well educated how to recycle waste in practice; what materials should be separated, how to sort, and where to deposit them. The support systems and perceived recycling skills are crucial because these factors appeared to be the key factors of people's decision to drive their recycling intention to the actual action.

Policies on reinforcing positive attitude toward recycling and raising awareness of recycling benefits should also be concerned. Though the results revealed that the factors did not provided significant direct impact on recycling behavior, these two factors significantly influenced the intention to recycle which further manipulated the recycling participation.

Furthermore, positive relationship between recycling behavior of involving societies and willingness to recycle was found. People's recycling intention tended to depend significantly on recycling norm of their engaging communities. If people perceived that recycling is a

common activity in their involving societies, they are likely to have intention to recycle. On the other hand, people might hesitate to participate in recycling activities if they feel that recycling is an irregular practice in the societies. Therefore, it is important to make recycling an activist and typical practice performed by a majority of people in the societies.

This study also has some limitations that should be refined. First, the behavior concerned in this study was self-reported. The respondents might be self-aware or had bias on reporting their recycling behavior. Other methods such as a diary report might be combined to overcome this limitation in the future study. Second, the survey covered only one geographical area. Future research might extend study areas and additionally investigate the different recycling behaviors of population with diverse characteristics and life styles, such as urban-rural citizens, to provide the best suit policy for different groups of people.

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