



## Original Research Article

## Factors influencing source separation intention and willingness to pay for improving waste management in Bangkok, Thailand



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## ABSTRACT

Source separation for recycling has been recognized as a way to achieve sustainable municipal solid waste (MSW) management. However, most developing countries including Thailand have been facing with lack of recycling facilities and low level of source separation practice. By employing questionnaire surveys, this study investigated Bangkok residents' source separation intention and willingness to pay (WTP) for improving MSW service and recycling facilities ( $n = 1076$ ). This research extended the theory of planned behavior to explore the effects of both internal and external factors. The survey highlighted perceived inconvenience and mistrust on MSW collection being major barriers to carrying out source separation in Bangkok. Promoting source separation at workplace may possibly create spill-over effect to people's intention to recycle their waste at home. Both subjective norms and knowledge on MSW situation were found to be a positive correlation with Bangkok residents' source separation intention and WTP ( $p < 0.001$ ). Besides, the average WTP values are higher than the existing rate of waste collection service, which shows that Bangkok residents have preference for recycling programs. However, the WTP figures are still much lower than the average MSW management cost. These findings suggest that Bangkok Metropolitan Administration targets improving people knowledge on waste problems that could have adverse impact on the economy and well-being of Bangkok residents and improve its MSW collection service as these factors have positive influence on residents' WTP.

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## 1. Introduction

Solid waste is one of the challenging environmental issues in developing countries, especially in urban areas. As a consequence of population expansion, urbanization, higher income, and intensive use of packaging, the quantity of municipal solid waste (MSW) in urban areas continues increasing. According to the United Nations Environment Programme Global Waste Management Outlook, total urban waste generation is around 2 billion tons per year globally, with a per-capita generation expected to increase by approximately 20% until the year 2100 [1]. MSW is globally considered as one of the important issues as waste management has been set as goals within the Sustainable Development Goals particularly in Goals 11 and 12 that aim to promote sustainable

cities and to ensure sustainable consumption and production patterns. If properly managed, waste management sector can potentially reduce global greenhouse gas emissions in the range of 10–15% and can substantially increase to 20% if waste prevention was applied [1].

Similar to other developing countries, MSW has been a major environmental problem in Thailand. In 2016, the Pollution Control Department reported a total of 27 Mt of MSW across country [2]. Waste generation per capita per day of Thai people is estimated to be 1.14 kg, which is higher than the average figure of other middle-income countries that is 0.79 kg reported by the World Bank [3]. Landfills and open dumps are the most common methods of solid waste disposal currently being used in Thailand that cause the environmental impacts in terms of air pollution, water and soil contamination, and climate change. After a big fire incident in the largest open dumpsite in Praksa district, Samut Prakan province in March 2014, MSW has been regarded as a national agenda and the Waste and Hazardous Waste Management Roadmap (so-called MSWM Roadmap) has been adopted by

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the government since August 2014. The urgent task under the Roadmap is to eradicate cumulative MSW from key existing waste disposal sites and transform cumulated MSW into energy in Refuse Derived Fuel and waste-to-energy facilities. Other measures under the Roadmap include improving MSW laws and regulations, strengthening law enforcement, and enhancing public awareness on MSW and 3Rs [4]. The current government puts MSW on top of its agenda, in the same way most budget and human resource of local governments are extremely devoted for waste collection and disposal. The government seems to focus more on promoting waste-to-energy whereas less attention and budget is given to expedite source separation initiatives and recycling facilities. With a general lack of political will to invest in recycling facilities, recycling programs in Thailand are mainly relied on market mechanisms operated by informal sector (waste pickers, waste collectors, and junk shops). However, market incentives can so far draw only high value recyclables such as papers, plastic bottles, and aluminum cans though low value or contaminated recyclables are discarded with other wastes. Nevertheless, recycling rates in Thailand still remain relative low (around 21%) in 2016 [2].

Since the achievement of at-source separation depends on active involvement of the households, there is a pressing need to investigate the current state of source separation practiced among people starting from recyclable waste that has economic values. In addition, it is useful to know the level of willingness to pay (WTP) for effective recycling programs in order to encourage policy makers to invest more on recycling programs and collection facilities. As a result, this paper aims to answer the questions of, what are the factors influencing source separation intention? How much would Thai respondents pay for improved urban waste collection services and management? Also, how can the challenges of segregation and management be addressed?

## 2. Literature review

### 2.1. MSW situation in Bangkok, Thailand

Bangkok is one of the world's megacities comprising about 10.6 million people including non-registered population [5]. Being the center of government and commercial institutions of the country, the city has attracted many people to work and earn their living temporarily or permanently. Also, there are approximately 36 million tourists visiting Bangkok each year based on 5-yr average of 2011–2015 figures [6]. These activities cause an increase in waste generation in Bangkok of over 10 kt d<sup>-1</sup>. In 2016, waste generation in Bangkok was estimated to be approximately 4.21 Mt, which accounted of 16% of total waste generated in Thailand. Of total generation, Bangkok Metropolitan Administration (BMA) could collect 3.73 Mt (89% of total waste generation) and only 13% of collected waste was recycled and composted [5]. In 2014, MSW composition at transfer stations comprised of organic waste 48% (food scrap, woods, and leaves), non-recyclable waste 38%, and recyclable waste 14% [5].

There is only a single stream curb side collection system MSW in Bangkok that is managed by BMA for enhancing its MSWM system by adopting various plans and strategies, such as 3Rs, improving waste collection system, and community-based solid waste management. However, the implementation of these strategies is far from being successful [7]. Low level of public participation in source separation and low rate of MSW service fee are two major barriers that obstruct the investment of waste separation and recycling facilities in BMA [5]. Estimated WTP will provide rationale for decision-makers in setting new MSW fees to improve overall MSWM including recycling facilities.

### 2.2. Theoretical framework

Under the concept of pro-environmental behaviors, the Theory of Planned Behavior (TPB) [8], the Norm-Activation-Theory [9], and the Value-Belief-Norm-Theory [10] have been applied to predict the likelihood or intention that individuals will engage in various pro-environmental behaviors. For waste management, many studies rely on TPB theory to prove that psychological factors including attitude, subjective norms, and perceived behavioral control (PBC) are main predictors to waste separation intentions, and are based on their positive intention. It is possible to forecast the actual behavior on waste separation. Although TPB provides a logical framework for predicting the environmental behavior, several studies argue that the framework does not adequately explain recycling behaviors. The studies suggest that additional variables be included in a model for a better explanation [11–13]. Thus, this study included additional variables both internal and external factors in explaining the source separation intention and WTP for improving recycling facilities.

### 2.3. Key determinants of waste separation intention

#### 2.3.1. Attitudes toward environment and climate change

General environmental attitude refers to a personal perception on environmental issues. While the New Environmental Paradigm has been used in previous research, many recent studies include attitudes or awareness on climate change impacts [14] and specific attitudes toward recycling. Balderjahn [15] and Valle et al. [16] further contested that specific attitude would lead to more consistent results on pro-environmental behavior compared with general environmental attitude.

#### 2.3.2. Awareness of consequence and perceived cost and benefits

According to Davies et al. [17], perceived benefits refer to the awareness of behavioral outcomes. If people have higher awareness level of desirable outcomes of recycling behaviors, such as environmental protection and resource preservation, he/she will tend to have more intention to perform recycling. Stern [18] suggested that pro-environmental behaviors be influenced by knowledge on perceived cost and benefits [19]. The higher the perceived cost of the desired behavior, the less likely that people conduct waste separation [20]. Beside this, economic incentive is also believed to draw a significant change in resident's waste recycling behavior in developing countries [21]. In a developing country, Chalcharoenwattana and Pharino [22] found that people in urban areas in Thailand are willing to recycle more if they can get monetary returns. In addition, recycling practice is seen as a convenient practice via itinerant recyclable buyers (IRBs). However, it should be noted that economic incentive alone, without raising environmental awareness, cannot lead to long-term source separation behavior.

#### 2.3.3. Past recycling behavior

Past behavior may influence future behavior in two ways, firstly through habit formation and secondly through semiautomatic actions particularly for complex behaviors [23]. Several studies indicate that past experience has a direct influence on intention and behavior and is not mediated by variables within the model [12,24]. The impact of past behavior on individual's behavior and intention to recycle is also reported in a recent study by White and Hyde [25], with the findings of a direct effect of attitude, subjective norm, self-identity, and past behavior on people's intention. Another study, Saphores et al. [26] found that prior e-waste recycling experience is one of significant variables on residents' willingness to recycle e-waste at drop-off points.

### 2.3.4. Perceived convenience

Boldero [11] reported that recycling behavior might be influenced by situational factors such as perceived inconvenience, the amount of effort involved, and access to recycling facilities [12]. Several studies reported that perceived inconvenience reduces participation in recycling activities [11,16,27]. Basically, inconvenience can be seen in two characteristics: first, it can be associated with lack of storage space, excessive time requirements, or perceived risks associated with recycling; second, it requires bringing recyclables to a drop-off point [26]. Kollmuss and Agyeman [28] found desire for comfort and convenience as one main driver that influences consumption patterns; the collection amount would triple if the collection point is located very close to households [20].

### 2.3.5. Trust in waste management

Another barrier of source separation for recycling related to recycling infrastructures is certain mistrust due to non-transparent recycling processes or recycling pathways [20]. The level of mistrust in MSWM can be reduced if people see the government and municipalities set clear and effective policy measures on source separation and recycling schemes. In a study on recycling behavior [29], perceived policy effectiveness is defined as perception of a specific policy measure referring to people's feelings on how well the government provides effective and adequate policies.

### 2.3.6. Knowledge on waste separation

Knowledge is considered to be one of the key drivers of recycling. Having sufficient knowledge, such as clear instructions provided in a communication and collection campaign, can increase the probability of recycling behavior [20]. Based on a meta-analysis of 67 studies, Hornik et al. [30] found that internal facilitators including consumer knowledge and commitment to recycling can predict recycling behavior while Saphores et al. [26] found that respondents' knowledge of the potential toxicity and recyclability of e-waste increases people's willingness to recycle e-waste.

### 2.3.7. Socio-demographic variables

Besides behavioral aspects, many studies have also investigated the relationship between demographic variables and recycling intention and behavior. The most common examined variables are gender, age, education, and income but the findings appear to be inconsistent. Moreover, when socio-demographic variables are statistically significant, their explanatory power is rather small [30]. Other socio-demographic factors analyzed in previous studies include household types (e.g., single, couple, couple plus one child etc.) and household sizes. Some researches suggests a positive link between residence types and recycling as having more storage space might encourage recycling behavior [26].

## 2.4. Previous studies in Bangkok

To our knowledge, there is only one published study that investigated TPB and other factors related to recycling intention in Bangkok. Ittiravivongs [31] found that attitude toward recycling, perceived facility condition, and perceived recycling skill (i.e., sorting knowledge) were identified as psychological factors influencing the intention of waste recycling. External subjective norm and awareness on recycling benefit have been shown to be associated to the intention. Chalcharoenwattana and Pharino [22] investigated WTP for the addition of recycling services in three towns in Thailand, namely the Greater Phang Khon, Hua Hin, and Bangkok and found that income level, education level, and waste separation were strong predictors of WTP. However, this study did

not investigate theory-based psychological factors that might have influence on WTP response.

In addition to these two studies, Sukholthaman et al. [7] conducted a survey in Chatuchak district to identify residents' attitudes on MSW situation and MSWM service but this study did not ask respondents about source separation intention and behaviors as a way to reduce MSW volume. Although previous studies provided useful information for policy-makers, they shared the same limitation that the surveys were conducted in one or two districts with small sample sizes of less than 400 while there are over 10 million people in Bangkok. This study aimed to improve the previous studies' limitation by increasing sample size and the number of surveyed districts to gain more insights from Bangkok residents. Also given the current government policies and the MSWM Roadmap in 2014, it is interesting to investigate the effect of people's perception on MSW situation and government policies (the Roadmap) on source separation intention and their WTP for improving MSWM facilities.

Drawing on the findings in the literature, this study was empirically set out following hypotheses and tests:

**H1.** Psychological factors especially PBC influence source separation intention and WTP

**H2.** Other factors including past behavior and knowledge on MSW problems and government policies can increase people's intention to source separation and their WTP.

## 3. Materials and methods

### 3.1. Questionnaire design and data collection

To investigate the current status of source separation intention and WTP of Bangkok residents, a questionnaire survey was conducted from August 25, 2016 to September 13, 2016. The targets were household leaders aged 18 years and older and having lived in Bangkok for more than one year. Since BMA divides its 50 districts into 6 administrative zones [5], we employ a multi-stage sampling method by selecting 6 districts that have the highest number of households in their administrative zones and calculate the number of questionnaires for distribution in each district (Table 1). At community level, the surveys were conducted by applying a random sampling method in a way that all respondents had the same probability to be selected for the survey. Approximately 1100 questionnaires were distributed to all selected districts. A self-administered survey was employed to reduce interviewer's bias; however, face-to-face interviews were used in some cases where the respondents reported difficulty in reading the questionnaire. At the end of the survey, after being eliminated invalid questionnaires (i.e., missing information, blank responses), 1076 questionnaires were finally obtained.

Questionnaire survey contained 5 parts. The first part asked about demographic questions to understand attitudes and behaviors of various population groups better. The second part gathered information about source separation behavior and intention. We focused on source separation of recyclable waste and hazardous waste but only the findings on recycling intention and behavior are reported in this paper. There were no questions about waste separation for home composting of organic waste since waste management practice is rarely used in urban areas such as Bangkok and BMA has not intensively promoted home composting facilities among households. A set of questions on paying waste collection fees to BMA and WTP questions were given at the end of this part. In the third part, we asked about attitudes on environment and climate change topics based on the World Bank survey in 2009 [32] and specific attitudes toward source separation and recycling. A

**Table 1**  
Number of questionnaires distributed in selected districts.

District zone	Selected districts	Number of households in 2014	Number of questionnaires distributed
Central Bangkok	Huai Khwang	65,131	143
Southern Bangkok	Suan Luang	65,869	198
Northern Bangkok	Chatuchak	99,740	212
Eastern Bangkok	Bang Kapi	97,866	241
North Western Bangkok	Chom Thong	63,846	142
South Western Bangkok	Bang Khun Thian	80,667	164
Total		473,119	1100

five-point Likert response scale was used to access attitudes including the level of satisfaction on BMA's MSWM service. The fourth part asked respondents' knowledge on MSW situation and on current national MSWM Roadmap with binary response choice. The last part was to gather respondents' opinions and suggestions on improving MSWM in Bangkok.

For WTP sub-section, we first asked whether respondents paid waste collection fees to BMA. Afterward, a statement was given to the respondents summarized as follows:

"At present, BMA's waste disposal cost is very high, up to 6500 million THB (195 million USD) per year. However, BMA collects waste collection fee, which is less than 500 million THB (15 million USD) each year. The current fee is very low, 20 THB per month per household compared to the total MSWM cost which is approximately 150 THB on average per household per month. If BMA is committed to improve MSWM service and to invest in recycling facilities to support residents' source separation, are you willing to pay the increased MSWM fee?"

If a respondent answered "Yes, I am", a payment card table was given for the respondent to indicate his/her maximum WTP. Although the dichotomous choice (DC) method was recommended by the contingent valuation guideline, this study used the payment card (PC) method because PC tends to provide more conservative outcomes than other methods and some previous studies on waste recycling found small difference between WTP from PC and DC [33,34]. In addition, results from PC do not typically generate high numbers of protests or extreme value bids. The biases associated with PC, e.g., range biases, can be minimized if the method is designed properly.

The payment card table presented a range of values starting from 40 THB (1.2 USD) and was incrementally increased by 20 THB to the maximum of 500 THB. A blank space was given for those who wanted to specify other amounts not listed in the payment card. Before selecting the value, a statement was given to respondents to remind their financial situation, incomes, and expenditures. For those who answered, "No, I am not", we asked reasons why he/she was unwilling to pay the increased MSWM fee.

### 3.2. Analytical framework

A logistic multiple regression was performed in which the dependent variable (household source separation intention) was regressed onto TPB constructs as well as other external and socio-demographic variables. In the first step, we included demographic variables (gender, age, income, and education) and other related factors (i.e., past recycling behavior and other external factors). Psychological variables derived from factor analysis were then included in the regression analysis. Similar analysis was done in the same line for WTP for MSWM. If the respondent answered, "yes" to the WTP question, then  $Y = 1$ ; if the respondent answered "no", then  $Y = 0$ . After that, the average WTP could be estimated

based on the fee rate they chose from the payment card. Multi-collinearity was checked by examining the Variance Inflation Factor scores for the linear regression of the predictors (independent variables). A value  $< 2$  indicated no existence of severe multi-collinearity [38]. The data were analyzed by using IBM SPSS 22.0 for Windows.

## 4. Results and discussion

### 4.1. Respondents' socio-economic characteristics and source separation

Of the sampled households who responded to the questionnaire, as shown in Table 2, the number of male and female was roughly equal. The age of the respondents ranged from 15 to 82 years old (42.3 years in average). The respondents were either married (52.6%) or single (41.7%). The average household size was 3.9 (SD 2.2), which reflected the dominance of nuclear families in the big city. In terms of education level, the sample represented a wide range of education attainment, 36.2% had Bachelor's degree with 23% high school education, and 19.1% primary school education. Of total sample, 55.3% stated that they were employed, while 28.3% were self-employed. About half of respondents had monthly household income below 30,000 THB (900 USD). Respondents have lived in Bangkok for more than 10 years (16 years in average). Compared to 2015 BMA demographic data, this survey results were closed to the BMA data especially in education issue. However, more than half of respondents (56.3%) reported that their household monthly income was less than 30,000 THB while the census data reported only 29.4%. It is likely that our sample tended to report their income lower than the actual figure, as it is a quite sensitive issue for Thai people.

Table 3 presents survey results on source separation behavior, 66% of the respondents indicated that they had separated waste for recycling regularly. This finding was consistent with previous studies in Bangkok, which 57–67% of Bangkok residents reported that they separated their waste at the original source (at least one type of recyclables) [22,31] but higher than Malaysian case of 49% [35]. However, these findings should be carefully interpreted with care because some previous studies observed that people tend to overstate their actions when it comes to recycling [26].

The most popular recycling mode is selling recyclables to IRBs who come to pick up waste door-to-door which accounts for 41.5%. Other recycling modes are donating recyclable to waste pickers or collectors (33.6%) and selling waste to nearby junk shops (24.3%). The result shows that 43.6% of Bangkok residents stated that the main reason for source separation was monetary reward while 40.6% did it for environmental purpose.

For those who answered having no practice of source separation, the main obstacles to separate their waste were lack of sorting bins (21.9%), lack of storage space (20.4%), and no interest or no time to sort (19.5%) (Fig. 1). It is interesting that 14.6% of total respondents stated that the separation practice was meaningless as



**Table 2**  
Socio-economic characteristics of the respondents (N = 1076).

Variables	This study (percent)	2015 census estimates*
Age	42.3 ± 14.1	35–39 years–8.2%
	35–39 years–11.6%	40–44 years–8.0%
	40–44 years–13.5%	45–49 years–8.1%
	45–49 years–10.6%	
Gender		
Male	51.0%	47%
Female	49.0%	53%
Marital status		
Single	41.7%	
Married	52.6%	
Divorced/Widowed	5.7%	
Education level		
Primary school and lower	19.1%	25.3%
High school	23.0%	29.8%
Vocational school	15.5%	–
Bachelor's degree	36.2%	44.7%
Master's degree or above	5.6%	
Presence of children in household		
Yes	37.1%	
No	62.9%	
Occupational status		
Employed (public/private sector)	55.3%	69.5%
Self-employed	28.3%	25.5%
Unemployed (students/housewives/retirees)	15.9%	–
Household monthly income (Thai Baht)		Mean 41,002 THB**
Below 30,000	56.3%	29.4%
30,001–80,000	33.0%	30,001–50,000 (37.7%)
		50,001–100,000 (28.1%)
Above 80,000	10.7%	Above 100,000 (4.9%)
Period of stay	16.1 ± 14.4	

Source: \* Bangkok Metropolitan Administration [36] \*\* National Statistical Office [37].

they had seen municipal staffs mixing their recyclables with other wastes. This indicates the level of mistrust in BMA's MSWM in achieving waste reduction through recycling programs.

Regarding source separation practice at workplace or in the community, 42.8% of respondents reported as having such practice in their offices while most respondents (81.2%) did not know about BMA's waste separation campaign in their neighborhood. They did not see recycling bins in their neighborhood (78.3%). This survey result reflects the perception of Bangkok residents in general that BMA has not yet done much on the promotion program of source separation and waste recycling. By considering their intention and tendency to do source separation in the future (starting from next month), 79.7% stated that they had intention to do so, compared to

Malaysian case (70%) [35]. The source separation intention is treated as a dependent variable in our logistic regression analysis.

#### 4.2. Factor analysis

Prior to the logistic regression analysis, a factor analysis was performed to group the Likert-scale variables into a small number of underlying factors. Commonly used in social science research, the factor analysis groups the variables that have the same construct. The principal component analysis (PCA) can be applied if the hypothesis matrixes are equal but rejected [38]. The PCA was performed by using 26 items of psychological factors together with perceived information level on waste separation (Table 4). The

**Table 3**  
Source separation behavior, reason, and frequency.

Variables	Categories	Percentage (%)
Regular source separation for recycling during the past year (past behavior/source separation habit)	Yes	66.0
	No	34.0
Recycling modes	Sell to nearby junk shops	24.3
	Sell to IRBs who come to pick up waste door-to-door	41.5
	Give to others (waste collectors)	33.6
	Others	0.6
Main reasons for source separation for recycling	Economic benefits (monetary rewards)	43.6
	Environmental benefits	40.6
	Helping the poor	14.2
	Others (e.g., cleanliness)	2.1
Having source separation in the office	Yes	42.8
	No	57.2
Did BMA undertake waste separation campaign in your neighborhood during the past year?	Yes	18.9
	No	47.9
	Don't know	33.3
Witness of recycling bins in your neighborhood/community?	Yes	21.7
	No	78.3

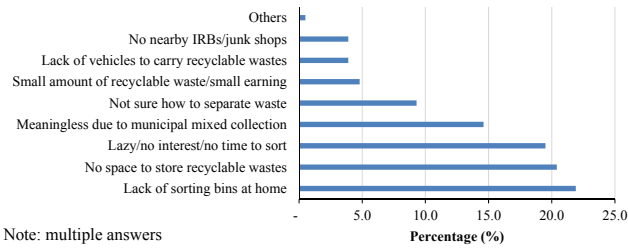


Fig. 1. Reasons for not doing source separation for recycling among Bangkok residents.

factor analysis grouped the variables listed on the questionnaire into seven independent components. All aggregated components explained 63.4% of the total variance. The Kaiser-Meyer-Olkin result of 0.877 showed a sufficient sampling adequacy of factor analysis. The Bartlett's test of sphericity was highly significant at p-value equal to 0.00. This approved that the variables in the population correlation matrix were uncorrelated, and therefore the data met the requirements for factor analysis. To measure the consistency of the questionnaire, Cronbach's alpha reliability test was employed for each component. Previous literature suggested that 0.7 be an acceptable reliability coefficient [12]. In this study, the overall reliability coefficient of all 26 Likert scaled variables was 0.78 while the reliability coefficients of internal consistency for 5 components (after factor analysis) were in the range of 0.76–0.82, indicating acceptable reliability.

#### 4.3. Factor influencing source separation

To measure the predictors of intention to separate waste, socio-demographic variables were entered on the first step. Demographically, variables including age, family with child, and house owner were found to have a positive influence on respondent's source separation intention. Measuring by gender, female tended to have a higher intention. In the second step, we entered other psychological factors and external factors comprising seven variables from factor analysis. All 30 variables together provided a model that was correctly classified 86.4% of the sample. The result of Hosmer and Lemeshow test was not significant indicating that the model with these factors was adjusted quite well to the data. The values of Nagelkerke  $R^2$  increased from 0.045 to 0.523. The  $-2$  Log likelihood decreased from 1053 to 643. All goodness-of-fit indicators showed that psychological factors and other factors improved the accuracy of the model. In this full model, all socio-demographic variables became insignificant which was consistent with previous studies in Bangkok [31]. The strongest variable was past behavior on regular source separation at home or recycling habit, confirming previous studies [24,25]. We also found that having waste separation in the office could have positive influence on source separation intention, which is consistent with the study of Saphore et al. [26].

Out of four MSW related knowledge statements, only one statement of 'knowing of Bangkok MSW situation' showed positive influence on source separation intention in this research. Regarding psychological factors, we found that awareness of consequence

Table 4  
Results of the principal component analysis.

Predictor variables	Statements	Loading	% Variance explained
Awareness of consequences (with PBC) (Cronbach's Alpha = 0.82)	MSW problem in our country is getting worse and it will affect the environment and human health.	0.593	25.4
	If everyone undertakes waste reduction and source separation, MSW problem can be solved.	0.751	
	Source separation can help mitigating global warming.	0.803	
	Mixing hazardous waste with other wastes could lead to toxic substance leakage causing harm to the environment.	0.735	
Environmental attitudes (Cronbach's Alpha = 0.77)	Source separation is easy in our daily life.	0.619	10.8
	We are approaching the limit of the number of people the earth can support.	0.706	
	If things continue on their present course, we will soon experience a major ecological catastrophe.	0.771	
	Climate change or global warming is a very serious problem and its effect is happening.	0.741	
	Dealing with the problem of climate change should be a priority, even if it causes slower economic growth and some loss of jobs.	0.695	
Subjective norms (Cronbach's Alpha = 0.81)	I am willing to pay for increase costs of products and services as part of taking steps against climate change (Assume you have to pay additional 150 THB (4.3 USD) per month <sup>a</sup> for electricity bill or clean energy)	0.466	8.1
	Source separation is everyone's responsibility.	0.410	
	I feel that source separation is very important responsibility for me.	0.694	
	I would feel guilty if I did not do source separation according to the rules	0.766	
	I feel that most people who are important to me (family, friends) expect me to do source separation	0.803	
Perceived information level on source separation (Cronbach's Alpha = 0.81)	If I see my neighbor doing source separation, I will do it too.	0.617	6.1
	To what extent that you received knowledge on source separation (organic waste, general waste, recyclable waste, hazardous waste) from your school?	0.706	
	To what extent that you received information on source separation from the BMA's district office?	0.848	
	To what extent that you received information on source separation from the media (TV/radio/newspaper)?	0.800	
Perceived inconvenience (Lack PBC) (Cronbach's Alpha = 0.80)	To what extent that prior BMA's PR could help increase your knowledge on source separation?	0.781	4.89
	Source separation is time consuming and useless.	0.829	
	Source separation is too complicated.	0.870	
	Source separation takes up too much storage space making it difficult to do source separation	0.709	
Mistrust on MSW collection (Cronbach's Alpha = 0.38)	Even I do source separation, garbage collectors would mix sorted waste with other waste.	0.843	4.1
	I know how to do source separation (I know what items of household waste can be recycled)	0.509	
Pro-economic attitudes (Cronbach's Alpha = 0.39)	Even the environmental quality is getting worse, I still think that the economic problem outweighs environmental problem.	0.759	3.9
	Solving MSW problem is the duty of the government and municipalities, not me.	0.497	

Notes: Varimax rotation with Kaiser Normalization, Extract method: Principal Component Analysis.

<sup>a</sup> Similar question with the World Bank [32], 150 THB is approximately equal to 1% of national annual per capita GDP, prorated on a monthly basis.

including PBC attribute, subjective norms, and perceived information level had a significant positive influence on source separation intention. In contrast, perceived inconvenience (implied the lack of PBC) and mistrust on MSW collection generally showed a negative correlation to source separation intention. In a sense, it was observed that the more people felt that they lack of time and space to do source separation and the more people perceived that BMA staff eventually mixed all waste in the garbage trucks, the less intention they had on source separation at home. Other situational variables such as municipal campaign, availability of recycling bins, and expectation of economic benefits from recycling were not statistically significant on respondents' source separation intention.

#### 4.4. Mean WTP and factors influencing WTP

Regarding respondents' WTP for improving MSWM and recycling facilities, 63.5% of respondents agreed to pay the fee at new rate of WTP while 36.5% did not. Reasons for not willing to pay more fee were financial constraints in household (39.9%), expectation of free service from the government (28.8%), having paid various forms of taxes (23.7%), and others (7.6%).

For respondents who agreed to pay new MSWM fee rate (WTP), the mean value of stated WTP is 71.6 THB (2.1 USD) per month (SD 54.2) and median value is 40 THB (1.2 USD). Since we observed many respondents reporting their satisfaction with the status quo, paying the existing rate of 20 THB, we assumed that the existing fee rate is their true WTP for those who did not want to pay more. By including all respondents' WTP answers, the estimated mean WTP for improving MSWM and recycling in Bangkok is 52.6 THB (1.5 USD) per month (SD 49.7) with a median value of 40 THB (1.2 USD).

The correlation analysis showed that source separation intention was positively correlated with WTP (Pearson correlation is 0.103 at 0.001 level) so we can apply all independent factors similar to source intention to test the effect on residents' WTP. The dependent variable was the binary response, willing or not willing to pay a new fee. Similar procedure with source intention was done where all socio-economic and demographic variables were included in Step 1 and all other factors were added in Step 2. In both cases, Hosmer and Lemeshow tests were not significant indicating that the two models were adjusted quite well to the data. In Step 2, Nagelkerke  $R^2$  and the  $-2$  Log likelihood were improved from Step 1 although the values were rather low compared to the models with source separation intention. All 30 variables together provided a model that correctly classified 69.3% of the sample in Step 2.

As shown in Table 5, the results from Step 1 showed that none of socio-economic variables was found to be significant factors for WTP response except period of stay, which had negative effect on WTP response. When included other factors in Step 2, we found that period of stay and expecting economic benefits (monetary rewards) from recycling had negative effect on WTP response; however, when we further analyzed with the reduced model (not shown here), these two variables became insignificant. So our findings are not in the same way as the previous study [22] that found income and education level being strong predictors of WTP.

From our study, we found that people who had high satisfaction with the current MSW collection service of BMA were more willing to pay for improving MSW service and recycling facilities. Also, knowing of Bangkok MSW situation could somehow increase the probability of the respondents saying "yes" to the WTP question. Interestingly, regarding psychological variables, environmental attitudes and subjective norms showed positive correlation with WTP which was in accordance with TPB (Fig. 2). The coefficients of perceived inconvenience and pro-economic attitudes were negative (i.e., people felt inconvenient for their waste separation and people who cared most about their living were not interested in

paying more for improving recycling facilities). Surprisingly, the coefficient of perceived information level on source separation was negative. Probably people who perceived having sufficient information on source separation could perform waste separation for recycling themselves so they were not willing to pay more for BMA's service. Other variables such as past behavior on recycling, having source separation in office, and BMA's campaign on source separation, were not statistically significant. This showed that these factors had little influence on respondents' WTP. Based on the results from logistic regression models presented in Table 5, we can confirm our hypotheses that several psychological and situational factors have influence on source separation intention and WTP especially subjective norms, knowledge on MSW situation, and perceived inconvenience (or implied PBC in reverse).

## 5. Discussions and policy implication

### 5.1. Source separation intention

Socio-economic and demographic variables seem to have small explanatory power compared to other factors. Together with the lack of intensive municipal campaign on source separation, this finding indicates that Thailand at national and local levels still lacks of sufficient environmental education as well as environmental awareness campaigns. This confirms previous survey results in Bangkok by Ittiravivongs [31] and in other developing countries like China [39]. Hence, it is even more urgent that the government should embed waste problems and management issues, particularly the 3Rs concept in the education curriculum system and promote waste reduction and recycling programs (e.g., waste recycling banks) in schools and communities [40].

In this study, both subjective norms and perceived inconvenience (or implied PBC in reverse) are factors that have influence on source separation intention, which is consistent with the results of previous research in Iran and China [13,39]. It also shows that Thai people care about other people's behaviors, thus improving residents' awareness on waste problems and providing an easy recycling atmosphere in the community as well as the workplace can effectively promote household source separation in Bangkok. Beside these factors, we found that environmental attitudes including climate change concerns can predict WTP response. So this study confirms the applicability of the Theory of Planned Behavior. However, this study found that the theory can be extended to include other factors including past behavior, awareness of consequence, and trust (reversed version of mistrust on MSW collection) as predictors to source separation intention.

Based on our findings, perceived inconvenience acts as a key barrier toward people's intention to separate waste. Therefore, BMA should provide more recycling facilities, such as common infrastructures in living communities, regular drop-off services, and promote waste collectors (junk shops and IRBs) that can pick up recyclable waste from the households. This improvement will significantly promote the separation of household solid waste and reduce the environmental and economic cost associated with waste processing.

Apart from perceived inconvenience, mistrust is another barrier that obstructs people from doing source separation in Bangkok and other cities in Thailand since many people think that their sorting efforts are meaningless when they see municipal garbage collectors mix their sorted recyclable wastes with other non-recyclable ones. In order to change people's perception, BMA needs to invest in separate collection; however, that needs large investment and it is not going to work if most people still do not sort their waste. Based on the interview with BMA officers, a pilot project on separation collection in Suang Luang district in 2016 showed disappointing

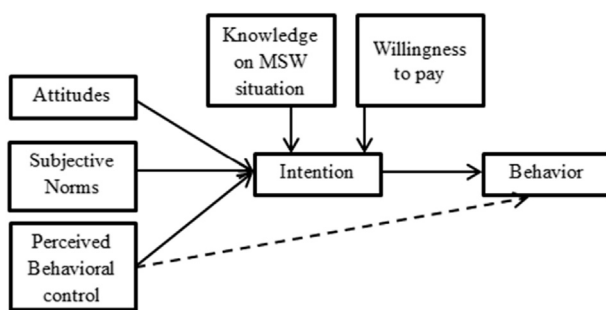
**Table 5**

Estimated regression coefficients of binary logistic regression model predicting source separation intention and WTP.

Predictors	Y1 Source separation intention				Y2 WTP for improving MSWM and recycling facilities			
	Step 1		Step 2		Step 1		Step 2	
	$\beta$	Exp( $\beta$ )	$\beta$	Exp( $\beta$ )	$\beta$	Exp( $\beta$ )	$\beta$	Exp( $\beta$ )
Gender (Male = 1)	−0.304*	0.738	0.146	1.157	−0.040	0.961	0.009	1.009
Age	0.018**	1.018	0.013	1.013	0.006	1.006	−0.003	0.997
Married	−0.009	0.991	0.007	1.007	0.115	1.122	0.177	1.194
Undergraduate and above	0.044	1.045	0.140	1.151	0.148	1.159	−0.030	0.971
Employed	0.042	1.043	0.089	1.093	−0.070	0.932	−0.044	0.956
Self-employed	−0.125	0.883	−0.421	0.657	−0.240	0.787	−0.183	0.833
Family member	−0.012	0.988	0.025	1.026	0.047	1.048	0.040	1.041
Family with child	0.324*	1.383	0.011	1.011	−0.161	0.851	−0.197	0.821
Low income	0.104	1.109	0.006	1.006	−0.164	0.849	−0.126	0.882
Single house	0.153	1.166	−0.003	0.997	0.229	1.258	0.275	1.316
House owner	0.413**	1.512	0.251	1.285	0.211	1.236	0.140	1.150
Period of stay	0.002	1.002	−0.010	0.990	−0.010*	0.990	−0.011*	0.989
Vehicle	−0.016	0.984	−0.441	0.643	−0.095	0.909	−0.143	0.867
Past recycling behavior			2.829***	16.935			0.273	1.314
Separation in office			0.767***	2.154			−0.061	0.941
Municipal campaign			0.177	1.194			0.137	1.147
BMA recycling bins			−0.116	0.890			0.160	1.174
Economic benefits from recycling			0.341	1.407			−0.345**	0.708
Satisfaction with MSW collection service			−0.186	0.830			0.219***	1.244
Knowledge on Bangkok MSW amount and disposal			0.769***	2.158			0.395**	1.485
Knowledge on environmental impact from mixed waste			0.004	1.004			−0.024	0.976
Knowledge on Thailand ranking the top 5th country in the world in dumping plastic waste into the oceans			0.147	1.158			−0.022	0.978
Knowledge on MSWM roadmap			0.045	1.046			0.234	1.264
Awareness of consequence			0.315***	1.370			0.056	1.057
Environmental attitudes			−0.002	0.998			0.239***	1.270
Subjective norms			0.538***	1.713			0.329***	1.390
Perceived information level			0.336***	1.399			−0.163**	0.850
Perceived inconvenience			−0.447***	0.640			−0.236***	0.790
Mistrust on MSW collection			−0.398***	0.672			−0.052	0.950
Pro-economic attitudes			0.009	1.009			−0.226***	0.798
Constant	0.369	1.446	0.019	1.019	0.307	1.360	−0.066	0.936
−2 Log likelihood	1053.3		643.2		1390.8		1290.9	
Nagelkerke R Square	0.045		0.523		0.027		0.137	

Notes: Dependent variables: Y1 is source separation intention (1 = have intention, 0 = do not have intention), Y2 is willingness to pay for a new MSW fee (1 = yes, 2 = no). Demographic and knowledge variables are dummy variables except age and period of stay which are continuous variables.

Statistical significant level \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ , variables in italic are from factor analysis.

**Fig. 2.** Extended TPB model in examining the intention of source separation.

results in terms of collection cost and mixed waste due to low public cooperation in source separation. Thus, BMA needs to immediately inform Bangkok residents regarding BMA's waste sorting and collection practice. BMA should explain to Bangkok residents that their sorted waste will be helpful for waste management and garbage collectors not to mix sorted waste with others. They actually do waste sorting during collection and after the waste is delivered to transfer stations but they do not have much time to sort waste along the way. Time and space in the truck limits their sorting during waste collection and they sort only high value recyclables, such as PET bottles and aluminum cans. To

enhance the trust level of Bangkok people, a clear sign 'recyclable waste' should be affixed to recyclable bins or bags in the garbage trucks. In the long-term, BMA should gradually introduce separation collection programs in the areas that BMA provides intensive education and campaigns on source separation.

As for other factors, we could see that people who have knowledge on Bangkok MSW situation have more intention to sort waste. To increase public participation on waste separation, BMA should convey this message to Bangkok residents more intensively through door-to-door or community meetings and various media channels. With regard to past behavior and separation in office which are strong predictors of source separation intention, BMA should seek cooperation with organizations, e.g., universities, schools, hospitals, hotels, and office buildings to undertake 3Rs and waste recycling programs in the workplace. By having actual practice on source separation in the office, it can have some spill-over effect to their houses. Due to limited human resource in public sector, the government and BMA should support environmental NGOs or non-profit organizations to help promoting and setting up recycling programs in those organizations.

## 5.2. Residents' WTP for improving MSWM and recycling facilities

Besides intention to do source separation, this study also investigated Bangkok residents' WTP for improving MSWM service



and recycling facilities. The average WTP in this study is in the range of 52.6 THB (1.5 USD) (SD 49.7) to 71.6 THB (2.1 USD) (SD 54.2) per month with a median value of 40 THB (1.2 USD). The mean values are close to previous study [22] which is 1.65 USD for Bangkok area. The mean WTPs are higher than the current rate for waste collection of 20 THB which indicates that the average Bangkok respondents support to improve MSW separation and recycling programs. However, the mean WTP figures and the medial value are still much lower than the true cost of MSWM, which is estimated at approximately 150 THB per household per month. This finding suggests that in the short-term, BMA increases the MSWM fee at least 50 THB to improve the current MSWM service and establish separation and recycling programs. Evidence from the regression analysis showed that if people feel satisfied with the MSWM service, their WTP increases and if they know about the current MSW situation that will create large financial burden to the local government, their WTP can increase as well. Raising environmental awareness among Bangkok residents can help increase both source separation intention and WTP for improving MSW separation and recycling programs. For those who consider that economic problems are more important than environmental problems, BMA should explain that the waste problems will eventually have adverse impact on the economy, for example, littering and lack of waste separation practice have worsened flooding problems in Bangkok since a lot of garbage block off the drainage system and canals. Also the 10-km long garbage patch recently found in the Southern part of Thailand can have impact on the economy, which largely relies on tourism industry.

Among significant factors, subjective norms have positive effect on source separation intention and WTP. Given this finding, the government should develop clear policies and supporting programs to improve the popularity of source separation and waste recycling in order to create atmosphere that doing source separation is socially desired. BMA should promote and publicize communities and organizations that can establish source separation system in order to motivate others to follow.

## 6. Conclusions

This study investigated factors that influence Bangkok residents' source separation intention and their WTP for improving MSWM system and recycling facilities. This study extended the theory of planned behavior and explored the effects of various demographic, situational and psychological factors on source reduction intentions and WTP response. In the Thai context, this empirical result indicated that urban residents' source separation intentions were positively influenced by past behavior on regular source separation and having source separation in the office, knowledge on waste problems, subjective norms, and perceived information level. Perceived inconvenience showed a negative effect on the intention implying the effect of perceived behavior control. Mistrust on MSW collection also reported to have negative effect on the source separation intention. To break the vicious cycle of mixed waste disposal and mixed collection, BMA needs to improve MSW collection practice to show that BMA staff actually separate waste to some extent. BMA needs to cooperate with other stakeholders such as universities and corporations in setting up a source separation system in the workplace which can have spill-over effect to household source separation as well as promoting informal sectors and recyclers to facilitate waste collection and recycling.

Residents' WTP for improving MSWM service and recycling facilities was likely to be positively influenced by knowledge on Bangkok waste situation, subjective norms, environmental attitudes, and satisfaction with MSW collection service. To increase

residents' WTP for recycling facilities, BMA should improve its effectiveness and dissemination by explaining the problems of increased MSW volume and BMA's financial burden of 6500 million THB per year for waste collection and disposal. It should be emphasized that if everyone does more source separation, BMA can use the saving budget for improving other public services such as health care and education.

Given that subjective norms being significant for both source separation intention and WTP, BMA needs to have strong political will on waste recycling by working with other organizations especially schools and universities that can act as role models to the society and cultivate environmental awareness and moral obligations of young generation. By working with educational institutions, BMA together with concerning agencies such as Ministry of Natural Resources and Environment and Ministry of Education can embed the concept of sustainable waste management (e.g., zero waste and 3Rs) in the school curriculum which can create recycling norms for the society in long-term.

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## References

- [1] Wilson DC, Rodic L, Modak P, Soos R, Carpintero A, Velis C, et al. *Global Waste Management Outlook: Summary for Decision-makers*. Nairobi, Kenya: United Nations Environment Programme; 2015.
- [2] PCD. *Thailand Municipal Solid Waste Situation of 2016*. Bangkok, Thailand: Pollution Control Department; 2017 [in Thai].
- [3] Hoornweg D, Bhada-Tata P. *What a Waste: a Global Review of Solid Waste Management*. Washington, DC: The World Bank; 2012.
- [4] PCD. *Waste and Hazardous Waste Management Roadmap*. Bangkok, Thailand: Pollution Control Department; 2014 [in Thai].
- [5] BMA. *Bangkok Municipal Solid Waste Management Plan of 2015–2019*. Bangkok, Thailand: Bangkok Metropolitan Administration; 2015 [in Thai].
- [6] NSO. *Situation to Domestic Traveler*. Bangkok: 2009–2015. Bangkok, Thailand: National Statistical Office; 2016 [in Thai].
- [7] Sukholthaman P, Chanvarasuth P, Sharp A. Analysis of waste generation variables and people's attitudes towards waste management system: a case of Bangkok. *Thail J Mater Cycles Waste* 2017;19:645–56.
- [8] Ajzen I. The theory of planned behavior. *Organ Behav Hum Dec* 1991;50:179–211.
- [9] Schwartz SH, Howard JA. A normative decision making model of altruism. In: Rushton JP, Sorrentino RM, editors. *Altruism and Helping Behavior: Social, Personality, and Developmental Perspectives*. Hillsdale, NJ: Lawrence Erlbaum; 1981. p. 189–211.
- [10] Stern PC. Toward a coherent theory of environmentally significant behavior. *J Soc Issues* 2000;56:407–24.
- [11] Boldero J. The prediction of household recycling of newspapers: the role of attitudes, intentions, and situational factors. *J Appl Soc Psychol* 1995;25:440–62.
- [12] Tonglet M, Phillips PS, Read AD. Using the theory of planned behaviour to investigate the determinants of recycling behaviour: a case study from Brixworth, UK. *Resour Conserv Recycl* 2004;41:191–214.
- [13] Pakpour AH, Zeidi IM, Emamjomeh MM, Asefzadeh S, Pearson H. Household waste behaviours among a community sample in Iran: an application of the theory of planned behaviour. *Waste Manag* 2014;34:980–6.
- [14] Wynveen CJ, Sutton SG. Engaging the public in climate change-related environmental behaviors to protect coral reefs: the role of public trust in the management agency. *Mar Policy* 2015;53:131–40.
- [15] Balderjahn I. Personality variables and environmental attitudes as predictors of ecologically responsible consumption patterns. *J Bus Res* 1988;17:51–6.
- [16] Valle POD, Rebelo E, Reis E, Menezes J. Combining behavioral theories to predict recycling involvement. *Environ Behav* 2005;37:364–96.
- [17] Davies J, Foxall GR, Pallister J. Beyond the intention-behaviour mythology: an integrated model of recycling. *Market Theor* 2002;2:29–113.
- [18] Stern PC. Psychological dimensions of global environmental change. *Annu Rev Psychol* 1992;43:269–302.
- [19] Wan C, Shen GQ, Yu A. Key determinants of willingness to support policy measures on recycling: a case study in Hong Kong. *Environ Sci Policy* 2015;54:409–18.

- [20] Welfens MJ, Nordmann J, Seibt A. Drivers and barriers to return and recycling of mobile phones. Case studies of communication and collection campaigns. *J Clean Prod* 2016;132:108–21.
- [21] Xu L, Ling M, Lu Y, Shen M. External influences on forming residents' waste separation behaviour: evidence from households in Hangzhou, China. *Habitat Int* 2017;63:21–33.
- [22] Chalcharoenwattana A, Pharino C. Wishing to finance a recycling program? Willingness-to-pay study for enhancing municipal solid waste recycling in urban settlements in Thailand. *Habitat Int* 2016;51:23–30.
- [23] Carrus G, Passafaro P, Bonnes M. Emotions, habits and rational choices in ecological behaviours: the case of recycling and use of public transportation. *J Environ Psychol* 2008;28:51–62.
- [24] Knussen C, Yule F, MacKenzie J, Wells M. An analysis of intentions to recycle household waste: the roles of past behaviour, perceived habit, and perceived lack of facilities. *J Environ Psychol* 2004;24:237–46.
- [25] White KM, Hyde MK. The role of self-perceptions in the prediction of household recycling behavior in Australia. *Environ Behav* 2012;44:785–99.
- [26] Saphores JDM, Ogunseitan OA, Shapiro AA. Willingness to engage in a pro-environmental behavior: an analysis of e-waste recycling based on a national survey of U.S. households. *Resour Conserv Recycl* 2012;60:49–63.
- [27] Domina T, Koch K. Convenience and frequency of recycling: implications for including textiles in curbside recycling programs. *Environ Behav* 2002;34: 216–38.
- [28] Kollmuss A, Agyeman J. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environ Educ Res* 2002;8:239–60.
- [29] Wan C, Shen GQ, Yu A. The role of perceived effectiveness of policy measures in predicting recycling behaviour in Hong Kong. *Resour Conserv Recycl* 2014;83:141–51.
- [30] Hornik J, Cherian J, Madansky M, Narayana C. Determinants of recycling behavior: a synthesis of research results. *J Socio Econ* 1995;24:105–27.
- [31] Ittiravivongs A. Factors influence household solid waste recycling behaviour in Thailand: an integrated perspective. *WIT Trans Ecol Environ* 2011;167: 437–48.
- [32] TWB. Public Attitudes toward Climate Change: Findings from a Multi-country Poll. Washington, DC: The World Bank; 2009.
- [33] Blaine TW, Lichtkoppler FR, Jones KR, Zondag RH. An assessment of household willingness to pay for curbside recycling: a comparison of payment card and referendum approaches. *J Environ Manage* 2005;76:15–22.
- [34] Ferreira S, Marques RC. Contingent valuation method applied to waste management. *Resour Conserv Recycl* 2015;99:111–7.
- [35] Akil AM, Foziah J, Ho CS. The effects of socio-economic influences on households recycling behaviour in Iskandar Malaysia. *Proc Soc Behav* 2015;202: 124–34.
- [36] BMA. Statistical Profile of Bangkok Metropolitan Administration 2015. Bangkok, Thailand: Bangkok Metropolitan Administration; 2016 [in Thai].
- [37] NSO. Household Socio-economic Survey: a Summary. Bangkok, Thailand: National Statistical Office; 2015–16 [in Thai].
- [38] Field A. *Discovering Statistics Using SPSS*. 2nd ed. London, UK: Sage Publications; 2005.
- [39] Wang Z, Dong X, Yin J. Antecedents of urban residents' separate collection intentions for household solid waste and their willingness to pay: evidence from China. *J Clean Prod* 2018;173:256–64.
- [40] Aroonsrimorakot S, Pradabphetrat P. Potential of recycle waste bank project for community waste reduction: a case study of sub-sin Pattana community, Bang Khun Thien, Bangkok. *Appl Environ Res* 2010;32:37–48.