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Vilas Nitivattananon

Yuthtapong Wattanalapa

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# **Evaluation as a Tool to Support Decision Making in Municipal Waste Recycling System for Thailand Sustainable Environment**

**Vilas Nitivattananon<sup>1</sup> and Yuthtapong Wattanalapa<sup>2</sup>**

<sup>1</sup>*Asian Institute of Technology ([vilasn@ait.asia](mailto:vilasn@ait.asia))*

<sup>2</sup>*Thailand Institute of Packaging and Recycling Management for Sustainable Environment  
([ypw2000@yahoo.com](mailto:ypw2000@yahoo.com))*

**Abstract:** This paper presents part of the results from a research project aimed at evaluating municipal waste recycling programs, supported by Thailand Institute of Packaging and Recycling Management for Sustainable Environment in collaboration with other recycling program partners in Thailand. The study applied sustainable municipal solid waste (MSW) management approach and program evaluation concepts. The evaluation design includes two main levels. At country level, a survey using a questionnaire was carried out to investigate perceptions on factors influencing success of representative samples including community recyclable banks (CRBs) and school recyclable banks (SRBs). A waste stream analysis at city level was conducted to examine the composition of waste at different selected urban centres. The results show that factors significantly influencing the performance of recycling programs are related to perceptions of source separation, facing inconsistent price problem, lack of skilled operators and financial support. The results of waste stream analysis reflect significant changes in waste proportion of some recyclables. The findings reveal key points, particular trends and status of each recycling program and each type of recyclable materials to the decision makers who are responsible to set sustainable MSW strategies and plans.

**Keywords:** Local government authorities; municipal solid waste management; private sector participation; program evaluation; sustainability

## **1. INTRODUCTION**

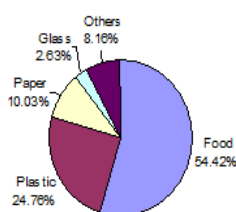
The principles of sustainable municipal solid waste (MSW) management strategies are to: (i) minimize MSW generation, (ii) maximize waste recycling and reuse, and (iii) ensure the safe and environmentally sound disposal of MSW. The sustainable MSW management depends on the overall effectiveness and efficiency of urban managements, and the capacity of responsible municipal authorities (Kaosal, 2009). According to Hardoy et al. (2001), national governments inevitably have the key role in linking local and global sustainability. As Agenda 21 recognizes the need to strengthen and expand national waste reuse and recycling systems, it argues that multinational and national government institution and non-government organization should actively promote and encourage waste reuse and recycling. At the level of city and municipal government, the key policy areas to secure both development and sustainability are to give further incentives to encourage innovative way to reduce pollution and conserve resources.

With rapid growing waste generation rates and high costs of waste disposal, depletion of landfill space and the problem in obtaining new disposal sites (as most of those sites are becoming open dump and nearly exhausted) are unresolved issue in most urban centres. These problems are of critical concern to local authorities that are the centres of MSW management system and play an important role for changing the traditional to more sustainable approaches of the management (Nitivattananon and Gauger, 2004).

In Thailand, the positive sign of recycling promotion has been started in 1997 by Ministry of Science Technology and Environment (MOSTE). In response to the sustainable MSW approach, most on-going efforts regarding waste recycling are focused on encouraging participation of communities such as setting school recyclable bank (SRB), community recycling bank (CRB), and recycling centre at municipal level. Some LGAs have established composting facilities (CFs) and material recovery facilities (MRFs) at a small scale. These models have been developed and promoted since 1999 including: (i) more than 500 SRBs, (ii) more than 300 CRBs, (iii) more than 10 municipal recycling centres, (iv) more than 20 CFs, and (v) 2 MRFs. In addition, itinerant recycling groups have also been promoted. Thailand Institute of Packaging and Recycling Management for Sustainable Environment (TIPMSE), officially established in 2005, aimed to reduce packaging wastes with a safety and sustainable methodology, which focusing to reduce the packaging wastes composition in municipal wastes approximately 19% of total waste within 5 years (TIPMSE, 2007).

Recently, many research studies have been conducted to determine how to make recycling programs more successful and propose various approaches for a sustainable SWM. Thomas (2001) studies how the public understanding's effect on recycling performance. Williams and Kelly (2003) presents the evaluation of the public perception towards a recycling scheme of a local authority. A strategy planning for drop-off centers has been extensively discussed in the paper by Chang and Wei (1999). Various authors (Ball and Lawson, 1989; Martin et al., 2006; Mcdonald and Oates, 2003) have studied how important factors – economic, political and social conditions- influence the success of the recycling programs and described people attitudes toward recycling programs.

Chula Unisearch conducted a research on packaging industry development for supporting solid waste management and recyclables. The research aimed to study an amount of solid waste which affected to environment, impact of solid waste management and recyclables to packaging industry. The result of waste stream analysis at selected sites was that the biggest amounts of waste are food (54.42%), plastic (24.76%) and paper (10.03%) (as also given in Figure 1). It was found the amount of packaging waste in whole country is 30.80% (Chulalongkorn University, 2004). Although with some data collection and compilation efforts by the government agencies, the overall evaluation of recycling programs and specific recycling models introduced by TIPMSE are yet to be evaluated.



**Figure 1.** Percent by wet weight of waste composition at the selected sites in 2004 (source: Chulalongkorn University, 2004).

This paper covers evaluation of recycling programs in two levels. At country level, it was carried out using samples of existing small-scale waste management of CRBs and SRBs by investigating their perception on factors influencing the performance of recycling programs. At city level, the investigation was conducted reflect changes in quantity of recyclable waste in municipal waste stream at selected LGAs compared to the previous study similarly conducted 5 years ago.

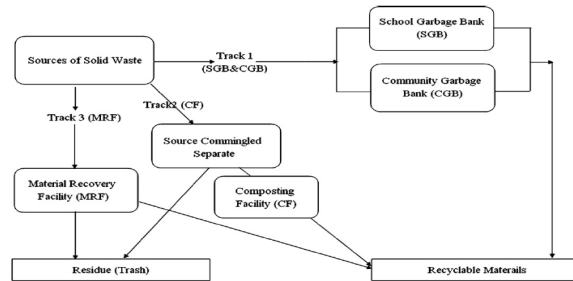
## 2. MUNICIPAL SOLID WASTE RECYCLING SYSTEM IN THAILAND

In 2009, a total of 15.03 million tons/year or 41,240 tons/day were generated. Only 3.5 million tons or equivalent to 23 percent of total waste is reported to be recycled. The

current recycling rate is low comparing to the potential recyclable waste of 12.5 million tons (83 percent approximately). The main factors influencing poor performance on recycling rate were limitations of good practices, lack of systematic procedure, public cooperation and budget (PCD, 2009).

LGAs have the direct responsibilities to handle MSW occurred within their governed areas, while central government plays supporting roles to solve the problem. In addition, stakeholders – including NGOs, communities and private sector – function to support the set up policies and implementation in various ways. Private sector takes lead role in forming committee and community network with other similar minded organizations to convey the 3Rs (Reduce, Reuse, Recycle) activities.

Pollution Control Department (PCD), a government agency, has set up the national policy and plan which focused on the sustainable consumption of the natural resources and the application of the ‘cradle to cradle’ concept, including control of waste generation at sources, increase on waste segregation and enhancement of waste utilization efficiency prior to the final disposal. The targets of waste minimization in this plan are to have the waste reduction scheme, to have the waste segregation system for reuse and recycling in every community over the country, and to minimize 30% of total waste generated. In addition, the following strategies have been drafted in order to archive sustainable solid waste management in Thailand: (1) encouragement of cooperation among various stakeholders; (2) promotion of science and technology suitable for 3Rs; (3) capacity building on the 3Rs for local communities; and (4) Initiation of the recycling-oriented society (ONEP, 2008 and PCD, 2006). There are three fundamentally different types of recycling programs, or tracks, implemented in Thailand (as also illustrated in Fig. 2).



**Figure 2.** Three types of recycling programs implemented in Thailand (source: adapted from Duston, 1993).

### 3. METHODOLOGY

For sustainable development, the appropriate evaluation method must be implemented in accordance with the sustainable SWM which is one of many aspects including in Agenda 21 (Hardoy et al., 2001). The evaluation research in this study involves two approaches - a survey design using a questionnaire (to gather the operational background of CRBs and SRBs and their perceptions on factors influencing a success of the programs), and a waste stream analysis using quartering technique (to explore the composition of waste at selected LGAs representing different political areas). The evaluation results in the research provide key for making decision and enabling government and non - government organizations to promote and encourage waste reuse and recycling in the right direction as well as expand national recycling system for sustainable development as mentioned in the Agenda 21.

The relationship of project evaluation and sustainability has also been adopted in this study. As indicated by Dale (2004), the relationship between sustainability and project evaluation is that sustainability is the maintenance or augmentation of positive achievement induced by the evaluated program or project after the scheme has been terminated. Sustainability may relate to all the levels in means-ends frame-work. The specific example of sustainability in this case is continued ability to plan and manage similar development

work, by organizations that have been in charge of the program or project or any other organizations that are intended to undertake the work.

### **3.1 Indicators selection**

The indicators selection was based on literature review and consultations with key stakeholders as well as applying a set of criteria for performance indicators – validity, reliability, sensitivity, simplicity, utility and affordability. The concept of sustainable SWM would function properly as long as accurate and sensible tools are applied for measuring. The overall indicators used in this research are related to the number of people involving in the recycling program; level of participation, public awareness; degree of members' perception on recyclables segregation, willingness to participate and quantity of recyclables waste. Those indicators show the results and efficiency of the on-going activities which then also fetch out the gaps of activities. It reflects the important point that still needed to be continuously improved for example - the quantity of recyclable waste imply level and quality of recyclable program, their perception shows their needs and expectation on such program. This would be used as a tool for decision makers to solve and run the program in a sustainable manner.

### **3.2 Questionnaire Survey**

A total of 60 questionnaires were distributed to selected 60 CRBs and 60 SRBs for data collection. A returned rate was 50 percent approximately. Statistical analysis methods using SPSS program including descriptive analysis and multiple regression are used to analyze the data. Regression analysis has been applied to investigate the significant factors influencing the recycling performance both of CRBs and SRBs. These were analyzed among related variables through compositing t-value generated based on the mean value of recycling performance as independent variable.

There are some limitations in the number of targeted programs that are supported by TIPMSE because not many SRB and CRB have been initiated and carried out in Thailand. Therefore, the performance and results of SRB and CRB were evaluated under these constraints. However, the returned questionnaires of around 30 for each should be able to be used for statistical analysis. The key topics of questions are recycling efficiency, participation rate, the report of revenue from selling recyclable materials, expenditure, encouragement methods, problem encountered, the number of cooperative involvement and members' perception on factor influencing the success of the program.

### **3.3 Waste Stream Sampling and Analysis Methods**

For comparison purposes of quantity and waste composition to the previous study, the followings sampling periods and methods have been applied to this study. The sampling technique used is to collect waste from selected waste drop-off centers. Manual sorting was done by the quartering technique. The collection procedure was seasonally conducted twice that cover two seasons - wet and dry, with the frequency of three days per season. The waste stream analysis was carried out at a total of 10 areas covering three different levels of LGAs scattered throughout Thailand.

## **4. RESULTS AND DISCUSSIONS**

### **4.1 Recycling Performance of CRBs and SRBs**

The recycling performance of CRBs were evaluated through participation rate (number of households involved), diversion rate (amount of recyclables to total amount generated), and

revenue from selling recyclables. While the performance indicators of SRBs were assessed through diversion rate, participation rate (number of students and teachers involved), and benefit-cost (B/C) ratio.

The results, as detailed in Table 1, show that the average diversion rate of CRBs and SRBs are 1.09% and 4.78%. The average participation rates of CRBs and SRBs are 76.54% and 86.80%. Revenue of recyclable waste of CRBs ranges from 300 to 64,026 THB/month, with the average of 6,446 THB /month. The average of benefit-cost ratio of SRBs is 10.15.

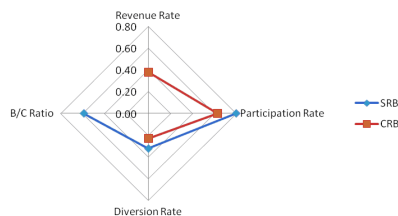
**Table 1.** The results of performance indicators of CRBs and SRBs.

Performance Indicators	Range	Minimum	Maximum	Mean	Std. Deviation
<b>CRBs</b>					
Diversion rate (%) <sup>1</sup>	13.02	0.00	13.02	1.09	3.05
Participation rate (%) <sup>2</sup>	279.40	8.00	287.40	76.54	76.48
Revenue rate (THB/month)	63,726	300	64,026	6,446.84	14,198.143
<b>SRBs</b>					
Diversion rate (%) <sup>1</sup>	40.15	0.00	40.15	4.78	9.92
B/C ratio	103.50	0.00	103.50	10.15	26.26
Participation rate (%) <sup>2</sup>	230.98	0.00	230.98	86.80	41.31

Note: 1 Benchmark: Beijing (10%); Thailand (11%); Manila (13%); Hong Kong (36%)  
2 Benchmark: Thailand (<10%); USA (64.5%); Ulaanbaatar, Mongolia (<50% Low, >51-100% High)

The overall recycling performance of SRBs and CRBs with mean values representing the central tendencies can be derived from scaled scoring, by assuming that the lower performance score value for a given indicator was set at 0 and the upper performance level was set at 1. They were categorized into five levels: poor (score: 0.00-0.20), fair (0.20-0.40), satisfactory (0.40-0.60), good (0.60-0.80), and very good (0.80-1.0).

The applications of the results show that CRBs' and SRBs' recycling performance was found to be satisfactory in terms of participation rate. However, diversion rate of both SRB and CRB are still in poor performance and needed to be improved. In addition the analysis of CRB shows poor performance of the revenue rate and B/C ratio of SRB is in a good performance (see Figure 3).



**Figure 3.** Mean values of recycling performance results.

#### 4.2 Factors Influencing the Performance of CRBs and SRBs

The results, as given in Table 2, show that perception of source separation and facing inconsistent price problem significantly affect the CRB's performance. For SRB's performance results, the analysis shows that perception of lack of skilled operators significantly affect the SRB's performance, because in the SRBs, the operators are on voluntary basis.

**Table 2.** Results of significant factors influencing the performance of CRBs and SRBs.

No.	Independent variables	Coefficients	t-value	Significant level
<b>CRBs</b>				
1	Perception of source separation	0.071	2.672	0.013**
2	Facing inconsistent price problem	0.333	1.937	0.065*
3	Perception of lack of skilled operators	-0.209	-1.163	0.257
4	Provision of compensatory goods	-0.224	-1.141	0.266
<b>Adjusted R<sup>2</sup></b>		<b>0.197</b>		
<b>F-test</b>		<b>7.138</b>		
<b>SRBs</b>				
1	Perception of lack of skilled operators	-0.107	-3.251	0.003***
2	Financial support by international agencies	0.072	2.441	0.020**
3	Private sector cooperation	0.273	1.817	0.079*
4	Provision of interest or money for members	0.233	1.606	0.118
5	Investment costs less than THB 10,000 <sup>(a)</sup>	-0.223	-1.535	0.135
<b>Adjusted R<sup>2</sup></b>		<b>0.283</b>		
<b>F-test</b>		<b>7.715</b>		

\*Significant at the 0.1 level or better (p<0.10)

\*\*Significant at the 0.05 level or better (p<0.05)

\*\*\* Significant at the 0.01 level or better (p<0.01)

(a) USD 1 is approximately THB 34.

### 4.3 Quantity and Composition of Municipal Waste Stream

The results of waste stream analysis, as shown in Figure 4, indicate that the major components of municipal waste at the selected drop-off centres mainly comprise of plastic (31.56%) food (24.01%), and paper (10.57%), which are in range of 17.35-42.22%, 1.33-45.56% and 2.32-19.42, respectively. In comparison to the previous study, it was found that waste proportion has changed – plastic increased by 6.8%, but food has vastly decreased by 30.41%, while paper remains at around 10% of total waste. The overall findings from waste stream assessment found that the plastic waste has been increasing. Instead of food, plastic has moved up to the top components of the waste stream. The possible explanation for the decrease of food proportion is 3R activities that are widely promoted and supported in LGAs.

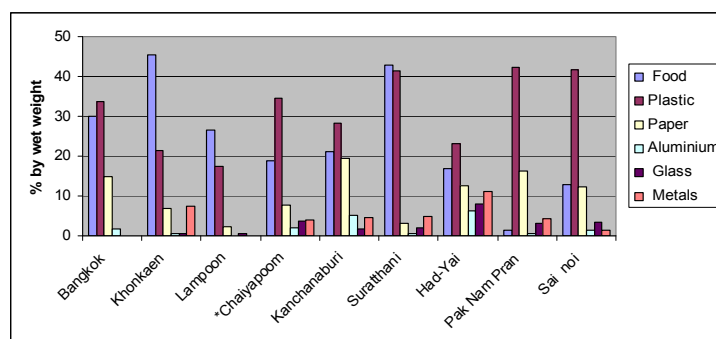


Figure 4. The percentage of recyclables in the MSW stream.

There have been many attempts to reduce plastic waste as mentioned in the relevant authorities' strategies and implemented plan of some agencies. Yet, plastic has been increasing in bigger proportion. In-depth details of the study show that plastic bag is the major type that affected higher percentage in the group of plastic, which equal to 63% of total plastic waste. In comparison to previous study, it is apparently seen that the proportion of three main types of plastic has changed – mixed plastic bottle and foam has greatly decreased, while plastic bag vastly increased. The other types mostly remain unchanged. Based on the result, it reflects the effectiveness of 3Rs programs applied to plastic bottle and foam, while the amount of plastic bag – non-recycling materials has increased according to higher waste generation rate from 2004 to 2009.

The result shows unremarkable change in proportion of metal, glass and aluminum, with a slight increase of 1.42% and 2.87% for aluminum and metal, whereas the glass amount remains constant at 2.62 %.

#### **4.4 Evaluation results and sustainability**

The strength of implementing recycling activities in the CRB and SRB model is that there are large number of households/students participated in the recycling programs. This shows environmental awareness on source separation and waste minimization. However, the evaluation also investigated their perceptions on the factors that could influence the performance of recycling programs. It is found that facing the recyclable waste price volatility is a major concern of CRB model. The fluctuation of recyclable waste price somewhat affects the number of members attending the recycling programs. For SRB, the skill of operator is considered as the most significant aspect influence SRB recycling performance. In achieving goals of recycling, SRB needs the financial support by agencies and cooperation of private sector in providing grant for establishing recyclable storage building at the initial stage of the program. In this regards, further improvement for sustainable recycling program could be managed by disseminating appropriate management and sustainable strategies for CRB, particularly financial management. In addition, LGA should provide support in encouragement to maintain the current members and expand to more recycling group members in the future. For CRB and SRB, a practical way aimed at sustainability is to hold the community/school workshop which focuses on capacity building on waste separation which would help increase the revenue rate and diversion rate.

The waste stream analysis reflects the quantity of waste at different drop-off centers where all valuable materials have been screened out through various types of activities – exchange between industrial sector, purchase shop, recyclable waste bank etc. The evaluation results indicate that there is a huge decrease in the amount of food proportion, while the amount of recyclable materials tends to be maximized. However, the current recycling rate is still at a poor performance in comparison to the recycling potential. For the sustainable SWM, reducing waste volume prior to the final disposal and shifting waste into raw materials by urging source segregation and source reduction are very important at this stage. Furthermore, recycling performance can be improved by supporting the informal recycling group and private sector with some help from policy makers for the sustainable development.

## **5. CONCLUSIONS AND RECOMMENDATIONS**

The evaluation results of this research links to ‘sustainability’ in three ways: (1) as the results reflect strength and weakness of the current specific recycling system, decision makers could use it as a baseline tool for further improvement such as maintaining its strengths and filling the gaps of the weaknesses; (2) clear and concise conclusions of existing evaluation results will provide a key for decision makers to set up their plans for sustainable SWM; and (3) it shows fact and status of stakeholders involving in the recycling activities as well as their needs which of course significantly affect their participation in the programs. For sustainable SWM, stakeholders must be taken into account and the program benefits should be fairly shared among them.

To further refine the results and outcome of the study, it is recommended that more research should focus on: (1) evaluating recycling activities at program level using case study approach, (2) drawing relationships among different levels of waste recycling programs, and (3) finding effective indicators for evaluating results of municipal waste management to reflect recycling-related programs.



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