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Municipal Solid Waste Management in Bangkok:

The cases of the promotion of source reduction and source separation in Bangkok and in Roong Aroon School

Panate Manomaivibool

Supervisors:

Thomas Lindhqvist

Naoko Tojo

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Tel: +46 – 46 222 02 00, Fax: +46 – 46 222 02 10, e-mail: iiiee@iiiee.lu.se.

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"ขอบคุณมากครับที่ค่อยเป็นห่วงและอยู่ด้วยตลอดเวลา รักมากที่สุดเลยครับ"

Finally, as a rule says, I hereby acknowledge that I am aware of the need for proper use of references and quotations in academic writing, and that I have been fully informed of this as a requirement in the Master's program at IIIEE. I further declare that I, to the best of my ability, have followed the standard rules, as for instance referred to at the IIIEE library website.

Panate Manomaivibool

Lund, September 2005

Abstract

Source reduction and source separation are important ingredients for sustainable municipal solid waste management. They facilitate waste reduction and valorisation. However, waste managers find that it is challenging task to promote source reduction and source separation. The situation is even more difficult in developing countries and lack of environmental awareness and lack of public cooperation are frequently mentioned as main barriers. This thesis takes a different angle to investigate the issue. It looks into the management, not the people. Two cases in Bangkok, one at the city level and one at the school level, are studied with the focus on how source reduction and source separation was developed in relation with the waste management system in each case. Both the municipality, Bangkok Metropolitan Administration, and the management of Roong Aroon School intended to incorporate source reduction and source separation in an attempt to make their waste management systems environmentally sound. Nevertheless, the results were very different. The study identifies the sequence of the system evolution as the main factor contributing to the difference. Other factors such as vision of the waste management, management support, public participation, target groups, etc. are also discussed. The thesis also stresses that the waste manager at the city level should put more emphasis on biodegradable fraction, not recyclable, in order to make action at sources beneficial to the municipal solid waste management system.

Executive Summary

Municipal solid waste management (MSWM) is one aspect of sustainable development. A sustainable MSWM system is a system that (1) minimise waste, (2) maximise resources recovery, (3) minimise negative environmental impacts of the system, and (4) maximise its coverage (UNEP 2005). Sustainability calls for a move away from traditional arrangement of MSWM, i.e. collection and disposal of mixed MSWM. Source reduction and source separation are necessary ingredients of sustainable MSWM. The former by itself is at the top of the waste management hierarchy and the latter facilitate other options in the hierarchy.

The situation in Bangkok before 1997 could hardly be classified as a sustainable one. The city faced rapidly growing municipal waste stream at the average rate of 9% per year between 1987 and 1997. The MSWM practice was also environmentally problematic. The municipality, Bangkok Metropolitan Administration (BMA), through its Department of Public Cleansing (DOPC) provided a collection of mixed waste. The presence of saleable recyclables in mixed waste stream made the collection system inefficient. BMA's waste collectors spent a considerable portion of collection time in sorting these materials to earn their additional income. Later, waste was landfilled almost without any pre-treatment. The landfill sites were also not state-of-art ones and related to a number of environmental impacts.

Under the 5th Bangkok Development Plan, BMA tried to reverse the trend. A promotion of source reduction and source separation through the Waste Minimisation Project (WMP) was a part of a comprehensive plan to modernise the system. BMA urged people to separate waste into four fractions: biodegradable waste, recyclables, household hazardous waste, and rest waste. BMA also planned to build material recovery facilities (MRFs), composting plants and incinerators with energy recovery in addition to its contracted landfill. Together, BMA expected a goal of 80% waste reduction (landfill diversion) in 2006 from a projected increase made in 1982, i.e. equal to 68% reduction if the 1997 is used as a baseline.

WMP was implemented as planned. BMA used various public relation campaigns to promote source reduction and source separation to reach households. In addition, a few supplementary projects were subsequently put forward such as a more intensive campaign among 14 selected groups and a promotion of home composting to produce liquid compost[1]. On the other hand, all mega-projects on alternative treatment and disposal facilities have never been materialised—largely due to political instability. Waste collection, despite some improvements in the area of punctuation and efficiency, was done in the same way as before 1997.

In 2003, the amount of waste landfilled was equal to 78% of the projected increase of the year. But this was 13% increase if the 1997 is used as a baseline. The 1997 economic downturn and subsequently outflow of unregistered populations were likely to account for a decrease in a growth rate of municipal waste steam after 1997. Normal households rarely separate their waste in accordance to BMA's instruction and BMA, in turn, mentioned a lack of public cooperation as one of the main problems in MSWM (DOPC 200b, 27; DOPC 2003b, 1). The only substantial result of the project is the amount of diverted recyclables among 14 target groups. However, after continuous increase from 9 kg/day to 102 kg/day between 1998 and 2003, the reported quantity started to drop dramatically in 2004 to 58 kg/day. All in all, WMP can hardly be labelled as a successful story.

[1] The term 'liquid compost' is used in this paper throughout to means a product derived from similar processes which fertilize microorganisms on selected food waste. Its origin is the Effective Microorganisms which is a patented name of the product contains 3 major genera of microorganisms: phototrophic bacteria, lactic acid bateria, and yeast, created by Dr. Teruo Higa in 1980s.

At the outskirt of Bangkok, Roong Aroon School (RAS) made an attempt to solve the waste problem in the school. Before 2004, the management of waste in the school was very simple. All school waste was openly dumped together at the collection room. BMA made a weekly trip to empty the room. The situation, especially at the collection room, was very unpleasant with bad odour from decomposed waste and annoying flies.

In February 2004, the management of the school with a strong determination to solve the problem started its Zero Waste Project (ZWP). A new division, called, the Resource and Environmental Management Division (REMD) was established a responsible body of the project. The aim of the project was to separate resources from waste and reduce the amount of waste generated. Like the city case, the promotion of source reduction and source separation was a main component of the project. Though there was no specific target in the project, its name showed that the school intended to make an as-much-as-possible reduction.

The project started with a thoroughly waste audit. Some teachers and staffs also involved in the process as environmental volunteers. Three types of resources were differentiated from waste in accordance to utilisation options: food residual for use as an animal feed, biodegradable waste for composting, and saleable recyclables for reuse and recycling. Sorting and composting stations were built and the owner of fish ponds were contacted shortly after the system was designed. In addition, a liquid compost station and organic plantation were also put in place as parts of composting process. Then four-coloured waste bins were placed in public areas in the school. Later a few zero waste campaigns such as Zero Waste Transaction and Zero Waste Classroom were put forward to promote source reduction and source separation.

The result of ZWP was impressive. Within one and a half year, the waste reduction rate of 90% from the baseline weight at the beginning of the project was achieved. Behavioural changes in waste reduction and separation were also reported among staffs and students. The effects of the project were not limited in the school's wall. Parents and neighbouring communities also participated in the project. Some of them even imported the idea into their organisation.

A comparison between the city and the school shows that, despite a similar system designed, the sequence of actions to introduce changes in the two cases was very different. BMA started with the promotion of source reduction and source separation first but has never been able to materialise the designed central system. Therefore, the justification of any action at source in relation with the central system was weak and people adjusted their cooperation given to BMA down to the level compatible with its service. On the other hand, things were done in a reverse order at RAS. Central system as designed was established right away. In the beginning, the promotion of source reduction and source separation would not be done unless necessary. But when the performance of the central system was proved, a stint of campaign was made to promote source reduction and source separation. Some are similar to producer responsibility schemes, subsidies, and green procurement adopted by cutting-edge developed countries.

The study also named ten factors contributing to the success of ZWP. There are (1) core business of waste management, (2) management support, (3) initial review, (4) public participation, (5) sequence, (6) (working with) children, (7) waste bins, (8) integration of the private waste collection business (at a right place), (9) convenience, and (10) intervention on the markets. BMA got some of these to certain extent but still failed to get others right, especially the fifth one.

Some suggestions are proposed to MSWM at the city level based on lessons learnt at the school. It is advisable to promote source separation to the degree that compatible with the existing facilities. Under current situation, saleable recyclables present themselves as a low hanging fruit in the system and only some modifications should be sufficient to improve overall efficiency of the system. However, BMA should not leave its eyes from the real problem of MSWM, namely, biodegradable waste. Alternative treatment is needed to relieve environmental problems related to the management of this fraction and to make source separation justifiable. Additional policies instruments such as subsidy, extended producer responsibility, or green procurement, at the local or national level have potential to stimulate the system development.

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1 Introduction

1.1 Background

Economic development has improved our living standards considerably during the last two century. In average, we are richer and live longer than our predecessors. However, this improvement does not come without cost. We need a huge amount of resources to sustain the engines of economic growth, namely, resource-intensive production and materialistic consumption. To make the situation even worse, in a throw-away society, most materials consumed are disposed without any valorisation.

A new notion of development that is friendlier to the planet earth is needed. Sustainable development is a response to this call. The term was officially defined in a so-called *Brundtland Report* as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987, 47). Since then, it has become central to a multitude of environmental policies.

When applied to waste management, sustainable development requires "the production of more value from recovered materials and energy, with the consumption of less energy and the production of less emissions to air, water and land" (White, Franke, and Hindle 1995, 303). The Agenda 21, adopted at the United Nations Conference on Environment and Development (UNCED)—the Earth Summit—held in Rio de Janerio, Brazil in 1992, emphasises on the four major waste-related programme areas (UNEP 2005):

a) Minimising wastes;

b) Maximising environmentally sound waste reuse and recycling;

c) Promoting environmentally sound waste disposal and treatment; and,

d) Extending waste service coverage.

These programmes, especially the first three, are in tandem with the waste management hierarchy. The hierarchy, as shown in figure 1-1, prioritises waste management options. Generally, waste minimisation, including prevention and reduction, is the most preferable option. Then, material recovery, i.e. reuse, recycling, composting, is preferred to energy recovery, i.e. waste-to-energy technologies. Controlled disposal methods without any recovery are the least, but still, preferable options. Other uncontrolled disposal methods are not included in the hierarchy (Kiss, Jakubaschk, Monchon, Bammanahali, Stavchuk, and Manomaivibool 2005).

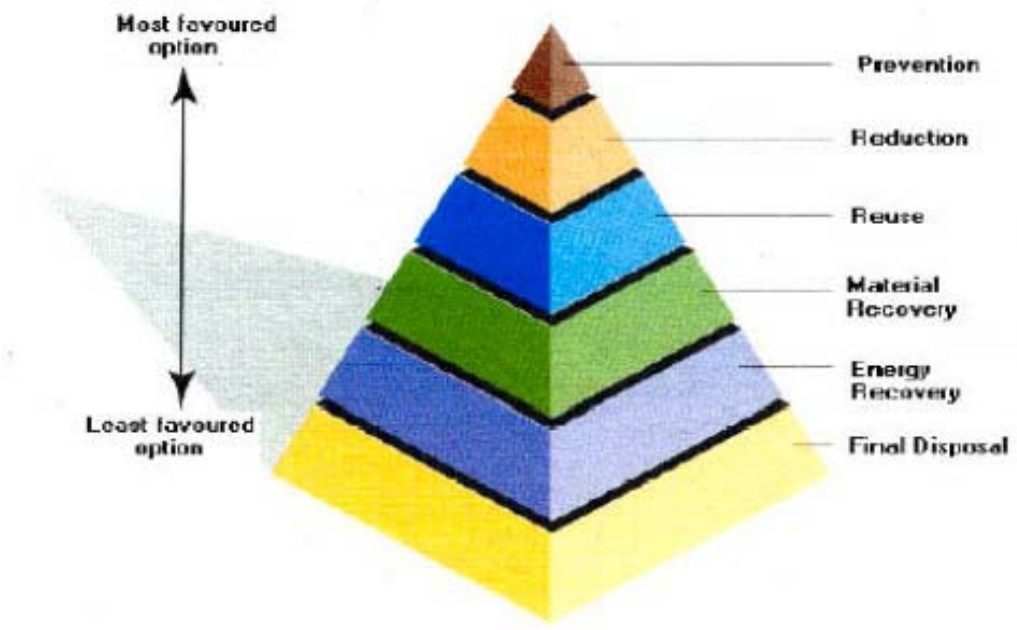

Figure 1-1 The waste management hierarchy

Source: (Abo Sena 2004, 25)

The history of the hierarchy dated back to the 1970s and Europe has been its stronghold. The waste hierarchy was first introduced into European waste policy in the European Union's Waste Framework Directive of 1975; in 1989 it was formalised into a hierarchy of management options in the European Commission's Community Strategy for Waste Management, and further endorsed in the Commission's review of this strategy 1996 (SITA 2004, 1). The hierarchy has been fundamental in designing many waste-related directives. For example, the Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles incorporated the extended producer responsibility to stimulate design change in the light of waste prevention (Article 4) and set specific targets for reuse, recycling, and energy recovery (Article 7). Although, at the other side of the ocean, the hierarchy does not receive any statutory status, the US EPA has also promoted the idea.

Although there are some controversial issues related to the prioritisation of treatment and disposal options[2], the hierarchy is still useful policy guidance. It simply shows that a range of options are available to manage waste, apart from an option of final disposal. And it encourages policy makers to fully exploit these options in an environmentally friendly, cost-effective, and socially acceptable way.

According to the hierarchy, source reduction and source separation are crucial to sustainable waste management. Source reduction by itself is at the top of the hierarchy. Source separation is a facilitator to waste treatment and disposal options at the lower levels. It seems like only landfill can handle mixed wastes alone (White, Franke, and Hindle 1995, 16). But, even for landfill, mixed waste is not an ideal input. The development of landfill, especially in Europe, shows a trend toward delimiting landfill of mixed waste stream. The Council Directive

[2] For example, see Rasmussen, Clemen, Vigsø, Dorte, Ackerman, Frank, Porter, Richard, Pearce, David, Dijkgraaf, and Vollebergh, Herman, (2005), *Rethinking the Waste Hierarchy*, Copenhagen: Environmental Assessment Institute.

1999/31/EC of 26 April 1999 on the landfill, for example, identified three classes of landfill: landfill for hazardous waste, for non-hazardous waste, and for inert waste (Article 4). The Directive further baned or delimited landfill of certain materials, e.g. tyre, infectious waste, biodegradable waste, etc. In sum, a sustainable waste management does not only calls for waste minimisation, but it also requires some sort of waste segregation.

1.2 Problem Statement

In 1997, there were as much as 8 500 tonne of municipal solid waste (MSW) generated in Bangkok every single day. This more than doubled from the 1987 figure of 4 200 tonne/day. This posed a considerable physical and financial burden on the municipality, Bangkok Metropolitan Administration (BMA). What made the situation even worse was the fact that there was no source separation for BMA's collection and BMA did not have any alternative to landfill of mixed MSW. However, the practice was hardly considered sustainable. The standards of landfill were generally low and inescapably gave away negative environmental impacts. Local emissions, in turn, led to local opposition to the importation of Bangkokian waste.

BMA's intention to overhaul its municipal solid waste management system reflected in the 5th Bangkok Development Plan (1997-2001). There were two main components in the Plan. The first was the Waste Minimisation Project (WMP)[3] aiming to "decrease the amount of solid waste by urging people to reduce and separate wastes before disposal" (DOPC 2005c). The other was the Middle Term Disposal Plan (1997-2006) aiming to modernise a waste treatment disposal system. However, the success at the end of the Plan was very modest. In 2001, over 9 000 tonne/day of MSW were handed to BMA and most, if not all, of them were mixed. To many people in the MSWM circle, the situation in Bangkok seems to be unsolvable. And, lack of public awareness and cooperation, especially of middle-class households, was mentioned as a root cause of the problem.

On the other hand, a very successful story comes from an outskirt of Bangkok. A private school named Roong Aroon School (RAS), in which most pupils are from middle class families, started its Zero Waste Project (ZWP) as late as 2004. But, within one year, it was able to decrease the amount of wastes sent out to the environment, i.e. BMA, by more than 80%, from 206 kg/day to 27 kg/day. Size is clearly one factor that makes the two projects different. But is it the only thing that matter? Or, there are some lessons the city can learn from the school.

1.3 Purpose

The purpose of the study is to understand mechanism(s) that makes the results of the two cases different. This can be useful to the management of municipal solid waste of Bangkok Metropolitan Administration (BMA). Regarding each as one entity, mechanisms make Roong Aroon School (RAS) successful and those deter BMA from success might be revealed. In addition, regarding RAS as a school, BMA might be able to apply its experience with hundreds of public schools under its control (with some modifications).

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[3] In Thai, the project was called "**โครงการลดปริมาณขยะมูลฝอยของกรุงเทพมหานคร**" [*the BMA Waste Reduction Project*] in 1997 and, later, called "**โครงการส่งเสริมการลดและการแยกมูลฝอยอย่างมีประสิทธิภาพของกรุงเทพมหานคร**" [*the BMA Efficient Waste Reduction and Waste Separation Project*] in 1998. However, in this thesis the name "Waste Minimisation Project" or WMP is used consistently throughout.

1.4 Research Question

The main research question is formulated as: Why are the results of Waste Minimisation Project different from those of Zero Waste Project? In order to answer this question, the study answers the following sub-questions:

1. What was the context of the MSWM in each case?
2. What was the main driver(s) to promote source reduction/separation in each case?
3. How did a designed MSWM system to implement the project look like in each case?
4. How was source reduction and source separation promoted in each case?
5. What was the result(s) in practice in each case?

1.5 Scope and Limitation

This study focuses on MSWM systems intend to reduce the amount of MSW from final disposal through source reduction and source separation. Municipal solid waste (MSW) is defined as "any solid waste generated from community activities, e.g. residential households, commercial and business establishments, market, institutional facilities and construction and demolition activities, excluding hazardous and infectious wastes" (Pollution Control Department 2000, 6). However, household hazardous waste (HHW) is mentioned from time to time because, from the Department of Public Cleansing (DOPC 2005a, 45)'s estimation, over 99% of HHW generated in Bangkok is mixed with MSW. Therefore, MSW in this study means to what is regarded and subsequently *treated* as MSW regardless of what it actually is.

The study examines two projects: the BMA *Waste Minimisation Project* (WMP) as a part of the 5th Bangkok Development Plan (1997-2001) and the RAS *Zero Waste Project* (ZWP) started in February 2004. The former project is chosen because it is among the first of its kind and has continued until today. The importance of its improvement is also paramount to MSWM situation of the city, which account for 23% of MSW in Thailand. The 5th Bangkok Development Plan is chosen because it provides a background of the project, especially its relation to the Middle Term Disposal Plan and the overarching goals and targets. The school project is chosen because of its success within short time. In addition, ZWP is one of few projects in Thailand that successfully works with those from middle class who are regarded as a hotspot in source reduction or separation initiatives, despite their rather high educational background.

There are limitations in the study that can hamper its repeatability. Data at the city level, especially on non-governmental sectors, are hardly available and if they are available, the reliability is always in question. Remedial actions taken in this study is to triangulate data from different sources if possible and to make a proper citation. Data accessibility is another limitation. Personal connections are very important to gain access to data in Thailand but there is unavoidably a risk of bias. An attempt to gain opinions from different stakeholders might reduce the risk but cannot eliminate it. In addition, an analysis based on data that already exist is inescapably limited to what exists; so, there is also a problem of validity, i.e. what exists might not be exactly what is needed. Following Babbie (1995, 307)'s suggestion, logical reasoning is used to fill this gap.

1.6 Methodology

The study is an exploratory research trying to understand the situation in municipal solid waste management in the developing world. The study is a mix of documentary and field research. This combination gives an opportunity to triangulate qualitative data yielded from field research with quantitative data yielded from archival.

It begins with a review of literature about municipal solid waste management (MSWM) in general and the relation of source reduction and source separation to the system in particular. Books and journals are the main sources of literature. The understanding is used to structure the presentation of the two cases studies.

Then, a list of relevant document in the city case was obtained through the database of libraries at the Department of Public Cleansing (DOPC), Bangkok Metropolitan Administration, and of the Pollution Control Department (PCD), the Ministry of Natural Resources and Environment. Several documents were recommended from key informants during the process. Documentary research of the school case is mostly based on the Diary of the 1st Year of the Zero Waste Project. Other school publications such as school weekly newspaper were complementarily used.

The period between 13 June and 30 August was assigned for a field research in Bangkok. An observation on the management of waste in the city was made during the period to triangulate with the document. In addition, three site visits to community-based-management schemes and six site visits to the private waste collection business were made. A number of interviews were conducted during the process. Key informants are based on snowball sample technique. It begins with a few relevant subjects identified and expands the sample through referrals (Babbie 1995, 287). The full list of interviews can be found in bibliography. Moreover, the author attended four seminars. The first was a training programme on waste sorting for commercial purposes held by Wongpanit Group in Phitsanulok during 21 – 25 June. The second seminar was on community-based waste management held by a NGO, the Urban Community Foundation (UCF) during 16 – 17 July. The third seminar was on waste policy in Thailand held by Health Systems Research Institute, Ministry of Public Health, on 27 July. The last seminar was on community-based waste management schemes held by the 70 Rai, Khlong Toei Community on 7 August. Interpersonal communication with key speakers and attendants, mostly in a waste circle, during these seminars yielded invaluable inputs.

The school case emerged later in the study. The case serves as what Whyte (1984) called an 'social innovation' and McCall and Simmons (1969) called a deviant case. The merit of adding the school case is to improve an understanding of fairly regular patterns of attitudes and behaviours in the city through contrasting it with that which do not fit into the regular pattern.

Three site visits to Roong Aroon School were made on 28 July, 26 and 30 August. The first site visit was special because it was arranged together with another study visit from the other two schools. The visit gave a comprehensive picture of the project. The latter two visits were meant to collect qualitative data from in-depth semi-structure interviews with key informants, whose name appears in the bibliography. Interpersonal communication with several actors such as pupils, parents, cooks, janitors, etc. also took place during the three visits.

The realist *RRRE* (Resolution-Redescription-Retroduction-Elimination) mode of explanation is used in the analysis (*Critical Realism*, 1998). First the complex event is *r*esolved into its components. Second the significant features of these components are *r*edescribed in the light of theories. The next step is the *r*etroduction back to possible explanations of the features. Then, the most consistent line of argument becomes the best explanation while others are

eliminated.[4] As the nature of a study heavily based on field research, the conclusion, despite its insight, is suggestive rather than definitive (Babbie 1995).

1.7 Thesis Outline

Chapter 1: Introduction

This chapter gives an introduction to the study. It provides background, problem statement, research questions, scope and limitations, and methodology of the study.

Chapter 2: Source Reduction and Source Separation and a Municipal Solid Waste Management System

This chapter provides general information about source reduction and source separation and its relation to a municipal solid waste management system and *vice versa.*

Chapter 3: Municipal Solid Waste Management in the City

This chapter describes a waste situation in Bangkok. It gives a brief overview of the city and its administration. The situation before 1997 is described as a problem. Then the Waste Minimisation Project with a broader framework, the 5th Bangkok Development Plan, is presented as an intervention to the system. The situation after 1997 and the results are described at the end of the chapter.

Chapter 4: Municipal Solid Waste Management in the School

This chapter described a waste situation in Roong Aroon School as a twin case to Bangkok. It gives a brief overview of the school and its administration. The situation before 2004 is described as a problem. Then the Zero Waste Project is presented as an intervention to the system. The situation after the project and the results are described at the end of the chapter.

Chapter 5: Analysis

This chapter analyses and compares the two cases. It begins with problem identifying of why there was a change in the cases. Then, it analyses the situation at the city level. The lessons about factors contributing to the success of the school project are discussed in relation with those at the city level.

Chapter 6: Conclusion

This chapter concludes the study. It also provides some suggestions to the city of Bangkok and to research in the future.

[4] For the detail of this mode of explanation in particular and critical realism in general see *Critical Realism: Essential Readings*, edited by Margaret Archer, Roy Bhaskar, Andrew Collier, Tony Lawson, and Alan Norrie. (1998). New York: Routledge; this is in line with what Wendt (1999, 63) called 'Inference to the Best Explanation; IBE.'

2 Source Reduction and Source Separation and a Municipal Solid Waste System

2.1 Source Reduction and Source Separation

2.1.1 Source reduction

Source reduction is defined by US EPA (1995, A-7) as "the design, manufacture, acquisition, and reuse of materials so as to minimize the quantity and/or toxicity of waste produced. Source reduction prevents waste either by redesigning products or by otherwise changing societal patterns of consumption, use, and waste generation."

Source reduction is possible only before the moment of discarding. Consumers make an ultimate choice on what products they will consume; when they will not be of value, i.e. regarded as waste; and how waste will be discarded.

To encourage source reduction, three families of policy families can be applied. First, a policy maker can adopt regulatory instruments to tell people how to behave and what sanction(s) will be applied in a case of non-conformance. A ban is a good and straightforward example of regulatory instruments to reduce the amount and/or toxicity of the waste stream. However, the effectiveness of regulatory instruments is depended on theirs enforceability.

Second, economic incentives can be used to induce people to source separate. A pay-as-you-throw, unit pricing, scheme is an example of economic instruments related to source reduction. In Zurich, Switzerland, a 25% reduction in domestic waste was seen after a pay-as-you-throw system was introduced (Wilson, McDougall, and Willmore 2001, 335). However, an application of unit pricing can be complicated. The choice has to be made between volume-based and weight-based pricing. The former can lead to the problem of "Seattle stomp"—whereby households buy and use home compactors to reduce the volume and hence the cost of their trash—while the latter can result in inefficiency of waste collection (Porter 2002, 47). In addition, there is always a concern over illegal disposal and littering where unit pricing is applied.

Finally, information can be disseminated to people. A policy maker assumes a condition of imperfect information and informative instruments will provide necessary information to make a change. This instrument is widely used to promote source reduction. However, it is not necessary that well informed actors will behave in a desirable way.[5] The link between information and action is still unclear.

Producers also have considerable influence over source reduction. They provide consumers with a range of products to choose, which in turn, determines possibility and difficulty of source reduction. Therefore, any decision made on a design stage of the product system can affect subsequent choices. This is where a concept of extended producer responsibility (EPR) emerged.

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[5] A case of the battery collection on the Danish island of Bornholm is a good example. Despite a very intensivly informative campaign, the collection rate were disappointting and not much different from other schemes in other European countries. For more detail see Lindhqvist, Thomas. (2001). *Extended Producer Responsibility for End-of-Life Vehicles in Sweden: analysis of effectiveness and socio-economic consequences*. IIIEE Reports 2001: 18, Lund: IIIEE, Lund University, 100-102.

The term 'extended producer responsibility' was officially introduced in a report to the Swedish Ministry of the Environment, *Models for Extended Producer Responsibility* (1990). Subsequently, the concept was revised and defined as a policy principle "to promote total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturer of the product to various parts of the entire life cycle of the product, and especially to the take-back, recycling and final disposal of the product." (Lindhqvist 2000, 154).

The goals of EPR are (1) to trigger a design improvement; (2) to promote reuse, recycling and recovery; (3) to improve the quality of the treatment; and, (4) to increase collection (Lindhqvist 2001). Based upon these goals, the words 'extended', 'producer', and 'responsibility' have their implication. In line with the polluter pays principle (PPP), the focus is on the producers since they are the ones who introduce the product into the market, which in turn, makes them very influential on its designed characteristics.[6] Four types of the producers' responsibility, as shown in figure 2-1, are identified: financial, physical and informative responsibility and liability (Lindhqvist 2001). The responsibility is extended beyond the conventional scope of responsibility to the end-of-life management of the product.

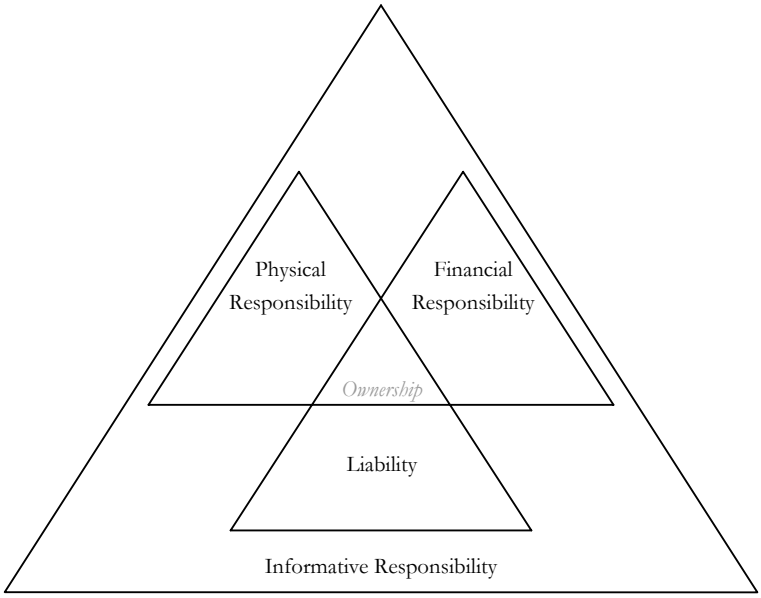

Figure 2-1 Ideal type of extended producer responsibility

Source: adapted from (Lindhqvist 2001, 38)

These four types of the producers' responsibility are the main mechanisms of an EPR system that create the feedback loops between the designers at the upstream and the waste managers at the downstream. The internalised end-of-life costs, for example, give the producers an incentive to make their product system cleaner. It is worth nothing that in the case that the

[6] However, whether this is a result of increasing awareness of consumers from internalising costs, which in turn, sends a signal to the designer (a demand-creates-its-own-supply argument), or the discretion of the designer, who has a better knowledge about the product (a you-do-not-know-what-you-want-until-it-exists argument) can be a topic for further debate.

producers decide to retain the ownership of their product, i.e. to implement the so-called product-service system (PSS), they also have these four types of responsibility.

EPR is widely applied in Europe and in some Asian countries. So far, packaging, electronic and electrical equipments (EEE), and end-of-life vehicles (ELV) are three main targets. In general, the producers of these products under EPR schemes compulsorily or voluntarily commit to meet specific requirements on (1) limit or ban on the use of certain substances such as heavy metals and (2) reuse, recycling, and recovery targets. The action on the part of the producers alone, though necessary, is not sufficient to meet these requirements. Therefore, in EPR schemes, it is also necessary for the producers to get consumers involve. Because the government monopolises the use of regulatory power, producers use economic instruments, informative instruments, or a combination of the two to approach people. A deposit-refund system and a free take-back service are examples of producers' initiatives which affect source reduction on the part of consumers.

2.1.2 Source separation

Waste separation is necessary for all waste treatment and disposal options. Except for landfill, recycling, biological treatment, or thermal treatment is suitable for certain material types. Separation of paper, plastics, glass, and metals from other wastes and each other is a must for recycling. Incineration also needs pre-treatment and pre-sorting to be able to unleash its energy recoverability with minimum its negative impacts. In the same line, biological treatment of mixed MSW is nothing but a smelling volume reduction. Moreover, separation is of use in landfill. Though it can handle all kind of wastes, landfill of mixed MSW is not preferable. To limit unknown reaction and subsequent emission, in the last two decades, we have experienced a classification of landfill according to the material types. The Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, for example, identified three classes of landfill: landfill for hazardous waste, landfill for non-hazardous waste, and landfill for inert waste (Article 4). The Directive further baned or delimited landfill of certain materials, e.g. tyre, infectious waste, biodegradable waste, etc. This automatically opens more room for other treatment and disposal methods for the separated fractions of waste.

There are two types of waste separation: source separation and central sorting. Source separation is "the segregation of specific materials at the point of generation for separate collection" (US EPA 1995, A-7). Central sorting will be presented in the next section. But, as the case of Bangkok will later show, wastes can also be sorted after source but prior to any central sorting facility by actors in an informal sector such as scavengers which might be loosely considered as a part of central sorting. The emphasis of waste separation is on separation for recycling. This is because there are quite a few types of recyclable materials and each needed to be separated from the others in order to be able to enter the reprocessing processes. In general, source separation of recyclables is more preferable than any form of central sorting. There are three main advantages of source separation. First, recovered materials are rather clean because they are not commingled from the source. Second, cleaner materials require less cleansing and, hence, the recycling process emits less pollutions. Last but not least, source separation "educates people about the need for waste reduction, reuse, and recycling" (Miller 2004, 538). During the process, people gain an understanding on which materials can be recycled. However, source separation is a complicated issue. It is still not conclusive on what makes people practice source separation. Fenech (2002) identifies a number of factors possible to affect source separation. Table 2-1 summarises these factors.

Table 2-1 Factors that motivate people to participate in source separation of waste

Intrinsic Factors: Intrinsic factors are autonomous motivations (but can anyway be influenced) which can be divided into:

- Attitudes: Attitude is a tendency to perceive something in a positive or negative way. It can be formed both before (based on prior knowledge) and after (based on direct experience) an action/inaction.
- Responsibility: People feel either morally or conventionally for the environment. Moral responsibility is based on moral concepts such as fairness, right. Conventional responsibility is based on social expectation, i.e. a role the person is expected to perform.

Extrinsic Factors: Extrinsic factors use the following strategies to influence actions:

- Information, Knowledge and Conviction: Lack of information is a barrier for action so information about how to recycle is obviously a necessary condition. But how information is transformed into knowledge and whether knowledge is sufficient to influence the behaviour is still contentious. Conviction is a knowledge that has taken root and might be a missing link between knowledge and action.
- Economic Incentives: Economists argue that behaviour is a result of private cost-benefit calculation. Therefore, adding economic incentive can change the input of the calculation and, hence, the result, i.e. behaviour. However, the relationship between economic incentive and behaviour in practice is much more complex than in theory.
- Reinforcement: Reinforcement is developed after the problem arises. In the case that a person performs desirable action, reinforcement can be either positive—the person gains something valuable—or negative—the person relieves from a noxious situation. On the other hand, punishment will be applied in the case of undesirable action.
- Feedback: Feedback is information about the effectiveness of the behaviour. It tells people whether they attain or fail to attain a goal.

Convenience and Situational Factors: The possibility of doing an activity with little effort or difficulty. Situational factors are related to convenience such as distance to recycling centre, type of dwellings, and space availability.

Socio Demographic Factors: Factors such as income, status, education, age etc. can affect behaviours.

Public Participation in the Design: Public participation in the design of the waste policies is to include people on who the success of the policy is based in the decision-making stage, rather than just inform people of the decision and expect them to conform.

Source: (Fenech 2002)

Although "sorting is an important part of any waste's lifecycle" (White, Franke, and Hindle 1995, 135), it is just a component of a MSWM system. And the system's components are interrelated. For example, while sorting is necessary for treatment and disposal options, availability of treatment and disposal options is determined the reason(s) and the degree of separation needed. Therefore, the next section gives a brief overview of a MSWM system.

2.2 Municipal Solid Waste Management System

2.2.1 System boundary

As a system, MSWM must have its boundary separating the system from its environment. White, Franke, and Hindle (1995, 39) defines the system boundary of MSWM as the following:

- "Cradle (for waste): when material ceases to have value and becomes waste (e.g. the household dustbin)

- Grave: when waste becomes inert landfill material or is converted to air and/or water emissions or assumes a value (intrinsic if not economic)."

2.2.2 System component

Figure 2-2 presents four components of a MSWM system. It begins with waste generation. Then, a component of source separation and collection comes into the picture. Central sorting includes material recovery facilities (MRFs) and a plant for refuse-derived fuel (RDF). The final piece is MSW treatment and disposal. Here, recycling is not presented as a component because the reprocessing business is normally outside the control, and the boundary, of MSWM. The rest of this part discussed system components with special attention to their relation with source reduction and source separation.

Waste generation varies, in term of quantity, composition, and physical and chemical characteristics, from one source to another. For example, commercial and institutional wastes tend to be more homogeneous than domestic waste. Waste generation is a point between source reduction and source separation. While source reduction determines the amount and composition of waste generated, what is generated determined the need and difficulty of its source separation.

Source separation and collection have a close relationship and, hence, are combined into one component. Source separation is segregation of MSW into different fractions at home. The degree of source separation has an implication on space occupation of separated and stored fractions of waste. Storage is also determined by the frequency of collection. Normally, collection methods are divided into "bring [in which households have to bring their waste to the central collection point] and kerbside [in which collection takes place at their houses] collection scheme" (White, Franke, and Hindle 1995, 93). Municipalities bear more transportation cost in kerbside schemes while in bring schemes this is shifted to households. In general, the bring system is less convenient than its kerbside counterpart. Collection affects source separation. There is no point to separate more fractions than separated collections in both bring and kerbside systems provided. Collection also has an implication on source reduction. It is estimated that in a collection system used waste bags instead of bins a 3% increase in waste volume can be expected from a presence of waste bags (Bilitewski, Härdtle, Marek, Weissbach, and Boeddicker 1994, 66).

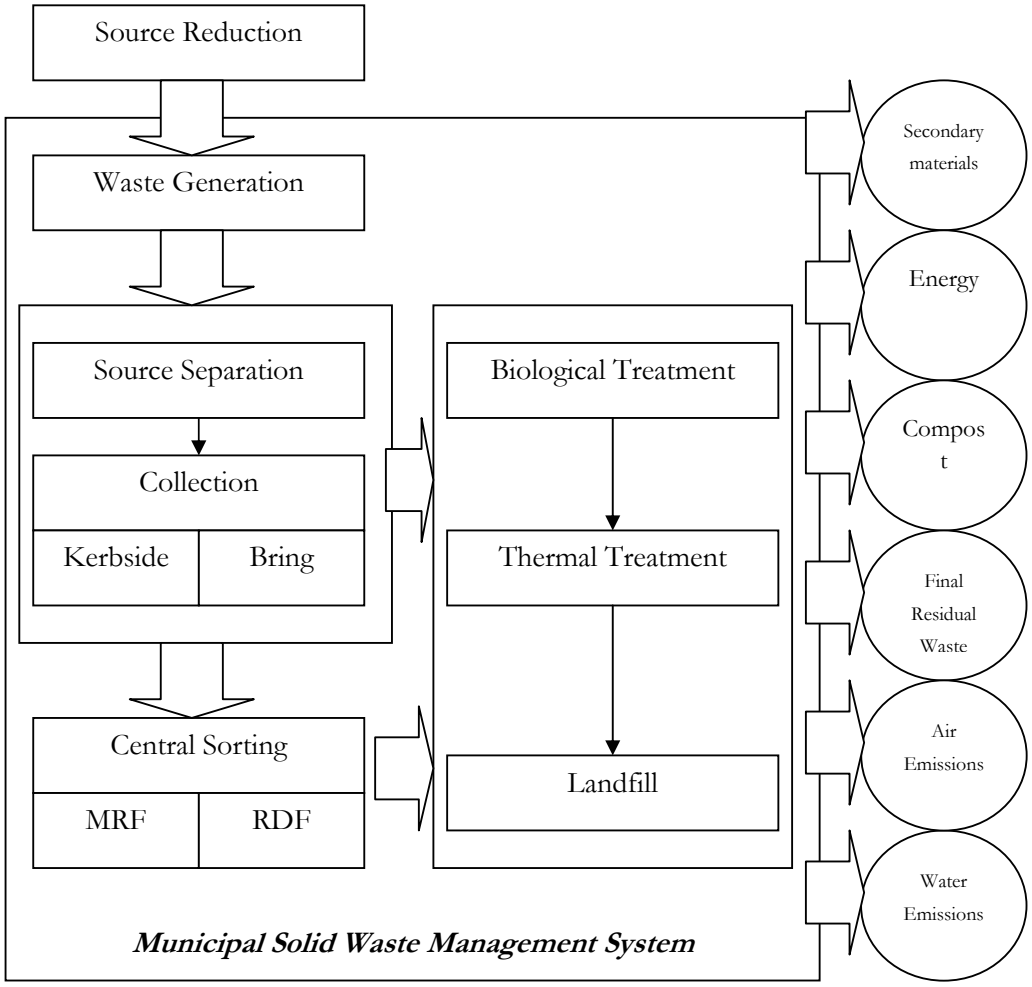

Figure 2-2 Components in a municipal solid waste management system

Source: adapted from (White, Franke, and Hindle 1995, 48-50)

Central sorting is situated between source separation (and collection) and treatment and disposal. Central sorting is an attempt to match prior sorting with requirements of the reprocessors. If materials from source separation can meet the requirements of the destined treatment and disposal method, there is no need for central sorting. Modern MRFs use a set of separation techniques such as density, flotation, optical, magnetic, and electrical sorting to separate various types of materials. Such plants, however, "appear to be too expensive [especially for a MSWM system in a developing country] and inappropriate for mixed waste

input" (Bilitewski and et al. 1994, 358). And they still need hand-sorting to a certain degree. Plants with intensive hand sorting, on the other hand, have less cost and provide more job opportunities but they are often "poorly designed and managed and impose health and accident threats to workers [which in turn] making such jobs hazardous and in most cases also low paid" (Fenech 2002, 3).

Treatment and disposal methods are classified into three families—biological treatment, thermal treatment, and landfill. Each method has different need in sorting and pre-treatment procedures. If a designed treatment and disposal component(s) is not compatible with other upstream components such as sorting and collection arrangements, it is subject to a failure. For aerobic and anaerobic processes, the moisture contents are critical. "The water content for aerobic composting needs to be over 40%, otherwise the rate of decomposition will start to fall" (White, Franke, and Hindle 1995, 203) and that for anaerobic processing is even higher. On the other hand, MSW with moisture content below 40% and a calorific value over 800 kcal/kg is suitable for incineration (DOPC 2005a, 32-33). Getting the right volatile solid and ash content are also important in thermal treatment. Although landfill can take up all waste, some pre-treatment processes such as compaction and separation of cetain materials such as tires are still preferable.

2.2.3 System Environment

The environment of a MSWM system can be very decisive on the outcomes of the system. Wilson, McDougall, and Willmore (2001, 331) provide a comprehensive list of factors that influence the MSW decision-making process, as shown in table 2-2.

Policy, management and institutional structure. Institute for Local Government Initiatives (ILGI, 2005) finds that political institution, i.e. the rule of political game, has implications on both the emergence and the approach of local initiatives in the area of waste management in Thailand. Only 3 cases emerged in competitive or monopolistic polities while the other 35 cases emerged in club (cooperative) polities (ILGI 2005, 165). A club politics is also a favourable soil for upstream initiatives—recycling programme and/or home composting schemes. On the other hand, all polities with high competition had initiatives to improve their landfill sites (ILGI 2005, 166).

Political stability is another important factor. Changes in government might bring about changes in MSWM policy that reflect "political gesture" more than "an effort to optimise the waste management system" (Wilson, McDougall, and Willmore 2001, 337). It is reported that the new administration of the Rayong Urban Municipality plays down a successful biogasification project inheriting from the rival previous administration (Sombat 2005). On the other hand, strong administration with popular support can lead to a successful story as in the case of the Phisanulok Urban Municipality (Sombat 2005). Stability is even more critical for a long term strategy and large-scale infrastructure investments (Wilson, McDougall, and Willmore 2001, 337).

How the waste manager perceive him/herself can be very critical to the system. Hogg *et al.* (2002, 2) criticise that technocratic approaches of the waste management in the United Kingdom, which focus almost solely on 'the real business' of collection and disposal, in the past hamper a development of sustainable waste management. At the other end of the spectrum, Wilson, McDougall, and Willmore (2001) report a semantic shift that some waste managers in cutting edge European cities call themselves 'material resource managers' or 'integrated waste managers.'

At managerial level, Fishbein and Gelb (1992, 40) argue that the most effective administrative structure for source reduction is that which is independent from and has equal authority to other waste management functions such as recycling and disposal units. Conflict of interest between each function is the rationale behind this separation.

Table 2-2 Factors that influence the MSW decision-making process

Policy, management and institutional structure	• Local and regional politics and planning—strategy, stability and vision • Societal support: public participation in the decision making process • Political support—NIMTOF (not in My Term of Office) • Form of government • Institutional and administrative structure for MSWM • Managerial capacity and personnel stability • Regulations and site specifications
Operational demands/constraints	• Critical mass (scale) • Infrastructure and waste disposal security • Existing contracts and obligations • Location and demography • Waste stream composition and change • Available technology versus proven technology—linked closely with cost
Economic and financial factors	• Available funding/subsidies • Costs of current system and other options • BATNEEC (Best Available Technology Not Entailing Excessive Cost) • CATNEP (Cheapest Available Technology Narrowly Avoiding Prosecution) • Local and regional budget limitations • Economic tools employed influencing the cost of waste management • Pricing system for waste services • Secondary materials markets
Legislation	• Prescriptive or enabling legislation (i.e. mandated targets) • International, national, regional, and municipal legislation • Definition of municipal solid waste
Social considerations	• Public opinion and support of waste management in region • Public participation in the decision-making process • Public ability to participate in IWM system (composting and recycling activities, etc.) • Noise pollution, local pollution, increased vehicle and road traffic • Public resistance—NIMBY (Not in My Backyard), LULU (Locally Unacceptable Land Use)

Source: (Wilson, McDougall, and Willmore 2001, 331)

Operational demands/constraints. These factors shape the technical environment of the system. As mentioned before, waste generation inescapably affects treatment and disposal options. A mismatch between two can lead to system failure or inefficiency. In the case of

Rayong Urban Municipality, for example, the municipality finds it is very difficult to fully exploit the capacity of a 60-tonne/day biogasification plant with its 15 tonnes of biodegradable waste per day (Sombat 2005). Existing infrastructure, contracts, and obligations must be taken into consideration in order to ensure "the complete use of capacities and resources in the process of waste management" (Abo Sena 2004, 7). There is also a trend of moving upward from local to regional waste management to take advantage of economies of scale.

Some EPR schemes in Europe lead to the opposite direction, i.e. they hand control over certain waste streams, often valuable ones, from municipalities to producers. Some commentators criticise that these schemes kill flexibility and efficiency of the MSWM system (White, Franke, and Hindle 1995, 11; Wilson, McDougall, and Willmore 2001, 338). However, this is depended on how an EPR scheme is designed to allocate physical responsibilities.

Economic and financial factors. Funding availability is of paramount importance especially for a system in need of overhauling. There is an 'initial peak' of investment and short-term costs that needs to be overcome (Wilson, McDougall, and Willmore 2001, 339). Kiss (2005, 11) mentioned an economic assistance from EU as a key enabler for Hungary to compliance with the Council Directive 1999/31/EC.

Financial factors are also important for an operation of a MSWM system. Economic reason was behind the discontinuation of recycling programmes for glass and plastics in the New York City in 2003 (New York City Independent Budget Office 2004, 5). In 2002, the City had to pay the recyclers to receive mixed metal, glass and plastics at the average cost of 59 USD per tonne.

Shifting financial from the municipality (and tax payers) to the producer (and consumers) can ease this transitional period. Lindhqvist (2000, 155), for example, argues that: "contrary to the traditional ways of financing [waste-management] activities, EPR provides a means of not raising taxes and municipal charges."

Legislation. Wilson, McDougall, and Willmore (2001, 340) identify two types of legislation: enabling and prescriptive. Enabling legislations are those that enhance the managerial flexibility of the system. These legislations normally set the goal(s) or a specific condition(s), e.g. landfill tax, without prescribe a means to achieve it. On the other hand, prescriptive legislations mandate also a means regardless of local circumstances. Those based on an interpretation of the waste management hierarchy as the strict prioritisation are examples of prescriptive legislations.

Social consideration. Public resistance toward the construction of treatment and disposal facility can be a major obstacle in the system. For example, Chiang Mai Urban Municipality is now paralysed due to strong local opposition to any kind of treatment and disposal facility (Sombat 2005). However, NIMBY attitude can also positively stimulate change. At Halifax County, Nova Scotia, Canada, initial opposition against a construction of an incinerator turned into a cooperation in a system to achieve 65% diversion based on source separation (Goldstein and Gray 1999). There a group of citizens formed a Community Stakeholder Committee which participated constructively to solve the waste problem. A final system included source separation, new established collection zones, aerated carts for organics collection, an expanded MRF, a stabilising facility, two separate composting facilities, and a landfill for stabilised waste. Therefore, even though NIMBY seems to be inescapably, it does not necessary come with a lack of public support to a MSWM system. The key point is how to

decouple the two. Wilson, McDougall, and Willmore (2001, 341) detects a trend toward a more pro-active public participation in the planning process.

ILGI (2005, 165) finds a relationship between a degree of public participation and a type of local initiatives. Continuous public participation was necessary for upstream initiatives. Success of initiatives on efficiency of collection system was also hinged on public participation in the beginning but at a lesser extent. No public participation process observed in downstream initiatives except in the case of locating new treatment or disposal facility to overcome NIMBY attitude.

3 Municipal Solid Waste Management in the City

3.1 Bangkok in Brief

3.1.1 The city and the people

Bangkok is located on the delta of the Chao Phraya River, as shown in figure 3-1. The area is a low-flat plain with a rather hot and humid climate. The average temperature is around 30 °C with the highest at 40 °C and the lowest at 10 °C (MD 2005).

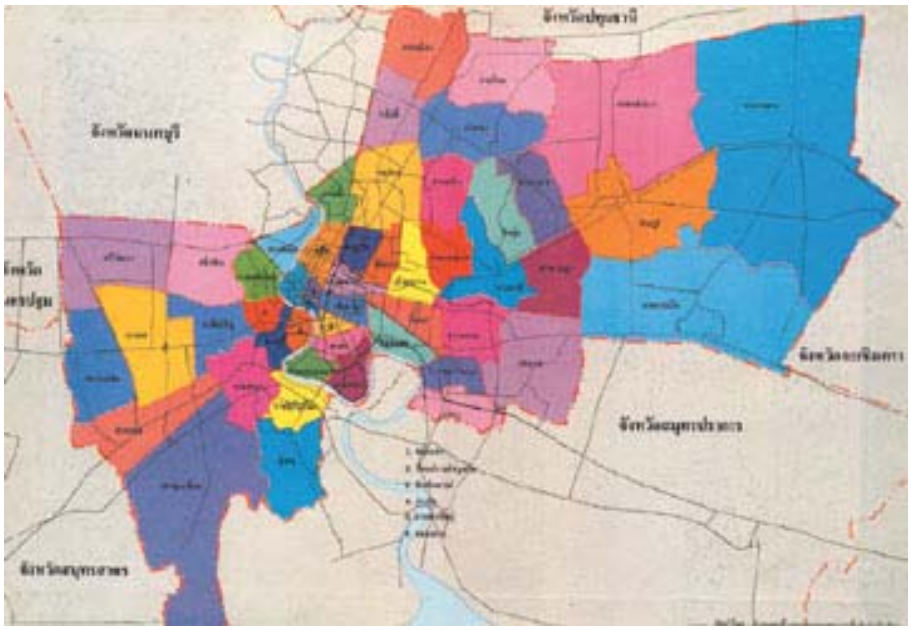

Figure 3-1 Bangkok

Source: (DOPC 2003a, 8)

Bangkok is the capital of the Kingdom of Thailand. In 1782, King Rama I moved the Royal Palace from the west bank of the Chao Phraya River, the area called 'Thonburi,' to the east bank, the area called 'Bangkok'.[7] In the beginning, the total area within the city wall was 3.46 km^2. The city, later, expanded to cover both sides of the river and now has the total area of 1 568.737 km^2. Bangkok is not only the capital but also the centre of the country. Table 3-1 reflects this through an high number of establishments in the city.

A Census made by the National Statistical Office (NSO) shows that there were 5.9 million people and 6.4 million people lived in Bangkok in 1990 and 2000 respectively (NSO 2005a). However, it is estimated that the number of unregistered populations not included in the Census can be in a range of 3 to 5 millions depending on economic conditions. The Department of Public Cleansing (DOPC 2005b, 19), for example, reported that in 2004 its service covered 9.1 million people, which was well over the registered populations reported at 5.9 million people. On the other hand, when the economy crashed in 1997, there were millions of people fled back to their homes in the country.

[7] Though it was renamed in Thai into 'Krung Thep Mahanakorn' (means the City of Angles), Bangkok is used in English.

Table 3-1 Number of industrial, commercial, educational, medical, and religious establishments in Bangkok

Type of establishment	Number
Factory[1]	19 899
School[2]	1 068
University & college[2]	79
Department store[2]	123
Mini mart[2]	694
Market[2]	146
Hotel[2]	225
Bank[2]	686
Public health centre[2]	261
Religious place[2]	535

[1] *Source: (DOPC 2004b, 38)*

[2] *Source: (DOPC 2005d)*

NSO reported that there were 1.7 million households in Bangkok in 2000 (NSO 2005a). Most of them were private households with the average populations per household of 3.6. Table 3-2 shows different types of private households in Bangkok in 2003. Almost 40% of households had accommodation with limited space, i.e. row house, brick row house, room, mobile, and others. In many high-rise buildings, there is a parachute where people can throw away their MSW to the storage room.

Table 3-2 Private households by type of living quarters in 2003

Type of living quarters	Households	Per cent
Detached house	561 154	32.2
Town house	217 903	12.5
Apartment, flat, condominium and others	277 753	16.0
Row house	222 991	12.8
Brick row house	339 115	19.5
Room	42 109	2.4
Mobile	2 462	0.1
Others including office room	76 537	4.4
Total	1 740 024	100.0

Source: adapted from (NSO 2005a)

Households in Bangkok are very individualistic. They have little or no interrelation with their neighbours. Nevertheless, in 2004, there were almost 1 800 registered communities in

Bangkok, as shown in table 3-3. In addition, there were a few neighbourhoods which could otherwise be classified as community but failed to register.

Table 3-3 Registered communities by type in December 2004

Type of communities	N	Populations	Households	Houses
National Housing Authority's flat	87	137 298	38 512	37 862
Housing estate	304	373 371	91 881	85 201
Suburban community	374	226 344	50 414	44 724
Urban community	199	181 070	51 972	38 788
Slum	817	784 653	188 949	134 528
Total	1 781	1 702 736	421 728	341 103

Source: (DOSD 2005)

3.1.2 Bangkok Metropolitan Administration

Bangkok Metropolitan Administration (BMA) is a local government responsible for the administration of Bangkok. It was established by the National Executive Council Order Number 335 in 1972 which merged the Metropolitan City Municipality and Sanitation Administration into Bangkok Metropolitan Administration (BMA 2005). Herein, different aspects of BMA will be described in relation with the municipal solid waste management (MSWM).

According to the Public Health Act 1992, each local government is responsible and has the authority over MSWM in its own jurisdiction (article 18). The Bangkok Metropolitan Administration Act 1985 transposes this stipulation in its article 89. With the authority given in the two laws, BMA can impose regulations on the details of MSWM, including, *inter alia*, the waste collection fee and the practices of actors in a MSWM system.

There are two institutional frameworks for BMA's MSWM. One is bureaucratic and the other is political. The bureaucratic framework comes from the Central Government in a form of a development plan. BMA, as other provincial administrations, operates under a supervision of the central government, the Royal Thai Government. BMA is obliged to propose a five-year development plan in accordance to the National Economic and Social Development Plan and other plans and policies at a national level. The Department of Policy and Planning (DOPP), BMA, is responsible for developing a development plan for Bangkok, called the Bangkok Development Plan. The Management of Waste, Nightsoil and Hazardous Waste Programme is an element in the Environmental Section of the Plan.

The second set of institutional framework is the Governor's four-year Policy. Bangkok is the only province in Thailand of which the Governor comes from a general election. The Governor Policy is important because it is his/her social contract to electorates. However, the timeframe of the political institution is not completely correspondent with that of the bureaucratic institution. The Bangkok Development Plan by its nature covers at least two political terms.

Figure 3-2 shows an organisational chart of BMA with a special emphasis on DOPC. BMA has a divisionalised arrangement (Mintzberg 1979). On the top of the pyramid, there is the

Governor and the Council. Both come from a general election and are in the office for four years. Under the Governor, there is the Permanent Secretary as a head of all BMA officials. Then, at the middle level of the organisation, 50 district offices with similar departmentation are coupled with headquarter. The district offices, each with its appointed director and an elected council, are the main service-providers in their own districts.

In term of horizontal differentiation, there are 14 departments. The departments are specialised units in certain functional areas. DOPC is one of the 14 departments responsible for "planning, controlling, and operating cleansing and disposal of waste and nightsoil and providing and maintenance mobile and temporary toilets" (DOPC 2003a, 10). The department also coordinates MSW collection done by the 50 districts.

The degrees of fomalisation and centralisation in the organisation are rather high. Most of its works are routinised and strictly follow the bureaucratic procedures. This results in inflexibility. The decisions, if not routinely done, will be passed to high levels. However, there are two exceptions to this general pattern. First, at a very high level, the Governor with a popular support can exert his/her innovations. Second, rules of thumb seem to dominate at the operational level, for example, in waste collection which will be described below.

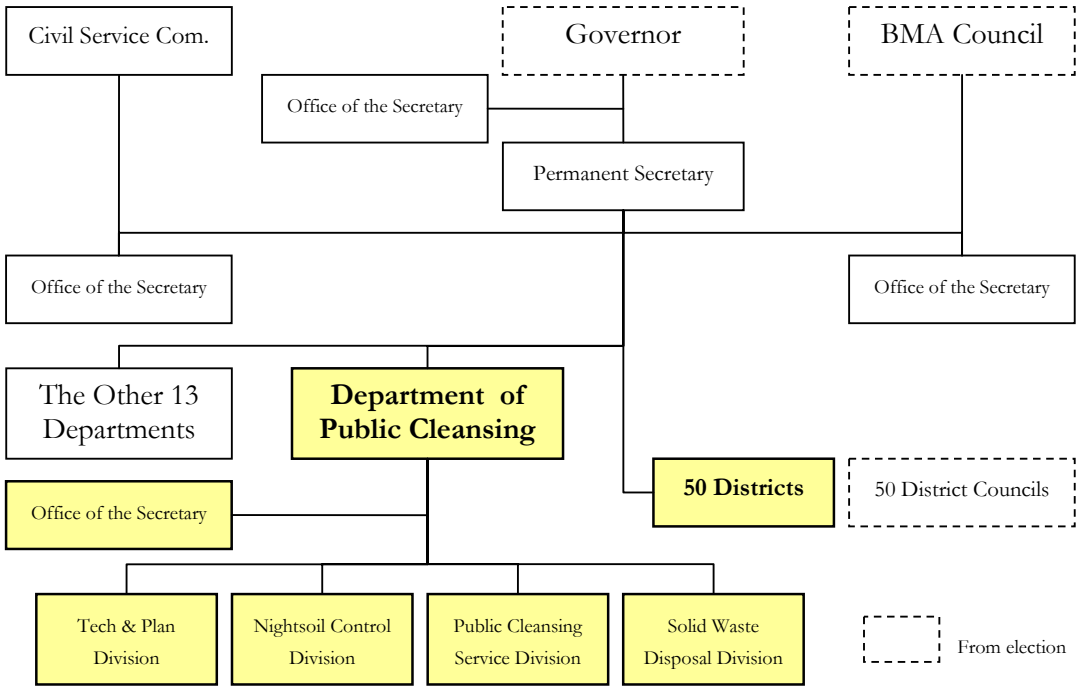

Figure 3-2 BMA's organisational chart

Source: adapt from (DOPC 2003a, 4)

BMA is the biggest local government in Thailand in term of the budget. Its budget falls in a range of 20 – 30 billion baths (500 – 750 million USD). Figure 3-3 gives an overview of the expenditures by sections. The budget allocated to environmental section is normally the most among 7 sections. And public cleansing normally accounts about a half of this amount. The top three sources of revenue of the city are value-added tax (40%), house and land tax (20%),

and vehicle tax and fee (15%). Normally, the city has a good fiscal discipline. For example, in 2005 it has a balanced budget.

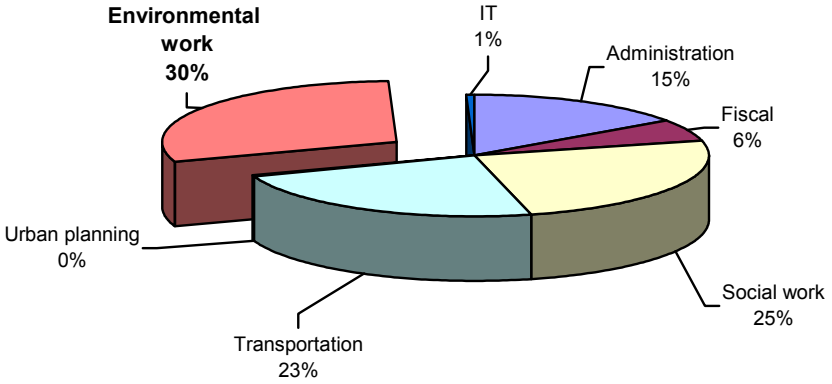

Figure 3-3 BMA expenditures by sections

Source: adapted from (Depart of Budget Bureau 2005)

3.2 Waste Situation before 1997

MSWM in Bangkok is under the control of BMA. Traditionally, the municipality put a lot of emphasis on supply side management (SSM), i.e. the management after households disposed their MSW. The decision on source reduction was totally left to households without any intervention from BMA. Anyway, some households did separate some saleable recyclables such as corrugated boxes, newspaper, refillable glass bottles, metal cans, wires and certain types of plastics and sold them to sa lengs (see Box 2-1 and pictures in Appendix A.1.3). It was estimated that 1 100 tonnes/day of MSW were diverted from BMA's responsibility through this activity (DOPC 1998, 73). However, sa lengs could not enter some residential areas due to security reasons. To some people, sa lengs were just another form of thieves.

In general, there was no source separation for BMA collection. BMA placed two kinds of waste bins, yellow bins for "*ขยะแห้ง*" [dry waste] and green bins for "*ขยะเปียก*" [wet waste], in many communities and public places. However, households rarely did the separation. The definitions of dry and wet waste, if exist, were confusing. In addition, due to under coverage collection, once one bin started to full, everything went to the other.

BMA provided two types of collection. In *direct collection*, BMA collectors picked up MSW on a door-to-door basis. In *indirect collection*, MSW was put in BMA's waste bins and later collected by BMA. Routing was done through a rule of thumb. The collection day and time was irregular. To make people know about their arrival and bring their waste for collection, the trucks rang the bell. However, this was considered annoying because the collection trucks normally operated either very late at night or very early to avoid traffic in rush hours.

Box 2-1 The private waste collection business

The private waste collection business is important to a waste management system in Thailand. The business collects and sells saleable recyclables to reprocessors. The business by its nature is informal and very complex. This box, derived from direct experience in the study, provides only some rudimentary understanding about the business necessary to the study.

There are many actors in the business. In general, these actors can be grouped into two categories according to their main activity: mobile waste collectors and stationary waste collectors or waste agents. Within the first category, there are those who roam a city to collect saleable recyclables either by buying them from households or scavenging them from waste bins for free. Actors in this group can be further specified by their means of traveling. The most well-known are those traveling by their tricycle—called "sa-lengs." Wealthier mobile waste collectors use pick-up truck and poorer ones, who can be rightly called scavengers, rely on their feet. Different means of traveling mean different carrying capacity; and, a general rule is that the bigger is the better. BMA's collectors when they sort out saleable recyclables from mixed MSW can also be viewed as mobile waste collectors whose operating cost borne on BMA.

Stationary waste collectors are called waste agents. They open a shop to buy discarded products and saleable recyclables. They, later, sell their "goods" to secondary markets, or reprocessors. Waste agents are different in scope and size. Though most are multi-material agents, single-material agents can also be found. Size also varies from a small shop with 2 workers to a multi-million business with a hundred of employees.

Mobile waste collectors and waste agents are unequally interdependent on each other in its traditional arrangement of the business. Mobile waste collectors sell their collected waste to waste agents who they have close relationship. The relationship is an unequal one because a waste agent normally has a number of mobile waste collectors under his/her control.

It is worth noting that traditionally there seems to be a career path in the business. A scavenger's dream is to own a tricycle, i.e. becoming a sa-leng whose dream is to own a pick-up truck. Waste agents are on the top of the path. However, horizontal entry is possible from every point provided that enough capital is available.

Most collection of mixed MSW is done by a 5-tonne rear end loader truck. The truck operated by a team of 5 crews: 1 driver and 4 collectors. The collectors did not only perform collecting, but they also sorted some saleable recyclables from mixed MSW, sometimes with bare hands. It was estimated that they recovered around 400 tonnes of recyclables per day. The practice, however, is considered undesirable. Table 3-4 shows the result from a time and motion study done in 1999. In order to separate recyclables weighted around 3% of the total waste collected, the crews spent 47.8% of their combined collection time: 29% in sorting and 18.8% in waiting (COWI-EP&T Associates 2000, 3-3 - 3-5). In addition, the truck had to stop by a waste agent's shop to sell these recyclables. This could hardly be considered an efficient collection. This inefficiency led to two problems. First, there was a problem of uncollected MSW. Though this problem was much less severe in Bangkok than in other provinces, it was very politically sensitive. The second problem was the presence of a collection truck on the street in the rush hours which worsened the city's horrible traffic jam.

Table 3-4 Operating time of BMA collection truck by activities

Activity	Time (%)
Time used in collection: • Moving between collection points • Collecting wastes • Loading wastes into the truck • Waiting for others • Sorting wastes for recyclables • Cleansing the areas • Others	59.6 19.2 (11.4) 15.1 (9.0) 9.2 (5.5) 18.8 (11.2) 29.0 (17.3) 8.3 (4.9) 0.4 (0.2)
Time used outside the route	20.0
Time used in other activities (unload waste at transfer station, clean the truck, stop by a waste agent's shop to sell sorted recyclables, have breakfast)	20.4

Source: (COWI-EP&T Associates 2000, 3-3 - 3-5)

Then collected MSW was sent to three transfer stations: Tha Raeng solid waste transfer station (TS 1), Nong Khaem solid waste disposal and nightsoil treatment plants (TS 2), and On-Nuch solid waste and nightsoil treatment (TS 3). In 1997, the three transfer stations received in average 8 700 tonnes of mixed MSW everyday. This more than doubled from the average figure in 1987 at 4 200 tonne/day, as shown in figure 3-4. Based on NSO's statistics on population, MSW per capita also doubled from 0.7 to 1.4 kg/person/day during this period. An expert from the Japan International Cooperation Agency (JICA) made an estimation in 1982 that if this trend continued, this would amount to 14 000 tonne/day by 2007 (DOPC 2005a, 27).

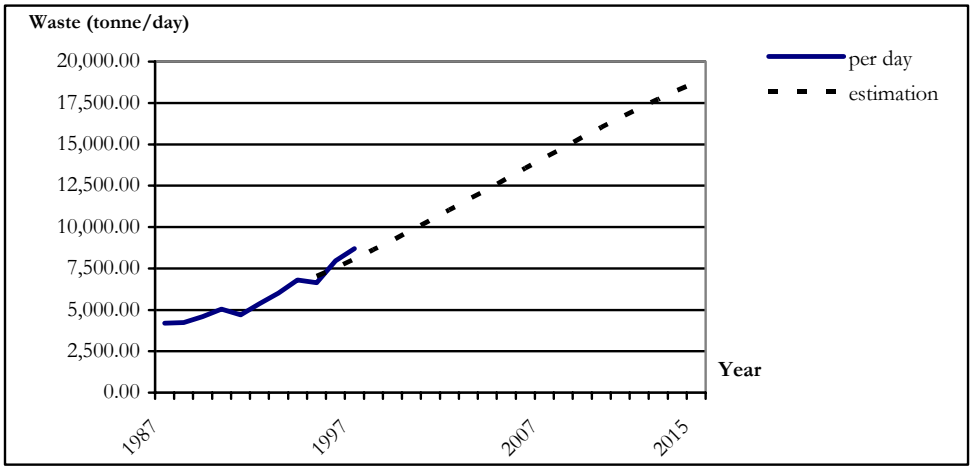

Figure 3-4 Quantity of MSW between 1985 and 1997 and an estimation between 1995 and 2015

Source: (DOPC 1998)

At that time, BMA had two options in MSW treatment and disposal. First, there was a composting plant at TS 3. The plant had a capacity of 1 000 tonne/day of MSW intake which

subsequently turned into 300 tonnes of compost and 700 tonnes of residuals (DOPC 1998, 31). Second, BMA made contracts with private landfill operators to landfill mixed MSW from each transfer station at least 1 500 tonne/day. One landfill site was located in Lat Krabang District, Bangkok. This site, however, was almost exhausted. The other site with more capacity was located in Kampaengsaen District, Nakhon Pathom. When compared the amount of mixed MSW under its responsibility, i.e. 8 700 tonne/day, with its treatment and disposal capacity, i.e. 300 tonne/day of compost and another 4 500 tonne/day of committed landfill, BMA faced unbalanced situation. Though these contractors always took more MSW than the minimum requirement, this could, in turn, jeopardised future landfill capacity in the long run.

Moreover, landfill mixed MSW was environmentally unsound. This was even the case with the modified landfill sites, i.e. no daily cover, no liner, and no properly operated leachate collection system and landfill gas collection system. The composition of MSW in 1997, as shown in figure 3-5, revealed that there were a lot of materials that could otherwise be recovered through recycling. Glass, metals, paper, and plastics constituted 34% of this MSW which destined to be landfilled. Another 58% was other biodegradable waste such as food residuals and yard waste. This fraction could be (and a part of it was) composted to get useful products. Last but not least, there was no separation of HHW such as batteries, fluorescent lambs, spray cans, pesticide containers, etc. from MSW. Although the quantity of HHW was relatively small, estimated at 0.29% of MSW, it could pose more and severer health and environmental problems than the entire MSW.

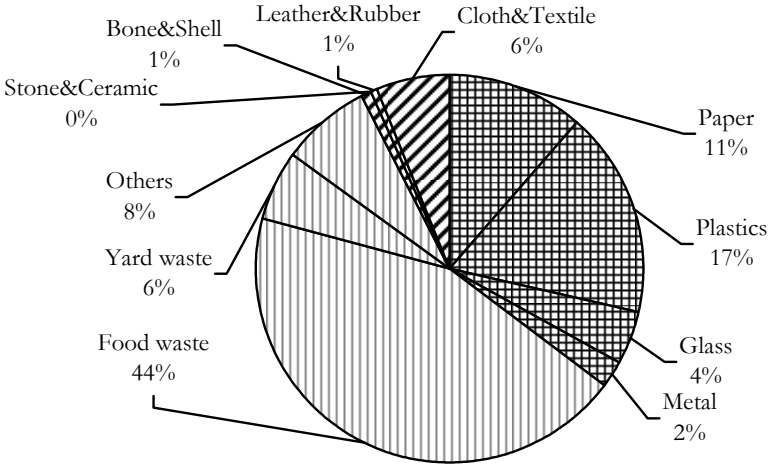

Figure 3-5 Composition of MSW in 1997

Source: (DOPC 2004b, 53)

There was also a financial problem related to MSWM. In 1997, BMA spent almost 3 000 million baths (75 million USD) on public cleansing function, including the management of MSW, HHW, infectious waste, and nightsoil, and street cleansing. About 60% of this amount was an *operating* cost of MSW collection and disposal. The total direct cost per tonne in 1997 was 545 baths (13.6 USD). On the other hand, BMA could collect only 57 million baths (1.425 million USD) as a waste collection fee from 35% of total households, equal to 19 baths (0.475 USD) per tonne. In other word, for every tonne of MSW entering its responsibility BMA gave a subsidy of 526 baths (13.15 USD) from its general revenue. Since there were 3 040 000

tonnes of MSW in 1997, this subsidy amounted to 1 600 million baths (40 million USD)! NSO (2004, 2) notes that there is a trade-off between the budget of public cleansing and that of economic and social development.

In addition, the presence of saleable recyclables in mixed MSW led to un-designed sorting activity of BMA's collectors. But, since BMA paid for the operating of collection trucks, the cost of this activity was borne on BMA. In 1997, this hidden subsidy amounted to, at least, 400 million baths (10 million USD)! If BMA's collectors sorted out 400 tonnes of recyclables a day, the direct collection cost per tonne of these recyclables was as high as 2 600 baths (65 USD).

Against this circumstance, WMP emerged as an element of the 5th Bangkok Development Plan (1997-2001). It tried to reverse this problematic trend through demand side management (DSM), i.e. it promoted source reduction and source separation.

3.3 Waste Minimisation Project

3.3.1 Background

Before talking about WMP, this section begins with a description of the 5th Bangkok Development Plan and the Governor's Policy between 1997 and 2001. These sets of policies served as an institutional background of the project.

The 5th Bangkok Development Plan. DOPP developed the 5th Bangkok Development Plan in accordance with (1) the 8th National Economic and Social Development Plan (1997-2001), (2) the 6th Ministry of Interior Plan (1997-2001), (3) the Governor's Policy, (4) an evaluation of the 4th Bangkok Development Plan (1992-1996), (5) suggestions from BMA's agencies, and (6) public opinion (DOPP 1997, 4). There were three occasions that people could participate in decision-making process. First, DOPP conducted a survey about public opinion on a development of Bangkok. Second, there were seminars, "Liveable District," held in all 50 districts on 31 March 1996. Finally, DOPP held a public referendum on 13 September 1996 to gain public acceptance of the proposed plan.

There are three main objectives in the 5th Bangkok Development Plan (DOPP 1997, 17):

1. To stimulate systemic growth of the city;
2. To enhance quality of life and the environment in Bangkok to make it "liveable city";
3. To improve accessibility to public services, especially among marginalised groups.

The plan was further divided into 6 sections. MSWM was a part of the Management of Waste, Nightsoil and Hazardous Waste Programme in the Environmental Section. The programme mentioned problems related to MSWM as the followed (DOPP 1997, 73):

> "The operation in the past did not achieve its objectives. There was a lack of public cooperation in source reduction and separation due to inefficient and inconsistent promotion. In addition, the collection of MSW both on land and on water was inefficient. On the other hand, the revenue from the waste collection fee was too low and BMA had to spend a lot from general revenue in MSWM. Finally, the disposal of MSW was also inefficient. Though BMA had contracts with private landfill operators, proper site with less local opposition was scare and expensive."

Therefore, three objectives were set in the programme to solve these problems (DOPP 1997, 73-74):

1. To enhance the efficiency and coverage of the collection and disposal of MSW;
2. To reduce the amount of MSW through source reduction and source separation; and,
3. To collect and dispose infectious waste and HHW in a sanitary way.

Table 3-5 presents selected goals and measures in the Management of Waste, Nightsoil and Hazardous Waste Programme related to MSWM. WMP was a project in the waste reduction area.

Table 3-5 MSWM Goals in the 5th Bangkok Development Plan

Area	Goal	Measures
• Waste Reduction	• People have public awareness of waste generation • MSW per capita (after source reduction and source separation) is not exceed 1 kg/person/day • 20% of the total HHW generated is separated • Recovered recyclables is not less than 20% of the total MSW generated	• Public campaign through all media to disseminate information to people • Construct a MRF (1 000 tonne/day) • Educate people on environmental and health effects of HHW • Encourage private business to take a part in recycling campaign
• Waste Collection	• The collection of waste is efficient and has public cooperation • Problems of uncollected waste and open dumping are eliminated	• Increase the number of collection truck • Increase the number of waste bins in communities for separated wastes • Establish a separated collection for HHW, including separated containers, and trucks • Encourage private business to take part in waste collection • Improve wage and fringe benefit of BMA's employees
• Waste Disposal	• BMA has state-of-the-art disposal technologies, e.g. incineration, biological treatment	• Introduce state-of-the-art disposal technologies o Construction of Incinerator at TS 2 and TS 3 (1 000 tonne/day) o Construction of Composting Plant at TS 2 (1 000 tonne/day)
• Managerial Support	• 80% of households in Bangkok pay the waste collection fee	• Improve the collection system for the waste collection fee • Establish local groups to support districts' activities • Encourage private business to take

Area	Goal	Measures
		part in MSWM by paying reasonable prices • Prepare land for being a sanitary landfill in the future • Study feasibility of long-range transportation for disposal in far degraded conservation forest

Source: (DOPP 1997, 74-79)

The second set of institutional framework is the Governor's four-year Policy. The timeframe of the 5th Bangkok Development Plan began in Mr. Pijit Ratanakul's term (1996-2000) and continued to Mr. Samak Suntoravej's term (2001-2004). The 1996 administration had the following policy on MSWM (DOPP 1997, 8):

> "Collect-sort-disposal: Modernise and enhance the efficiency of collection, sorting, and disposal systems to handle waste on a daily basis and introduce incineration with energy recovery."

The 2001 administration led by the former conservative MP, Mr. Samak Suntoravej, had the following policies based on a command-and-control and techno-centric approach (DOPC 2002, 6-7):

1. *Policy on uncollected waste*. BMA would cease the problem of uncollected waste by increasing its efficiency in waste collection;

2. *Policy on the wage of BMA waste collectors*. BMA's collectors must stop sorting waste during working time and BMA would increase their wage as a compensation of the lost income;

3. *Policy on appointed waste collection*. BMA would set collection frequency, time, and point of different types of waste;

4. *Policy on the waste collection fee*. BMA would increase the coverage and the amount of the waste collection fee collected from households. BMA would use the increased to compensate its waste collectors in accordance with the second policy; and,

5. *Policy on introducing state of the art disposal technologies*. BMA would introduce state of the art disposal technologies, e.g. biotechnology, an integrated disposal system, to increase the efficiency in waste disposal with the highest regard to the environment.

3.3.2 Rationale

BMA saw source reduction and separation as a way to enhance the efficiency of the management of MSW. Four benefits were expected from WMP (DOPC 1998, 83):

1. Reduction in MSW generation;

2. Households sort MSW in accordance to the designed system;

3. Increase in efficiency of the MSWM system; and,

4. Cost saving in the management, collection, and disposal of MSW.

3.3.3 Objective

WMP has three objectives (DOPC 2000b, 2):

1. To change people's attitude and stimulate public cooperation in separation of recyclables;

2. To minimise MSW disposal and subsequently environmental impacts; and,

3. To promote resources conservation and sustainable development.

3.3.4 System design

This part describes how a MSWM system was designed to incorporate source reduction and source separation. Figure 3-6 depicts an overview of the designed system derived from WMP and the Medium Term Disposal Plan (1997-2006). However, as the story will be unfold, not every planned component described in this part have been materialised.

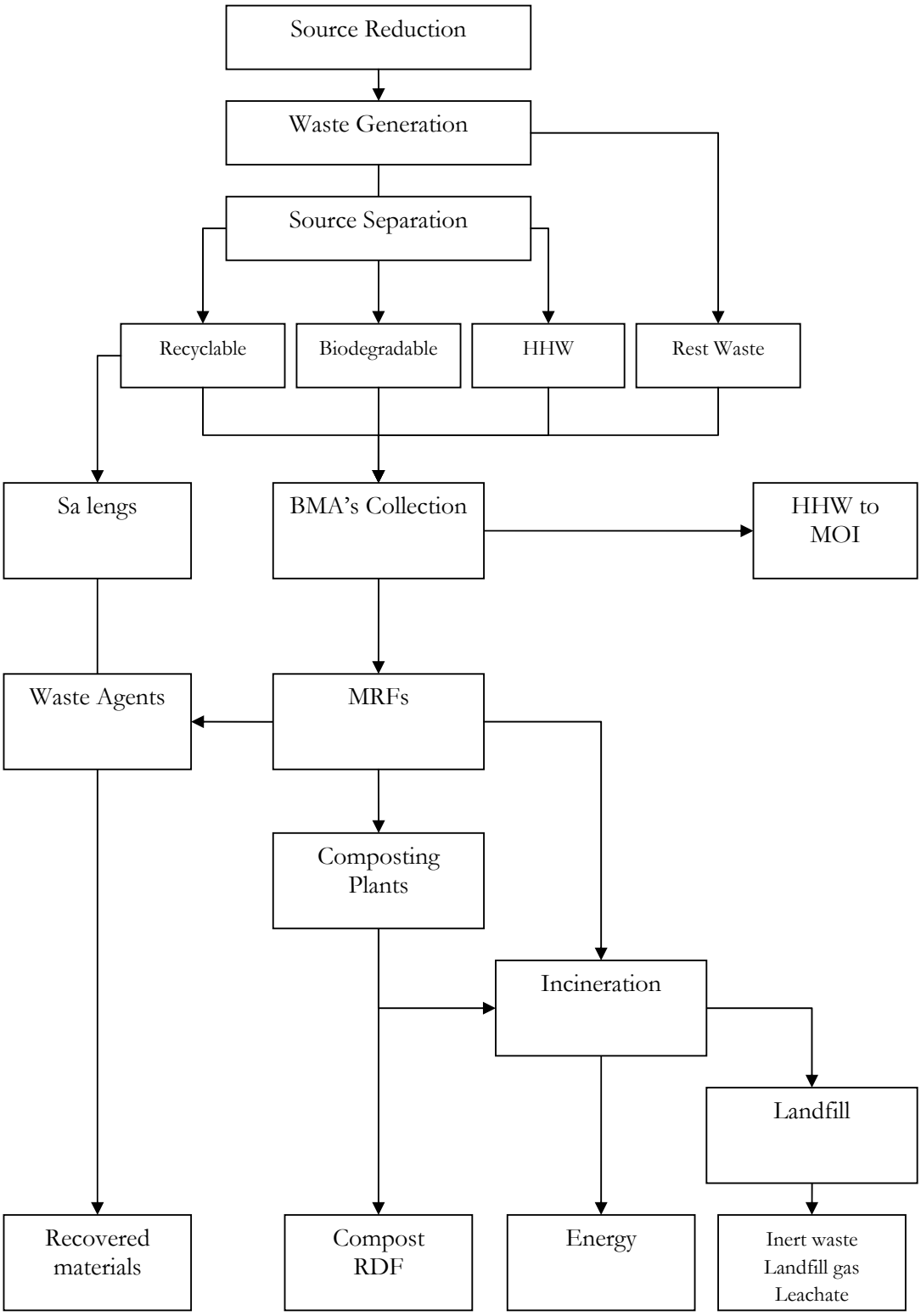

Figure 3-6 The designed system in the Middle Term Disposal Plan (1997-2006)

Source: adapted from (DOPC 2000b, 12; DOPC 1999, 199)

The system begins with an estimation of MSW generation in 2006. The aforementioned JICA estimation of 13 550 tonne/day was used. Then, through source reduction and source separation for other sectors 20% of this amount will be diverted from BMA's responsibility. There are three main actors in this activity. The first actor is households. Households are expected to practice 4Rs: reduce, reuse, recycle and repair. The second actor is sa lengs. These people are seen as an important component in recycling process because they roam the city to buy separated recyclables from households. In the designed system, they will, in 2006, handle 2 710 tonnes more of recyclables per day if the project succeed. The third actors are waste agents. They bridge the suppliers of secondary materials, i.e. households, and the reprocessors. Waste agents come into picture as a buyer of collected recyclables from sa lengs.

BMA compared four options of source separation for its own collection, as shown in table 3-6. It is worth noting that this comparison was done without any consideration to subsequent collection system. This fact later reflected on incompatibility between chosen separation option and the collection system in operation.

Table 3-6 BMA comparison of separation options

Option	Advantage	Disadvantage
Detailed Separation: separate as much as possible	• Very high quality recovered materials	• High transportation • Need many separated containers
Four-can system: recyclable, biodegradable, HHW, and rest waste	• High quality recovered materials	• Need many separated containers
Three-can system: recyclable, biodegradable, and HHW	• Easy to valorise biodegradable and dispose HHW	• Recovered recyclables still mix up
Two-can system: recyclable and biodegradable	• Easy to valorise biodegradable	• Confusion about the definitions

Source: (DOPC 2005b, 42)

BMA decided to change from the two-can to the four-can system. Different colours are assigned to different fractions of MSW and HHW, as shown in figure 3-7. Recyclables, unless sold to sa lengs, should be put in yellow bags or BMA's yellow bins. Biodegradable waste should be put in black bags or BMA's green bins. HHW should be put in orange bags or BMA's bins with a red lid. Rest waste should be put in BMA's blue bins.

Figure 3-7 BMA waste bins

Source: (DOPC 2003a, 33)

Then, collected waste would enter two MRFs, planned to build at TS 2 and TS 3. Approximately 400 tonnes of recyclables would daily be recovered from this central sorting. A part of collected biodegradable waste enters (aerobic) composting process. BMA planned to build one more central composting plant at TS 2 in addition to the plant at TS 3. Each has a capacity of 1 000 tonnes of intake per day. The process was expected to produce 600 tonnes of soil conditioner and 1 400 tonnes of residual. Some 5 400 tonnes of waste and residuals from different processes would be burnt daily to recover their calorific content in incinerators planned to be built at all transfer stations. A fraction of residual ash from incineration will be used in concrete production. The rest will end up in landfill.

Figure 3-8 summarise the designed system by waste management options. Together, BMA expected to reach 80% waste reduction/landfill diversion in 2006 from a projected increase made in 1982, i.e. equal to 68% reduction if the 1997 is used as a baseline.

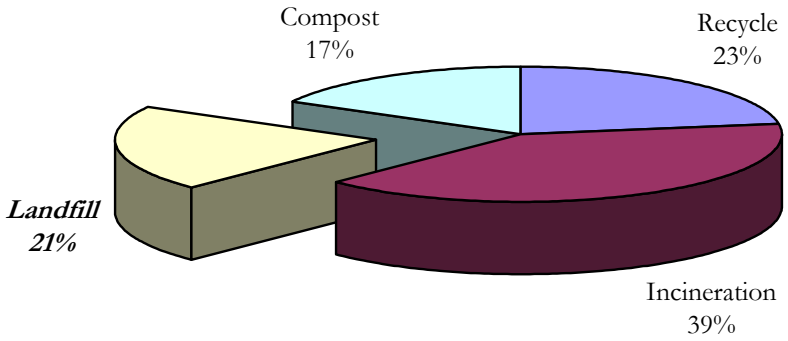

Figure 3-8 Designed system by waste management options

Source: adapted from (DOPC 1999, 199)

3.3.5 Implementation

WMP started in 1997. At the beginning, it targeted at the public at large. BMA conducted many campaigns through various mass media to promote source reduction and source separation. This continued in the following years. For example, in 1999, campaigns were worth 18 760 000 baths (469 000 USD), 10 million baths from DOPC's budget and the rest from Thai Petroleum Co. Ltd. (see detail of the 1999 campaigns in Appendix C).

The content of these campaigns generally focused on five issues. First, they informed people that wastes should be divided into *three* fractions: recyclable, biodegradable, and hazardous waste. Second, they told people about different colour bins or bags assigned for different fractions. Third, they stressed risks related to HHW. Forth, they informed a benefit of source reduction and source separation in term of budget saving. Finally, they showed how separation relates to waste treatment and disposal.

In 1998, there was a sub project of WMP. This time BMA concentrated on source reduction and source separation in 14 target groups, as shown in table 3-7. These groups are point sources of MSW and can be considered low-hanging fruits.

Table 3-7 14 Target Groups in the Waste Minimisation Project

Target Group	**Target**
BMA school	100% of the total in the district
Public school	50% of the total in the district
Private school	50% of the total in the district
University & college	50% of the total in the district
Department store	50% of the total in the district
Bank	20% of the total in the district
Hotel	10% of the total in the district
Mini mart	30% of the total in the district
Market	30% of the total in the district
Public health centre	50% of the total in the district
Religious place	50% of the total in the district
Community	At least 10% of the total in the district
Housing estate	At least 10% of the total in the district
High-rise building (> 8 stores)	At least 10% of the total in the district

Source: (DOPC 2000b, 19)

Each district office is responsible to select partner organisations. Partner organisations are suggested to follow the procedure as shown in figure 3-9. In addition, BMA arranged a study trip to visit successful community-based waste management schemes for partner organisations (Chadaporn 2005; Surachai 2005). For schools and communities, BMA endowed some money for initial investment in a range of 5 000 to 10 000 baths (125 to 250 USD). In 1999, BMA also used a part of 310 million baths (7.75 million USD) from the Miyazawa Loan to hire 130 unemployed graduates as temporary presenters of the project: 30 at DOPC and the other 100 at 50 district offices. These presenters partner organisations laying down a reporting system.

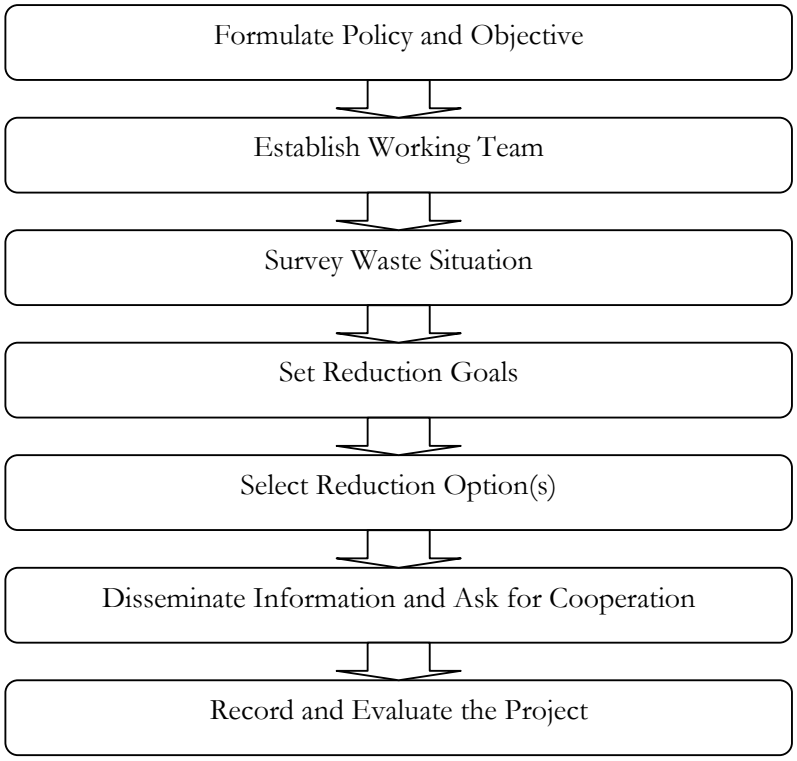

Figure 3-9 Procedure for waste minimisation initiative

Source: (DOPC 2000b, 13)

Between 1999 and 2002, BMA conducted another project called *Good Smell Waste*. This project aimed to reduce the amount of biodegradable waste entering municipal waste stream at source. It promoted the production of liquid compost. Target groups were communities, public schools, and private businesses such as restaurant and hotel which generate a considerable amount of biodegradable waste everyday. BMA sent an instruction and a presenter to interested bodies on request.

On supply side management, BMA provided waste bins with colours in accordance to the designed system in several areas. Yellow and green bins were placed in residential areas, public offices, and places with a huge amount of MSW. Blue bins were placed along main and subsidiary roads for commuters. And bins with red lids for HHW were placed at gas stations. In addition, some department stores printed symbols represent three fractions of wastes on 200 000 free shopping bags to be used later as waste bags (DOPC 2000a, 11).

BMA allocated new 120 one-tonne collection trucks, figure 3-10, to collect recyclables. These trucks had four compartments for four main types of recyclables: paper, plastics, glass, and metal, as shown in figure 3-10. However, BMA used them only for promotion purpose with partner organisations (DOPC 2000b, 23). For normal households, BMA modified 500 collection trucks by adding a small compartment for recyclables and HHW (DOPC 2000a, 11). The rest of the fleet hung gunny sacks at the truck's tail for these two fractions.

Figure 3-10 Collection trucks for recyclables

Source: (DOPC 2002, 32)

On 22 January 1997, BMA made an agreement with the Ministry of Industry (MOI) about the management of HHW (DOPC 1999, 85). According to the agreement, BMA is responsible to collect HHW and MOI is responsible to dispose collected HHW in a proper way. In July 1997, BMA started its campaigns on the separation of HHW, some included in WMP's campaigns. BMA also placed 2 268 bins with a red lid exclusively for HHW at gas stations and other places such as public offices.

The Integrated Waste Disposal System Project was proposed by BMA to materialise its designed disposal system. Initially, there were four sub projects: one at TS 1, another at TS 2, and the other two at TS 3. Each sub project consisted of a 2 000-tonne MRF, a 500-tonne composting plant, and three incinerators with combined capacity of 1 350 tonne/day. Each project was initially estimated to cost 6 000 million baths (150 million USD) (DOPC 2005c). On 12 October 1998, BMA submitted its project to the National Economic and Social Development Office for approval to make a long-term loan. However, on 29 September 1999, BMA pulled out three out of four sub projects and retained only the On-nuch 1 project at TS 3 with an expanded capacity of the composting plant to 700 tonnes.

The On-nuch 1 Project went through a number of procedures, including, feasibility studies, a mandatory referendum, a mandatory environmental impact assessment (EIA), and social impact assessment. This 7 640 million baths (125 million USD) project was put into the Foreign Debt Plan in the fiscal year 2000 as a stand-by project. Initially, BMA planned to accept a credit of 5 000 million baths (125 million USD) from Japan Bank for International Cooperation (JBIC). JBIC financed two studies to study the appropriateness of the project. A technical study done by an academic team found the project favourable but a social impact study done by one NGO, Urban Community Foundation (UCF), reached the opposite conclusion (Chadaporn 2005). This controversy made JBIC ambivalent and later pulled out. The project was finally abandoned after BMA could not secure sufficient financial support within the political term of the supportive administration. The new administration from the 2004 election seems to be indifference with the project. Dr. Samart Ratchapolsitte (2005), a present Deputy Governor of Bangkok in charge of MSWM, mentions that now a new feasibility study is underway and it is not certain which alternative disposal technology will appear to be preferable.

In 2002, BMA initiated another project on waste disposal. This project aimed to introduce new biological treatment facility. A private contractor invests in the project and BMA would

guarantee an inflow of 1 000 tonne/day and pay a tipping fee per tonne of 350 baths (8.75 USD) from its annual budget for 10 years, i.e. in total 1 277.5 million baths (37.94 million USD) (DOPC 2003a, 81). The Bangkok Council is project approved the project in 2002 and the expenditure of 127.75 million baths was budgeted for the fiscal year 2002 (DOPC 2003a, 15). However, the project suffered the same fate as the Integrated Waste Disposal System Project and was silently discontinued in that year.

3.4 Waste Situation after 1997

3.4.1 Waste diversion from BMA

Source reduction at the city level is difficult to be measured. This part, in turn, focuses on waste diversion from the municipal waste stream instead. This can be done either by source reduction such as home composting, or source separation for recycling outside the public collection system. A DOPC survey conducted in 1999 indicated that if they practiced source separation, 54% of 2 508 interviewees *would* give sorted recyclables to BMA's collectors (DOPC 1999, 12). However, personal communications reveal that most people sells recyclables from source separation directly to sa lengs or waste agents, instead of gives them away for free to BMA's collectors. Then, the next part presents source separation for BMA's collection.

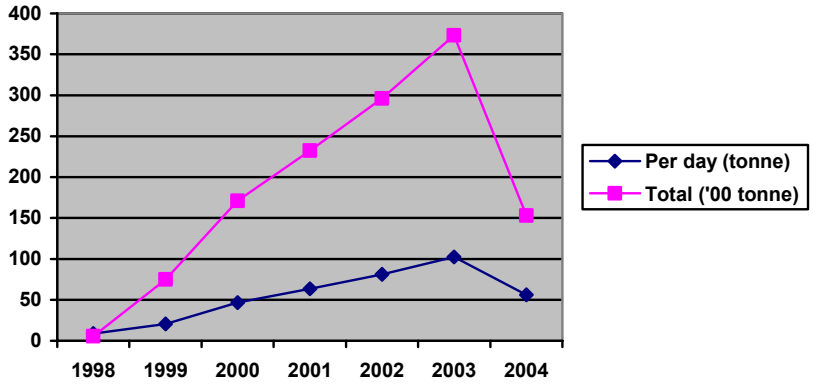

Figure 3-11 Quantity of recyclables recovered from the 14 target groups in WMP

Source: adapted from (DOPC 2005a, 19)

Figure 3-11 shows diverted recyclables from 14 target groups participated in WMP. The project had made a progress over time. For example, in 2003, there was a reduction of over 100 tonnes of recyclables daily. However, the project started to see a drop in 2004. This might be explained by decreases in participatory rate among commercial and residential groups after 2003, as shown in table 3-8. Some communities withdraw from the project because of local politics. Most community based management (CBM) schemes rely on the support of the elected committees who in many cases run the scheme themselves. But when these people fail to be re-elected, some schemes cease their operation and the others, though still running, stop reporting their operation to BMA through a new and rival elected committee (Charas 2005). In addition, a number of CBM schemes, some very successful, are independent from BMA and do not cooperate with BMA and prefer to work with NGOs or other agencies with some kinds of supports because they think that BMA wants to present their (hard) work as its own

success. It is also reported that several housing estates pull out after BMA stopped giving separated bags for free (Chadaporn 2005).

Table 3-8 Participatory rate in the Waste Minimisation Project

Target Group	**Total May 2005[2]**	**Target (%)**	**April 2000 (%)[1]**	**May 2005 (%)[2]**
BMA school	431	100	87	97
Public school	129	50	61	81
Private school	508	50	44	57
University & college	79	50	50	66
Department store	123	50	83	72
Bank	686	20	55	49
Hotel	225	10	81	60
Mini mart	694	30	65	53
Market	146	30	58	58
Public health centre	261	50	61	72
Religious place	535	50	40	59
Community	1505	10	70	38
Housing estate	825	10	64	34
High-rise building (> 8 stores)	872	10	46	53

[1] *Source: (DOPC 2000b, 26)*

[2] *Source: (DOPC 2005c)*

For normal households—outside CBM schemes, WMP affected their behaviours in the area of source reduction just slightly (Suwanna 2005). Middle-class households are mentioned as very indifferent toward source reduction (Suwanna 2005; Chadaporn 2005; and Mattana 2005). Some of households, nevertheless, still separate recyclables for sale to the waste collection business. The differences, which again do not connect with BMA's WMP, are on the part of the business. Recently, some sa lengs have organised themselves as a group. For example, 270 sa lengs and 47 pick-up trucks in Siaoy Yai U-tid community work together and control some 300 tonnes of saleable recyclables per month (UCF 2005). Though this is reported to be very difficult, its results, if succeed, are rather sweet. Organised sa lengs gains more social acceptance from households than unorganised ones. At the same time, a group of sa lengs with a control over a considerable amount of recyclables has more say with waste agents than each individual sa leng.

There is also a change in waste agents' business. Some waste agents, especially those from Wongpanit Group, bypass sa lengs and work directly with households. The Lam Luk Ka Branch is the first branch of Wongpanit Group in Bangkok and vicinity area opened in 2003. They encourage households to bring their saleable recyclables to their shops. Wongpanit Group's agents confirm that the majority of their suppliers are households and only few scavengers and sa lengs are connected with them (Somthai 2005; Preecha 2005; Preeyapong 2005; Santhiti and Phimonmas 2005; Suvida 2005). One shop with a storage area of 300 m^2, for example, gets some 3 - 5 tonnes of recyclables every single day from 50 – 100 households stopping by (Preecha 2005). To make this change possible, three mechanisms are needed. The first and arguably the most important is the location of the shop. To make it convenient to

households, the shop needs to be situated near a residential area or along the roads that households use regularly (Somthai 2005). Second, these waste agents change the image of the business from a dirty to a tidy and environmentally friendly one. A trustworthy digital scale and keeping the shops as tidy as possible are proved to be key factors. Finally, Wongpanit Group's waste agents employ intensive and proactive advertising. Four-colour leaflets are distributed door-to-door in surrounding residential areas. The main contents of the leaflet (see an example in Appendix C) are (1) the logo of the network, (2) the location of the shop, (3) examples of what can be sold, and (4) their prices. From direct observation and personal communications, many households which did not separate recyclables in the past begin to do a business with this (self-claimed) environmentally friendly business with much less awkward. An additional income of households from this activity normally falls in a range of 100 – 1 000 baths (2.5 – 25 USD) per transaction (Santhiti and Phimonmas 2005).

The reduction of biodegradable waste is by and large depended upon the production of liquid compost. In 2002, DOPC (2003, 26) reported that participants used 86 tonne/day of certain biodegradable waste to produce some 1.2 million litres of liquid compost. The product is very useful as deodorant, cleansing agent, and fertiliser. However, there is a problem with the markets or end users of the product and handling of residual both produced in large volume (Charas 2005; Mattana 2005; and, Chadaporn 2005). In some cases, people stop practice it after one or two batches because they simply have enough to use.

3.4.2 Source separation for BMA's collection and waste collection

Households are rarely separate MSW for BMA collection though BMA issued an Announcement on Source Separation in accordance with Article 7 of the BMA Decree on Waste and Nightsoil Collection, Transfer and Disposal 2001. The separation of HHW from MSW has also achieved modest success. Though the amount of separated HHW has increased from 30 kg/day in 1997 to 136 kg/day in 2004, it is still less than 1% of the estimated amount of HHW generated.

The study done by the Danish consultant, COWI-EP&T Associates, during October 1998 to March 2000 concluded that "people do not sort waste because they did not know how to sort it and subsequently to put it in different containers" (COWI-EP&T Associates, 2000, 2-32). But, a lack of knowledge of households is just one of the factors. Actually, the 1999 DOPC survey showed that 92% of the respondents received information about WMP (DOPC 2000a, 12).

Other and arguably more decisive factors may be a lack of incentive, negative feedbacks, and inconvenience. It is very likely that households would not sort their waste unless they see any benefit in the activity, let alone whether the benefit exceeds the cost. From a household's viewpoint, there is no tangible or direct benefit from source separation for BMA collection. In general, BMA informed people that source separation would ease the work of BMA, let it be collection or disposal. For normal households, the waste collection fee, despite changes in 2001 and 2005[8], has still been flat and, hence, given no economic incentive neither to source reduction nor source separation for BMA's collection.

The situation is further worsening when households received real or seemingly negative feedbacks. A number of anecdotes and personal communications revealed that people do not believe in the collection system. Since they see only *one* collection truck coming, households

[8] See more detail in Manomaivibool, Panate, (2005), *Financing municipal solid waste management in a developing country: A case of Bangkok Metropolitan Administration*, IIIEE ARPEA II research paper 2004/2005, Lund: IIIEE, Lund University.

believe that all waste will be mixed together regardless of pre-sorting. This is a seemingly negative feedback, MSW, or at least saleable recyclables, will not be mixed up in the collection truck due to the sorting of BMA's collectors. A real negative feedback happens less frequent but is more severe. From time to time, a collection truck collects only sorted valuable recyclables and leaves other smelling or hazardous waste behind (Sompop 2005). This effectively kills people's motivation.

Last but not least, there are inconveniences. While different colour bins are not provided sufficiently, waste bags in accordance to the colour rule are hardly available in the market.[9] Therefore, most households provide their own waste bins, normally, a plastic bucket or a heavy used oil tank (COWI-EP&T Associates, 2000, 2-32) or waste bags. Uncapped or leaking containers are also commonplace.

Waste collection is more punctual than it used to be. BMA under the Article 7 of the 2001 Decree issued the Announcement on Collection Day, Time, and Place. Households are expected to place their waste between 6 pm and 3 am in front of their house for direct collection or on the collection point for indirect collection on the collection day. The collection should be finished by 6 am to keep away from the streets in morning rush hours. BMA communicated the specifications in the Announcement through the Appointed Waste Collection Time Project. In general, BMA can live up with its standards. Now there is no need to ring a bell to notify households. However, there have still been reports about late collection and presences of collection trucks in the morning rush hours. This might be a result of inefficient collection due to undersigned sorting activities.

Since there is no source separation for BMA collection, saleable recyclables still commingles with other wastes. And, BMA's collectors still sort them during collecting time. As mentioned before, this leads to significantly inefficiency in the collection. Therefore, the Samak's administration had a policy against the practice. To compensate loss in this additional income, BMA passed a new decree in 2003 to give a part of the collected fee to its workers. Nevertheless, direct observations and a recent TV documentary (TV Burapha 2004) do not detect any change in collection practice.

3.4.3 Central sorting

Up till now, BMA does not possess any MRF. The projects to build MRFs were abandoned with those of treatment and disposal facilities which will be presented in the next part. However, there are informal sorting activities at the transfer stations.[10]

Under the control of the private contractors, scavengers cannot enter the stations without a permit. They have to pay (1) an entrance fee of 100 baths, (2) a shift fee of 10 bath/shift, (3) a washing fee of 5 bath/day, and (4) an insurance fee of 1 600 bath/year to the sub-contactors who have a monopoly over scavenging at the transfer stations (UCF 2001, 47-48) to the sub-contractors, who win a bid from the contractors,[11] in order to gain access. JICA (cited in

[9] Even though some department stores did give bags for different fractions of waste for free in the beginning, they did not follow the colour rule.

[10] Before 1995, BMA used the areas which are now TS 2 and TS 3 to open dump collected waste. Though wastes at the transfer stations are regarded as grade C because they are what left over from the activities of sa lengs and BMA's collectors (Kiaometha 2002, 23), hundreds of scavengers roamed freely to sort saleable materials to earn their living. But, when the space was used up, BMA changed the disposal arrangement. It contracted private landfill operators to transfer wastes from the areas and landfill them in their lands. The areas were modified into transfer stations which also under the control of the contractors.

[11] At TS 3, the winning bid was worth 320 000 baths (8 000 USD) a month (UCF 2001, 59)

Kiaometha 2002, 24) estimated that their activities recover some 20 tonnes of recyclables per day. The sorting is done by scavenging a pile of wastes with hands and simple equipments such as a hook and a rug sack. The sub-contractors monopolise all materials recovered. The prices the sub-contractors offer are generally much lower than the market prices.[12]

3.4.4 Treatment and Disposal

BMA has contracted out all of disposal activities to private contractors. The maximum service charges are set in the Account of Maximum Service Charges for Businesses Collect, Transfer, or Dispose Waste or Nightsoil with a Service Charge. Table 3-9 presents some selected maximum charges in the Account.

Table 3-9 Selected Maximum Service Charge for a Private Operator

Activity	Maximum Charge	Unit
Collect MSW	250	bath/m^3
Landfill MSW	500	bath/tonne
Incinerate MSW	2 000	bath/tonne
Compost MSW	800	bath/tonne

Source: (DOPC 2005b, 153)

Landfill has still been a dominant disposal method for Bangkok's MSW. Figure 3-12 shows that since 1998 at least 97% of the waste sent to the transfer stations ended up in landfill. As mentioned above, there were a lot of disruptions for materialisation of designed alternative methods to landfill. In addition, the existing composting plant at TS 3 was closed down for a revision between 1999 and 2004. The plant was just reopened in February 2005 (Voranuch 2005).

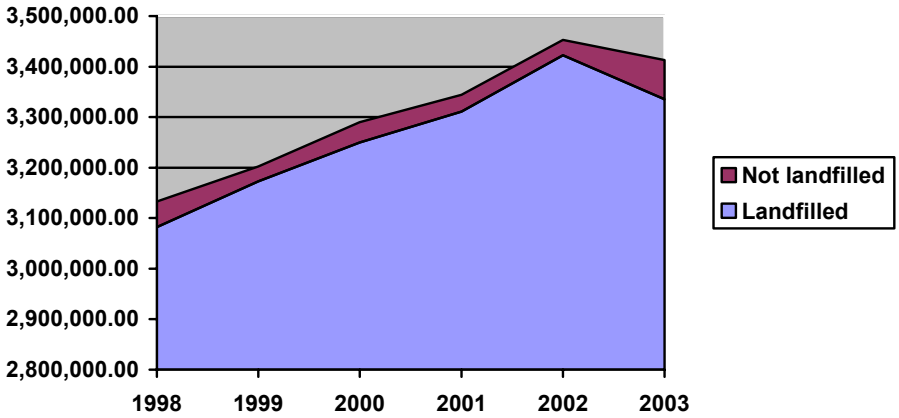

Figure 3-12 Proportion of waste landfill

Source: adapted from (DOPC 2004b, 21)

[12] UCF (2001, 60) reported prices lower in a range from the factor of 3 to 10 for different materials.

For landfill, BMA has had contracts with three landfill operators since 1995. Two contractors in charge of TS 1 (Contractor 1) and TS 2 (Contractor 2) share a site at Kampaengsaen District, Nakhon Pathom Province (Landfill 1). The other (Contractor 3) used a site at Lat Krabang District, Bangkok, until it exhausted in 2000. Then, Contractor 3 acquired a new site at Rajatheva, Samut Prakarn.

However, as mentioned before, modified landfill involves with several environmental impacts, some of which are very local. So, whether local opposition will follow depending on how well the operator approaches (or controls) local people. Unfortunately, this was where Contractor 3 failed in the Rajatheva case. Though, the site was regarded by an expert at PCD as a better site than the other one (Rangsan 2005), local opposition plus local politics in the area was too high. Local people even went to the Administration Court asking for a withdrawal of a landfill permit. The inquisitions of the Administration Court led to a closure of the site. The Court also blamed BMA for its negligence (Administration Court 2004, 55). According to the Court, BMA failed to provide a sufficient supervision over the operation of its contractor. In addition, when the contractor operated in an unsanitary way and caused negative effects on local people and the environment (and the case was brought to the Court), BMA still did noting[13] and prolonged the contract with the contractor (Administration Court 2004, 55).

The court case also affects the economics of landfill. Although Contractor 3 could find a new site at Phanomsarakham District, Chachoengsao, and won a new extended 10-year contract in a recent tendering,[14] it has to follow an untypical additional requirement of plastic wrapping of waste before transportation and landfill. This requirement, in turn, results in an increase of a service charge of this contractor by 65% from 323 bath/tonne to 535 bath/tonne, as shown in table 3-10.

Table 3-10 Changes in tipping fees between 1995 and 2005

Contract	Charge 1995-1999 (baths/tonne)	Charge 2000-2004 (baths/tonne)	Charge 2005-2014 (bath/tonne)
Vadsadukarupan (Station 1 to Landfill 1)	214	351	438
Group 79 (Station 2 to Landfill 1)	173	354	418
Piroj Sompong Phanij (Station 3 to Landfill 2)*	149	323	535

Source: adapt from (DOPC 2003a, 47, 50; Thairath, 2005)

3.5 Result

3.5.1 Physical result

Figure 3-13 shows the amount of MSW sent to the transfer stations and subsequently to the landfill sites. It is rather obvious that there were two trends. The first trend was the period with a rapid growth from 1985 to 1997. In this period, the quantity of MSW sent to the

[13] BMA was otherwise able to charge the contractor up to 100 000 baths (2500 USD) per day in case of nonconformance (Samart 2005).

[14] From an insider, initially there were 7 companies buying the application form for bidding. However, after a period of heavy lobbying, only the former contractors submitted and won the bids. It is also worth noting that the contracts were extended from 4 to 10 years.

transfer stations grew at the average 9% per year. Then the trend has been stabilised with the average change rate at 1% and always below the estimation since 1998. A figure of 2005, though not finalised, is reported at around 8 500 tonnes/day (Samart 2005), i.e. 900 tonnes/day less than the preceding year.[15]

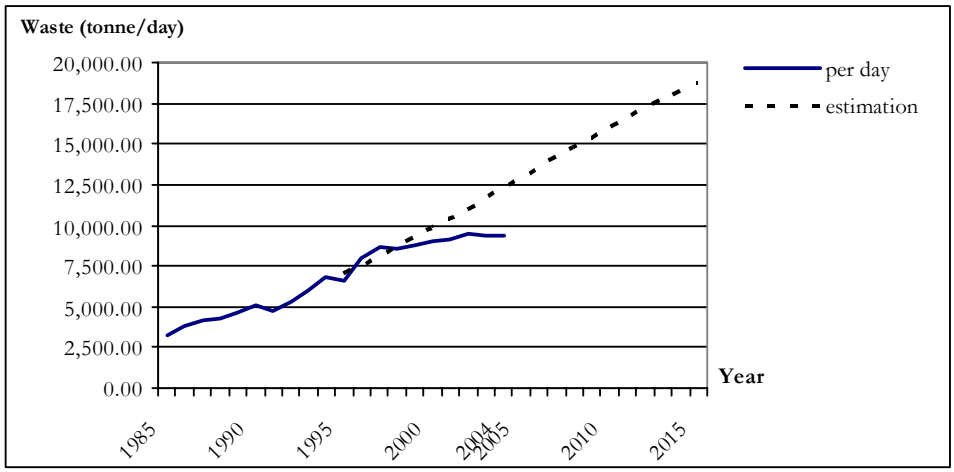

Figure 3-13 Quantity of MSW between 1985 and 2004 and an estimation between 1995 and 2015

Source: adapt from (DOPC 2005b, 27)

Figure 3-14 compares the composition of MSW at the transfer stations in 1997 and the average between 1998 and 2004. There are a few points worth mentioning here. First, though there is also a drop in a share of food waste, this is compensated with an increase in that of others—likely decomposed food waste—and yard waste. The shares of three main families of recyclables: metal, glass, and paper, decreased. On the other hand, the share of plastics increased significantly. One detailed study made in 2001 on the composition of MSW at TS 3 found that more than 80% of what classified as 'Plastic/forms' was plastic bags (PCD 2002a, ก-2). Last but not least, not all paper and plastics were suitable for recycling because there is no market for some of them while the others are too contaminated. DOPC (2005a, 32), for example, reported that in 2004 only 9% of paper and 10% of plastics could be classified as recyclables. Therefore, MSW suitable for recycling in the year was reported at 8% not 40%.

[15] However, a part of the explanation for this drastic reduction might be a stricter supervision on a compacting operation at the transfer stations which squeezes some water content from MSW.

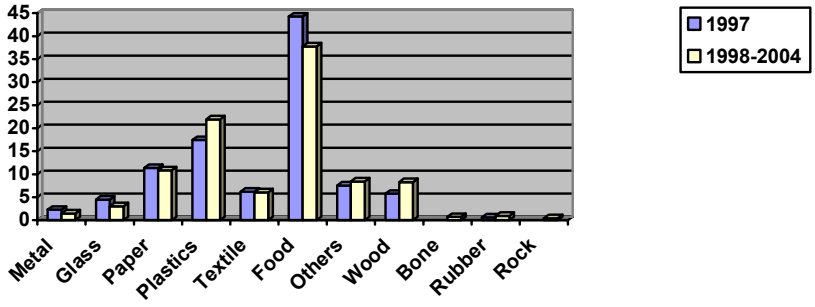

Figure 3-14Comparison between the composition of MSW in 1997 and afterward

Source: (DOPC 2005a, 33)

3.5.2 Financial result

WMP does not only aim at a reduction in MSW, but also at a reduction in the financial burden on BMA from increasing efficiency and cost savings. Figure 3-15 displays a collection cost and a disposal cost per tonne of MSW collected between 1995 and 2003. Surprisingly, the year 1997 was when the total operating cost per tonne was at its lowest. The average total cost per tonne between 1998 and 2003 is about 150 baths (3.75 USD)—50 baths in collection and 100 baths in disposal—more than that in 1997. After 2003, it is expected that the disposal cost per tonne would go up even more because of increases in the tipping fees in a recent tendering, as shown in table 3-15.

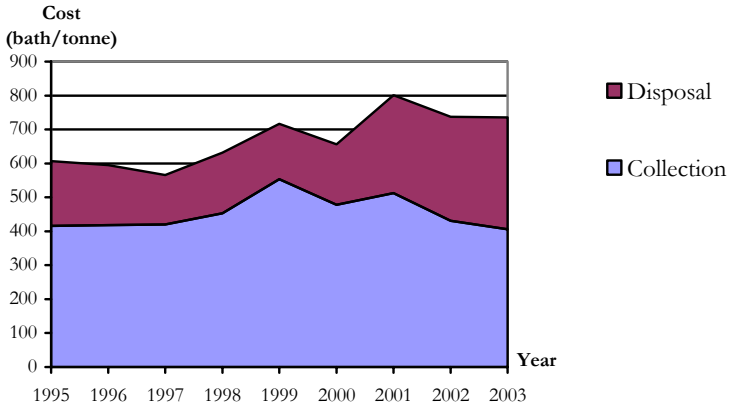

Figure 3-15 Collection and disposal costs
Source: adapted from (PCD, BMA 2005a, 46)

4 Municipal Solid Waste Management in the School

4.1 Roong Aroon School: The dawn of wisdom

4.1.1 The school and the people

Roong Aroon School (RAS) is a private school. It is located on in Bang Khun Tian District, Bangkok. The school area covers approximately 80 000 m^2. There are 19 buildings in RAS (REMD 2005). All constructions in RAS are designed in harmony with and open to the nature to stimulate children's learning process. Most of them have two to three storeys.

The school was established in 1997 in the hope that it would be a pilot school in search of excellence continuous improvement toward the best practice in educational management. The name "Roong Aroon" was given by Professor Praves Vasee, M.D., the Chairperson of the Executive Board. It means the dawn (of wisdom).

RAS is one of three Buddhism-oriented schools in Bangkok. Its basic educational principle is that "education begins when people eat and live in a proper way" (REMD 2005). It is a policy of the school that everything thought must be of use in real life (Apidon 2005). The following are the objectives of the school (RAS 2005):

1. RAS is a learning community. RAS facilitates everyone to learn and share their knowledge and experiences. The environment of RAS imitates the nature as close as possible so the students have an opportunity to explore and learn how to harmonise the nature, culture, and individual;

2. Teachers are able to integrate their expertises with other aspects of life. They understand learning behaviours and possess a good knowledge about their subjects. Teachers work in team to synergise their effort to help children develop themselves. They must also have necessary skills to make students understand the subjects through participation in class;

3. Students have an active learning mind. They have intellectual freedom. Through academic and extra-curriculum activities, they are equipped with necessary knowledge, skills, and ethics to be a good member of the society;

4. Curriculum is Buddhism-oriented. A team of teachers develops a curriculum in accordance to the need and capability of the pupils. Every element in the curriculum must be defendable in the light of its merit for the sake of children's development.

Table 4-1 shows a number of students, teachers and staffs, and workers in the school. Most of the students are from middle-class families. They learn academic subjects and experience real-life activities from teachers and staffs. Each day pupils spend almost half of their time outside classrooms. For example, in the morning, children follow the cooks to the fresh market to observe how the shopping is done. The ratio of teachers and staffs to pupils at RAS, 1:3, is considerable higher than other schools. Because a few building are under construction, there are 55 workers stay in the school's area and use its facility including waste services.

Table 4-1 People at Roong Aroon School

Level	Students	Teachers & Staffs	Workers
Nursery School	253	n/a	n/a
Primary School	383	n/a	n/a
Junior Secondary School	151	n/a	n/a
Senior Secondary School	62	n/a	n/a
Total	849	267	55

Source: (REMD 2005)

4.1.2 The management

RAS is a non-for-profit organisation. This means that its activities might generate revenue and profit which will be used in the development of organisation's missions (RAS 2005). On 2 September 2003, RAS established and registered the Roong Aroon School Foundation (RASF) as a governing body of the school. P.A. Payutto, a well-known monk, is the Chairperson of the Advisory Board. Professor Praves Vasee, M.D., is the Chairperson of the Executive Board.

RAS has a flat professional bureaucratic arrangement (Mintzberg 1979, 355). The Director is the top management of the school. Associate Professor Praphapat Niyom is the first and present Director of the school. RAS has three departments: nursery, primary, and secondary schools. Each department has a school principal in charge of the management. However, operators, i.e. teachers and staffs, are the ones driving the organisation. They have considerable expertise and discretion over their work. Therefore, the degree of decentralisation is rather high in RAS. Formalisation does not result from explicit regulations but from implicit professional ethics implanted in operators' mind through a socialisation.

4.2 Waste Situation before ZWP

Many activities in RAS—a community of 1 100 members—inevitably gave away a considerable amount of wastes. According to a waste audit done during 5 to 11 February 2004, 206 kg of waste were generated in the school everyday. Figure 4-1 shows the composition of RAS's wastes before ZWP. The term non-biodegradable waste was assigned to plastics and laminated paper, most of which were one-way packaging. Several items were imported into the school. For example, there were around 500 laminate milk boxes ended up in the trash everyday despite the fact that school milk came in bulky plastic containers.

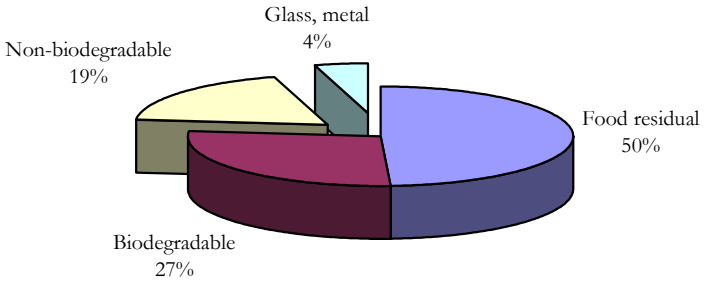

Figure 4-1 Composition of waste before ZWP
Source: adapted from (REMD 2005)

The waste management before ZWP was very simple. Each unit in RAS had its own trash bin for mixed waste. In common areas, the Building and Compound Division (BCD) was responsible to place waste bins. BCD copied BMA's two-can system and installed green and yellow bins for wet waste and dry waste respectively. However, people did not distinguish one type of bin from the other and use both to dispose mixed waste. All bins were emptied daily in the evening by housekeepers. Wastes from all sources were dumped at the collection room, shown in figure 4-2. BMA's collection truck came to pick up wastes once a week.

Figure 4-2 Collection room at RAS before ZWP

Photograph by Apidon Jareon-aksorn (2004)

This practice, despite its simplicity, proved problematic. First of all, the smell at the collection room was horrible because the biodegradable part underwent decomposing processes. \There was also a problem of leachate. For example, it was reported that, among the waste sitting at the collection room, there were heavy plastic bags containing grease from water treatment tank. From time to time, these bags broke and released what inside. Moreover, the collection room fed and hosted a swarm of pest animals such as flies, rats, etc. These problems were not limited only to RAS. Moo Ban Hao, a neighbouring community, often compliant about the disamenity resulted from RAS's wastes (Apidon 2005; Saya 2005).

4.3 Zero Waste Project

4.3.1 Background

The waste collection room was a blind spot of RAS. Therefore, in February 2004, there was a discussion to improve the situation. Mr. Apidon Jareon-aksorn, who has an engineer background and is inspired by the Danish system, proposed a project to change people behaviour. After the consultation process, Zero Waste Project (ZWP) was put forward with a full support from the management. A working team consisting of three people was established. Mr. Apidon Jareon-aksorn, as known as, Kru Duj, is a leader of the team and responsible for set up the system. Ms. Pranee Hwad-pia, as known as, Kru Pui, a former teacher in the nursery school, was chosen because of her motherhood and tidiness. Kru Pui is in charge of the sorting station with an emphasis on its tidiness. And Mr. Jakchai Kulavong, as known as, Pee Jakchai, who has an agricultural background and a good knowledge on compost, is responsible for the management of biodegradable fraction. Later, the forth member, Ms. Sopaporn Permpibul, as known as, Pee Sa-long, joined the team.

4.3.2 Rationale[16]

The rationale of ZWP is that wastes are simply resources in disguise. Valuation and ignorance turn resources into wastes. As people gain utility from consumption, the value of the products consumed in the eyes of consumers are decreasing. To one point, consumers no longer regard them as products instead they become "wastes." But these wastes still have some value and can be perceived as resources by others. Ignorance about proper disposal is what makes wastes real wastes.

For example, a boy drinks milk from a laminated box and receive utility from the activity. Then he is full and stops drinking. He does not want left-over milk and its container, i.e. from his perspective, they are waste. But, laminated paper can be recycled if cleaned and dried while milk can be used to feed animals or micro-organisms in composting processes. The boy's ignorance to throw away the box with milk inside, however, destroys their values. The box is now too dirty to be recovered. On the other hand, it will not be decomposed and lower the quality of the product if composting is chosen. In addition, other resources in the same bin can also be contaminated and lost their values.

There are two main ways to get rid of waste. The first is to change consumption behaviour to generate less waste. From the previous example, the boy can choose to buy milk as much as he can drink and does not choose one-way packaging. Valorisation of discarded items is the second solution. This can be either recovery of material or energy content of those items.

However, prescriptive information is not enough to change people behaviour. "A Buddhist learning process begins with "**ทุกข์**" [unpleasant state] not with "**มรรค**" [solutions]" (Apidon 2005). Therefore, first of all, people must know the problem. Then, public awareness has to be raised that everyone is a root cause of problems related to waste, i.e. we are the polluters, and should be responsible in solving them. According to a Buddhist perspective, this can be achieved through a process of merit rousing, i.e. making people want to do a good deed by showing a merit of the action. The process will lead to a change in behaviour.[17] And, to sustain the result, conditions needs to be set to facilitate a new way of life, a new and sustainable culture.

4.3.3 Objective

ZWP has three main objectives (RAS 2005a):

1. RAS will be a self-contained community in the area of waste management. The project aims to manage waste in an environmentally friendly way and to minimise exporting waste to the environment, i.e. to BMA;

2. The project will be a learning centre of environmental studies. The project will support classrooms to integrate real-life experiences with academic subjects; and,

3. The project will establish and strengthen an environmentally friendly culture. At the highest level, the project aims to incorporate a new and environmentally friendly pattern of consumption and waste management into its members, i.e. teachers, students, staffs, and parents.

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[16] This part is extracted from personal communication with Mr. Apidon Jareon-akson, the project leader of ZWP.

[17] In an economic perspective, this process changes valuation in individual's utility function.

In addition, RAS also aims to establish a network of self-contained community in the area of waste management with other schools and communities in Bangkok (REMD 2005).

4.3.4 System design

Figure 4-3 presents a designed system of waste management in RAS. The system is a result of a collective learning process in the first phase of the project (see below). The system is based on the demarcation between resource and waste. Resources are materials that can be further utilised after the point of discard by RAS. There are three types of resources based on its use: residuals from school meals (from now on called "food residuals"), biodegradable, and recyclables.

Food residuals. Food residuals are those left over from school meals. These resources are full of nutrients. Food residuals will be used as animal feed. The animal is fish that eats almost everything except fruit peels (Apidon 2005). The collection point of food residuals is in the kitchen, which is its main source. Food residuals from waste bins at other places will be brought to the kitchen daily by housekeepers, Pee Sa-long, and, sometimes, students on duty. Blue bins are assigned for this type of resources. Every two days, a farmer come and pick up the fodder.

Biodegradable. Biodegradable waste includes yard waste, wooden sticks, and contaminated but non-laminated paper, fruit peels and other food residuals that do not go to the fish pond. The system uses biodegradable in the production of compost and of liquid compost. The composting process is aerobic. Yard waste is under direct responsibility of the gardeners who collect and carry them to the composting station. Green bins are assigned to the rest of the fraction. Housekeepers, Pee Sa-long, and, sometimes, students on duty carry them to the collection point at the liquid compost station. Later, Pee Jakchai brings them to the composting station. Compost is used in school's organic plantation.

The production of liquid compost comes into the picture later. Liquid compost is produced from fruits and their peels and is used in the composting process to reduce the odour and cut the life-cycle of pest insects.

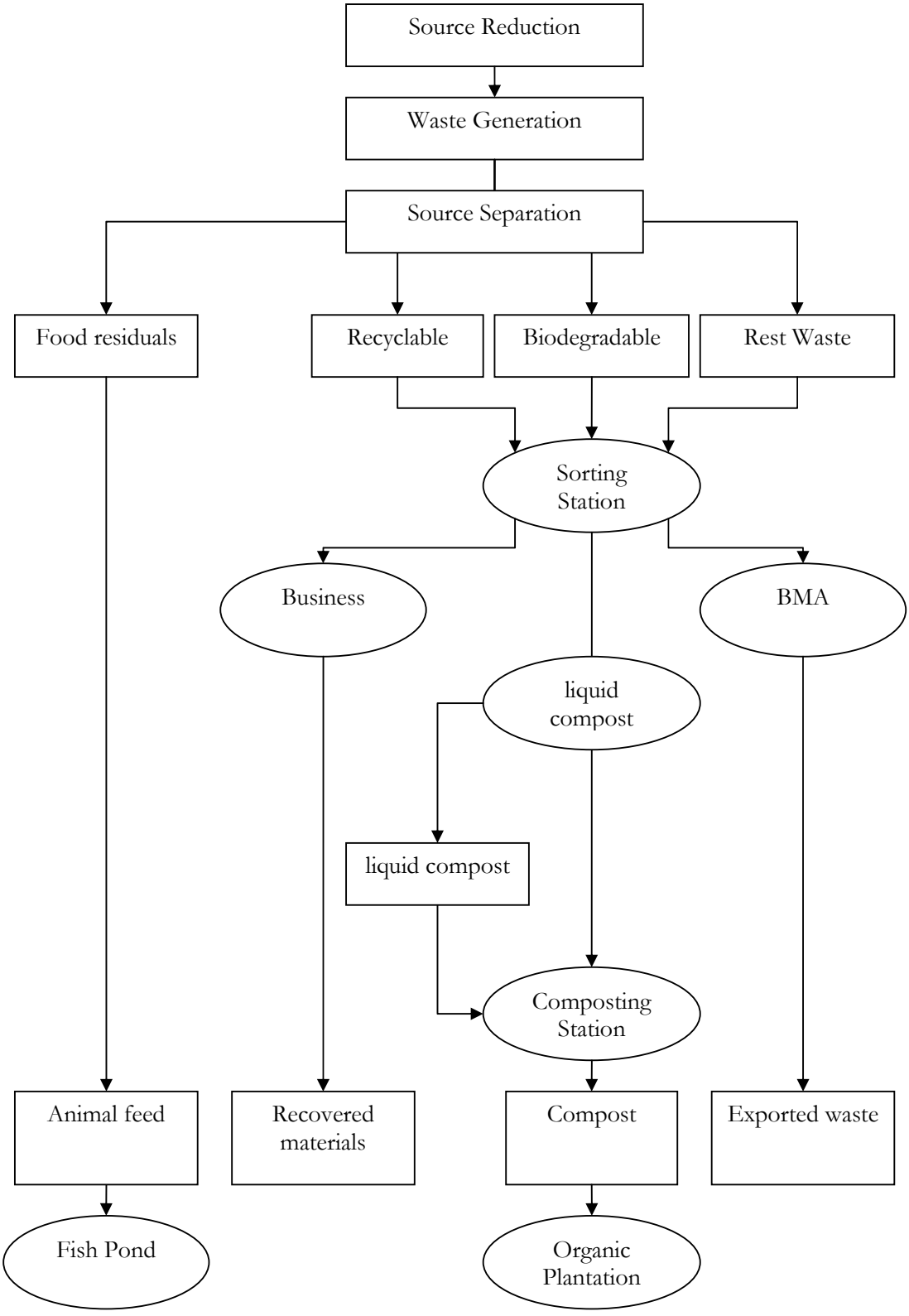

Figure 4-3 The designed system in ZWP

Recyclables. Recyclability is determined by technical and economic reasons. For example, thermosetting plastics such as tableware made out of melanin cannot be recycled technically while there is no market for post-consumer laminated paper. Initially recyclables consists roughly of non-laminated paper, thermoplastic, glass, and metal products. The orange bins are assigned to recyclables. There is one requirement for disposing recyclables into these bins, i.e. recyclable packaging must be clean. Contaminated recyclables cause difficulties in subsequent process and degrade the quality of recovered materials. Recyclables from the bins are sent to the sorting station daily by housekeepers, Pee Sa-long, and, sometimes, students on duty.

The sorting station is central for recyclables. It is full-timely manned with the working team. Within the station, there are a number of containers assigned for different types of materials. Operators further sort mixed recyclables collected from orange bins into more than 40 fractions. For example, a pen will be sorted into plastic cover, stainless/brass ball-pen, metal spring, and hazardous left-over ink. People are also encouraged to bring recyclables directly to the plant (but this is not compulsory). In this case, they do the separation of their own wastes. Operators will provide help if needed. To make the plant tidy and, hence, welcoming, operators clean the area, containers, and equipments frequently.

There are three main uses of collected recyclables at the sorting stations. The first is reuse. In this case, the station acts as a storage room. People can come and look around for the thing they need such as a metal spring, a corrugated box, a plastic bag, used paper, etc. Second, some materials are donated for free. There are two examples. Colourless aluminium caps are given to Siriraj Hospital to produce artificial legs. Smooth A4 paper is sent to be used at the Bangkok Blind School. Third, the project sells the majority of collected recyclables to waste agents. The main reason of this selling is not to earn some revenue but simply to empty the station. These materials subsequently enter reprocessing processes to produce new products. The prioritisation is (1) reuse, (2) donation, and (3) sale (Jakchai 2005).

Rest waste. Rest waste is real wastes. Animals do not eat them. They are difficult to be decomposed. And no one buys them. Yellow bins are assigned for rest wastes. Examples of rest waste are HHW, infectious waste, toilet waste, thermosetting plastics, ceramics, and, at the beginning, foam, laminated paper, candy wrapping, and wrapping foil. RAS, then, sends these wastes to BMA. The goal for this fraction is to reduce things classified as rest waste.

4.3.5 Implementation

The implementation of ZWP is divided into three parallel phases with the first phase began a bit earlier than the other two.

Phase I: Separate resources from waste. The first phase set up a system for waste management. It began with a thorough waste audit. Before waste was brought to the collection point, the working team weighted and sorted it to investigate its composition. The working team also asked housekeepers to put a tag identifying where each bag from. This investigation lasted about one week. The process of sorting mixed waste was very pain-taking: the working team suffered bad smell, pest animals, dirtiness, etc. They said that they spent two days to sort waste generated within a single day (Apidon 2005; Jakchai 2005). The overall baseline weight of 206 kg/day and detailed composition, and the average weight and composition of each source were the results of this investigation.

The system was, then, designed in accordance with characteristics of waste. Three resources were identified: food residuals, biodegradable waste, and recyclables. Many system components such as sorting station, composting station, and a contact with the farmer, were

also established to facilitate the separation of resources from waste. The system has been continuous updated according to circumstances. For example, an liquid compost station was established later to ease the problems in the composting process at the end of this phase. The Director of the school ordered to destroy the old collection room to demonstrate a strong will to solve the problem.

Phase II: From waste to resources. In the second phase, the project tried to spread the new discourse of resources and waste. It first targeted at teachers and staffs. It is general policy of RAS that teachers must trail whatever they want pupils to do. There are also more subtle reasons. Teachers were chosen because they could later have an influence over the pupils. Staffs were chosen because they directly involved in the operation of the designed system. For example, cooks are responsible to separate fruit peels from other food residuals and gardeners are responsible to bring yard waste to the composting plant.

These pioneers marched under the name "Environmental Volunteer." Initially, there were 8 volunteers (Apidon 2005). They devoted themselves to the project and helped the working team separate smelly mixed waste to collect monthly statistics. During the process, the volunteers learned about (1) wastes generated in the school; (2) the problems related to unsorted wastes such as bad odour, pest animals, and waste of resources, and (3) quality of separation of different sources, through direct contact with waste. These change the volunteers into the change agents. The volunteers received a reward, designed by art teachers and made from recovered materials, as recognition of their devotion. Then, the working team and environmental volunteers approached different units of the schools. Many offices started to their own sorting system.

Students were the next target. They are the majority in the school. Most of wastes result from their activities. However, they are also non-point sources which are difficult to manage. Teachers proved to be effective facilitators here. A few teachers, who are environmental volunteers, tried to promote ZWP among their pupils. Components of the system e.g. sorting station, liquid compost station, composting station, and organic plantation also serve as learning stations. For example, at grade 5, a math teacher gives an exercise to his students to daily measure and to make a presentation of the quantity of separated wastes at the sorting station.

Phase III: New generation, new culture. After the central system succeeded to a certain degree, ZWP was expanded in three directions. First, it expands its service. Now the project serves as a community waste management centre. Members of RAS can bring recyclables and biodegradable waste from their home to the sorting station. Neighbouring communities are also welcome to use the facilities. It is reported that some parents even store their biodegradable waste in the fridge during weekend to bring it to school on the next Monday (Apidon 2005).

Second, the project extends to the producers of the products which subsequently turn into wastes. RAS asks shops and vendors in the school to stop giving away one-way packaging under the campaign "Zero Waste Transaction." In the beginning, the school provided table ware and a washing station near shops. Everyone can use these wares providing that they clean and return them after use. Later, the campaign urged people to have their own durable container such as a mug, a food-carrier, a basket, and a textile bag. In addition, the school intends to change its plastic wares made from melanin into glass wares. Glass wares are seen as a superior choice because (1) it makes people more careful and (2) it is recyclable if broken.

Finally, to consolidate the emerging culture, the zero waste concept seep in the core units of RAS, namely, classrooms. Every classroom is encouraged to design its own waste management system in tandem with the central system. The goal is to the real management at source and reduces the role of the central system. Table 4-2 summarises the main activities took place during the first year of ZWP.

Table 4-2 Activities in ZWP during the first year

Data Collection	Activity	Average Weight (kg)	Per cent
5 – 11 Feb 2004	• Establish the working team • Diagnosis the situation • Prepare the areas for the sorting and composting stations	206	100
27 Feb – 3 Mar 2004	• Develop the system • Communicate with the cooks and housekeepers to collect food residuals from washing points for the farmer • Start the activity of Environmental Volunteer • Destroy the old collection room for mixed waste	114	55
29 Mar – 2 Apr 2004	• Place waste bins in 11 communal areas • Communicate with every units in the school	65	32
28 May – 4 June 2004	• Some units develop their own sorting system • Some teachers use the sorting and composting stations as learning stations	46	22
29 June – 5 Jul 2004	• Hold a seminar on recycling milk cartons to green board • The nursery school is a pioneer of recycling milk cartons	38	18
4 – 10 Aug 2004	• Receive waste from outsiders • Become a nominee in the national competition of Creative School for the Environment	46	22
27 Sept – 1 Oct 2004	• Start the phase I of the Zero Waste Transaction campaign, using and washing provided containers • Design advertising posters	35	17
1 – 5 Nov 2004	• Promote the concept of Zero Waste Classroom	32	16
13 – 17 Dec 2004	• Install 20 recycling stations for materials sent to Green Board	44	21
5 – 11 Jan 2004	• Start the phase I of the Zero Waste Transaction campaign, bringing durable and reusable your own containers	31	15

Source: (REMD 2005)

4.4 Waste Situation after ZWP

4.4.1 Source reduction

In ZWP, the first attempt of source reduction was on food residuals. Therefore, the cooks and housekeepers were asked to separate food residuals from other wastes and giving them to the farmer. Children are also told to scoop up just what they really need to reduce the residual. Within a month, even before the system development was finished, the total waste went to BMA collection was reduced by 44%!

The sorting station facilitates reuse. On one side, people can dispose unwanted but still usable items at the station. On the other side, others can stop by the station to look for materials they need. The station acts like a meeting point that match supply and demand for materials.

4.4.2 Source separation and collection

Nowadays, source separation becomes a normal practice in RAS. The change happens gradually and expands like a wave from the working team to the environmental volunteers to other teachers and staffs and to students. Apidon (2005) says that there was a paradigm shift when the critical mass of people practice it was reached. Now, the difference is on to what extent the separation is done at source.

In the beginning, only few units practice detailed separation. It would be good enough if the four-fraction system worked. Waste from different bins were brought to the sorting station by housekeepers and Pee Sa-long for further separation by the working team and the environmental volunteers.

Later, more units develop their own detailed separation of recyclables. They adapt the central system in accordance to their parameters such as the characteristics of their waste, space available, etc. These attempts were consolidated through the promotion of the Zero Waste Classroom concept late in 2004. These units also bring their own separated waste to the sorting plant and help in sorting there. During the process, they get a feedback both through the working team and through their own experiences about the quality of their source separation. This feedback is subsequently transmitted to colleagues in these units. However, not all classes have participated. There seems to be a negative relationship between grade and sorting attempt. The nursery, primary, and junior secondary schools enthusiastically practice source separate.

In a near future, there is an idea to replace most waste bins in the communal areas with 20 recycling stations (Apidon 2005; Jakchai 2005). Figure 4-4 shows the model of the station. There is no more a yellow bins for rest wastes. Biodegradable is disposed into the green hole. Packagings are washed and dried before housekeepers or Pee Sa-long collect them. Paper, plastic bags, and metal and glass will be separated from each other.

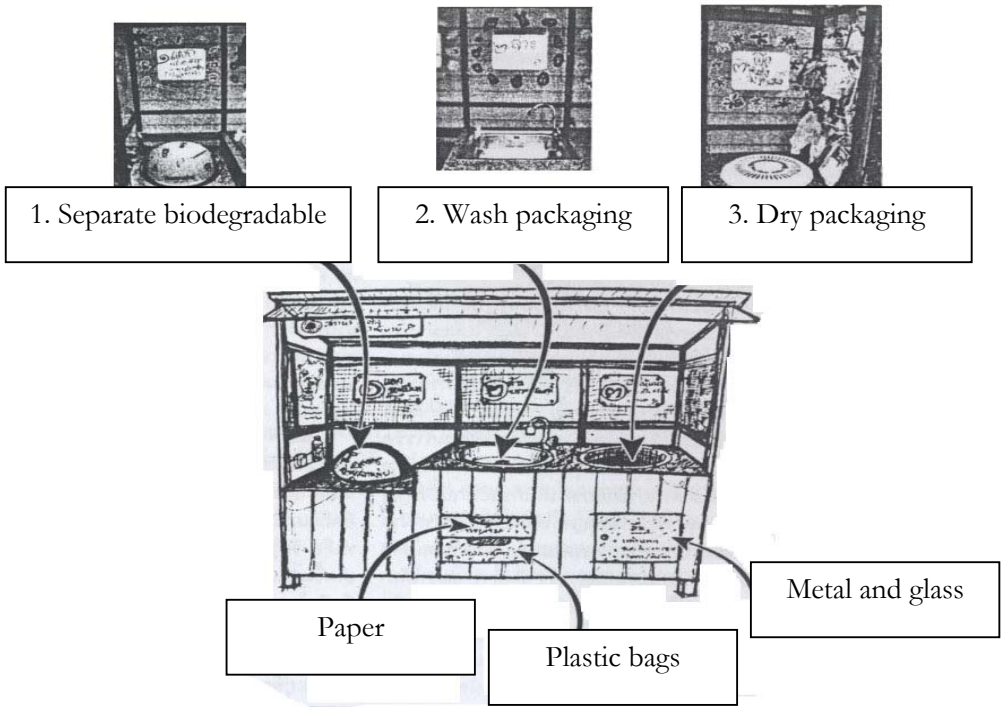

Figure 4-4 Recycling station at Roong Aroon School

*Source: (***ข่าวดี รอบรั้วรุ่งอรุณ** *2005c, 10)*

In addition, it is reported that source separation is not limited to RAS. Some children practice source separation even when they are outside the school. In the case that no facility available in the outside world, they clean and keep their separated waste to dispose it at the school. These children are a change agent in their home. Parents report that they are effectively told by their kids to separate waste. The sorting station performs a task of a multi-material bank in a bring collection system for sorted waste from households. Some parents also introduce source separation into their organisations. For example, one parent who runs a restaurant separates recyclables and sells them to sa leng and composts biodegradable waste (Apidon 2005).

4.4.3 Central sorting

Central sorting is central to recyclables and rest wastes. Food residuals and biodegradable are normally proper sorted at source. Pee Jakchai is responsible for sorting contaminants from biodegradable during preparation of composting process. The separation of recyclables and rest wastes are much more intensive.

Wastes collected from the yellow and orange bins are checked, further sorted by hands and if needed cleaned at the sorting station into more than 40 sub-fractions of recyclables. At the beginning, there was a need for the volunteers to help the working team. Now, despite a lot of works still have to been done, the working team can cope with them by itself.

Recycling is one of the main components in the system. In ZWP, the indication of success in recycling is the proportion of recyclable materials in the wastes sent to BMA. Figure 4-5 is an example. There have been attempts to redefine some items classified as rest wastes into

recyclables. The working team with a help from everyone involves has tried to find a demand for certain materials such as laminated paper. Apidon (2005) regards the redefinition as helping materials to "reborn." Finally, the school found and contacted a Tetra Pak's company, Green Board (Thailand) Co., Ltd., producing "green boards" made out of the components of Tetra Pak beverage carton. Initially, the company felt reluctant to set a new production line for this post-consumer source. But the school guarantees the quality, cleanliness and dryness, of the products. Green Board, later, becomes one of the main alliances of the project and receives not only milk boxes but also other mixed-material packaging.

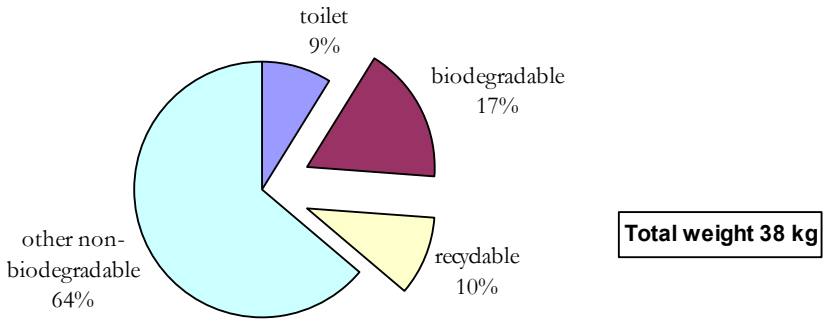

Figure 4-5 Composition of waste sent to BMA in July 2004

Source: (REMD 2005)

4.4.4 Treatment and disposal

There are three main waste treatment and disposal methods in RAS. The first is the production of liquid compost. Some biodegradable, mainly left-over fruits and fruit peels, is mixed with sugar residual and water with a ratio of 1:1:10 to produce concentrated liquid compost. After being left for 3 months, the concentrated product is ready to be dissolved and used for many purposes. The main use of liquid compost is to spray it on piles of compost to get rid of odour and pest problems.

The second treatment method is aerobic composting. Pee Jakchai is take charge of the composing station. The process takes around 7 months to get a valuable product (Jakchai 2005). The compost is used in school organic plantation.

The least preferable but necessary disposal method is exporting waste to BMA. BMA has to guarantee that it will manage exported waste such as HHW in a way the school is incapable to do (REMD 2005). BMA collection truck comes to RAS to pick up exported waste every week.

4.5 Result

Figure 4-6 shows change in the amount of waste sent to BMA. It reduced from the baseline weight of 206 kg/day in February 2004 to 24 kg/day in May 2005. This is almost 90% reduction within one and a half year.

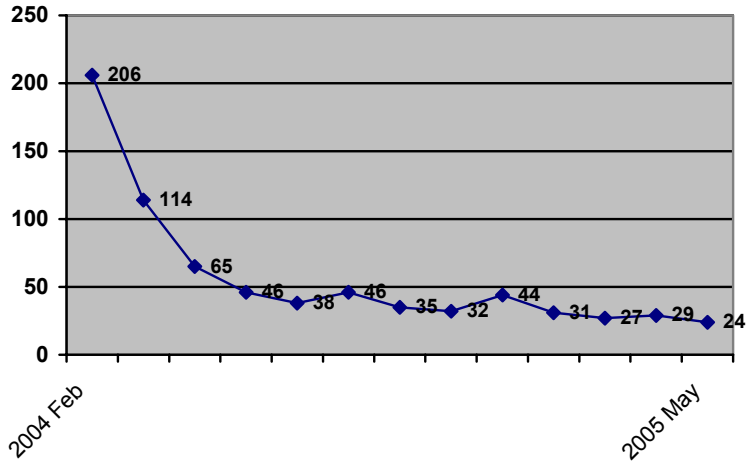

Figure 4-6 Changes in the amount of waste sent to BMA

Source: (RAS 2005)

The project earns around 9 000 baths per semester (at RAS there are three semesters in one academic year) from selling recyclables. The money goes to the school financial office and, later, is allocated to the expansion of ZWP. However, ZWP as a whole is not financially self-sufficient, i.e. it needs a financial support from the school.

In 2005, RAS won the second place from the national competition, namely, "Creative School for the Environment". It is the first school in Bangkok to achieve this honour. Apidon (2005) mentioned that this competition motivated people to work more for the project.

Despite all achievements and satisfaction, the working team is still not totally convinced that the project has already achieved its objectives in changing behaviours and establishing new way of living (Apidon 2005). To really consolidate behavioural and cultural changes, more have to be done.

5 Analysis

5.1 Environmental Problems: A call for changes

The case of Bangkok and RAS reveal the challenge in primitive MSWM systems, i.e. systems collecting and disposing mixed MSW. The practice, despite its simplicity, relates to a number of environmental problems. Here, these problems are grouped into categories:

1. Local pollution emissions such as leachate and contamination of soil, water, and underground water, bad odour, vermin, eyesore disamenity; and loss of space;

2. Global pollution emission of green house gases (GHGs); and,

3. Waste of resources that could otherwise be recovered either in term of material or calorific contents.

The first two categories are mostly related to biodegradable waste. Decomposition process unavoidably gives away bad odour. And bad odour is the main issue in both city and school cases. The controversial of the Rajatheva case was initially a result of discontent among neighbouring communities about the smelly landfill site. At RAS, bad odour made the old collection room very unpleasant. Two main products of an anaerobic decomposition, methane and carbon dioxide, are both prime GHGs. Though the concern over the emission of GHGs from waste disposal sites has not been very strong yet in the country, the issue of global warming has turned out to be central in environmental discussion in the past decades as well as the contribution of the MSWM to the problem. Recyclables, on the other hand, account for the problems in the first two categories to a lesser extent since they are not biodegradable, with paper as an exception.

Commingleness of biodegradable with recyclable materials is a cause of the last category. Each fraction, if kept separated, can be utilised with modest cost. In the case of Bangkok, the presence of saleable recyclables in the mixed stream also gives rise to inefficiency in waste collection, i.e. waste of municipal resources.

The presence of mixed waste stream is a main barrier to solve or alleviate the problems. So, there is a call for a segregation of waste and source separation seems to be one of the preferable options. At the same time, more waste simply means more problems and a need of source reduction is also prevail.

From problem identification, it is clear that proper management of biodegradable waste is in grave need. The composition of MSW before the projects also shows that biodegradable waste was the majority of the waste stream. In the case of the city, it constituted 58% of the total waste entering the municipal responsibility. This amount was not included paper which accounted for another 11%. In the case of the school, there was even more biodegradable in the waste stream at 77%. Simple disposal methods such as landfill and open dumping (in the case of RAS, all waste is left open for a week before BMA came to collect it) tend to cause environmental problems cited above.

Recyclables, on the other hand, led to fewer problems and was not the majority of the waste stream. In addition, not all paper and plastics could be considered recyclables under the normal market situation. As one detailed study revealed, only 10% of paper and plastics presented at one transfer station could rightly be called recyclables (PCD 2002a, ก-2). The

estimation of saleable recyclable under existing arrangement in both cases was around 10%. Therefore, from disposal diversion viewpoint, changes in this fraction can only lead to marginal change. However, financial gain from this fraction should not be, and have never been, overlooked.

5.2 Hitherto Trends at the City Level

5.2.1 Vicious circle in alternative treatment

For years, BMA planned to build alternative treatment options to landfill. Unfortunately, none has been materialised. Political instability creates a vicious circle that hampers the development of MSWM policy. In the last 14 years, no Governor succeeded in re-election. Though every Governor proposed to introduce some sorts of state-of-art treatment and disposal technology, he/she rarely continued the on-going project from the previous administration. The first two years in the office were spent in feasibility studies, compulsory EIA and public referendum. Most projects had enthusiastic advocates, e.g. Governor, bureaucrats, or the supplier of the proposed technology, passed this stage. Then, the issue of how to finance the projects came into the picture. A very large-scale project like the integrated system had to be approved by the central government. The process took years to be finalised. Smaller scale projects such as the biotechnology project were approved at the local level by the City Council within a shorter period. The last practicality was public tendering process in the case that BMA prefers to have private contractor builds and operates the facility, a concept known as Build-Own-Operate (BOO). But none has reached this stage within one political term, four years—the closest is the biotechnology project with its first year budget was approved by the City Council in 2002. When the new Governor came into the office, old projects were abandoned and a wheel of (un)fortune rolled again.

According to inside source in DOPC, the Medium Term Disposal Plan (1997-2006) suffers the same faith and is now "just a pad of paper." The planned MRFs, composting plants and incinerators were all abandoned. The present administration, entering its second year, is in the process of "finding appropriate alternative technology" (Samart 2005). However, source separation has still been promoted through WMP although no compatible downstream arrangement exists. This incompatibility makes source separation for BMA's collection pointless activity. The only justifiable source separation in current arrangement is that of saleable recyclables for the private waste collection business which turned to be a talk of the town in recent years.

5.2.2 Boom in recycling

Since 1997, the salience of saleable recyclables has been obvious to three main actors. BMA sees this fraction as a low hanging fruit in landfill diversion without any need to establish new facility. At the policy level, recyclables are also a root cause of inefficiency in waste collection. With these two reasons, an emphasis in the later phase of WMP is on the reduction and separation of recyclables. This is evident in the DOPC's report of progress of the project. Only the amount of recyclables diverted by partner organisations is reported.

Private waste collection business has grown since the economic downturn in 1997 (Somthai 2005). In the stiffer economic condition with high employment rate, people started looking for new way to earn their living. These people are different from traditional waste collectors. With their capital resource, they bypass traditional career path and start as a waste agent. They also apply the mainstream business administration to the business. Service mind, transparency, and proactive marketing change the face of the business. Those in Wongpanit Group are the clear example of these new-blood agents. They promote source separation of recyclable

among households with straightforward message on monetary benefit derived from specific items with a combination of the sense of doing-something-good-to-the-environment. This strategy seems to work well and even better than BMA's PR. Figure 5-1 compares the emerging business model with the traditional business model.

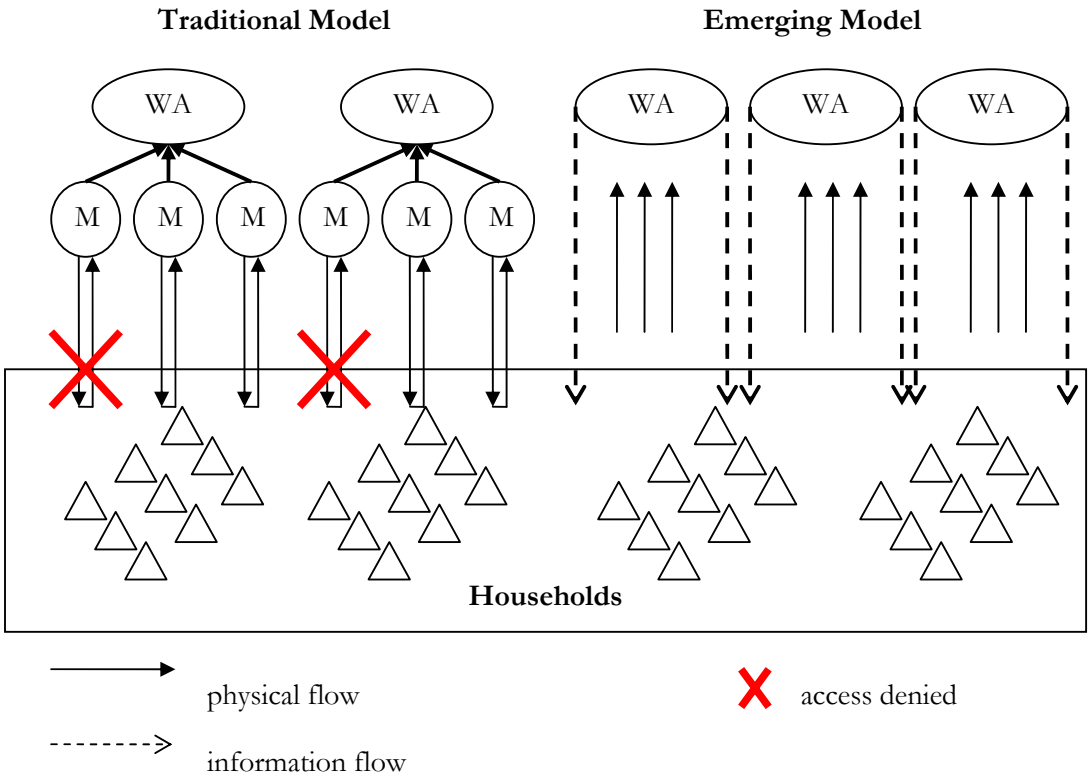

Figure 5-1 Two business models in the private waste collection business

The third stakeholder woken up by the call for more recycling is waste generator. Intensive PR both by BMA and by the business has intended effect on some households. They start to separate recyclables and sell them to the business. The change in several communities is even more impressive. To them, recyclables are perceived as a resource enabling them to solve the problems in the community (Surachai 2005). CBM in this sense is not a management of waste *per se*, but waste is regarded as a resource of a community which can be used to achieve other goal(s). There can also be a management of biodegradable and a separation HHW in CBM schemes. However, these activities happen at a much lesser extent compared to those related to recyclables. The general trend in CBM schemes is striving toward financially sound community business.

In sum, source separation of recyclables to be sold to waste collectors is on the upward way. It is reported that the recovery rate, in which recycling has the lion share, in Bangkok increased from 13% in 1999 to 21% in 2004 compared to the municipal waste stream (PCD 2000, 2005). If we assume that there is not much change in the activity of BMA's collectors and the all kinds of scavenging, the difference can be attributed to change in the practice at source.

5.2.3 Where does the effect fall?

The two trends—lack of alternative treatment technology and boom in recycling—do not lead to any radical systematic change at the city level. Better collection for mixed MSW is the only obvious change in the MSWM system after 1997. However, BMA claims success by showing that after 1997 the municipal waste stream has been continuously smaller than the estimation made two decades ago. For example, in 2004, the difference was between the actual 9 400 tonne/day and the estimated 12 300 tonne/day, i.e. 24% reduction (DOPC 2005, 27). If the growth in recycling was in a range of 10% and there was no new city-scale treatment facility installed in the system (not mentioning that the only composting plant was closed for revision during the period), can this mean WMP contribute to 15% reduction? Unfortunately, one factor, namely, a financial crisis began in 1997 has to be taken into account before any conclusion made.

Figure 5-2 shows change in the amount of MSW and change in gross provincial product (GPP) of Bangkok. There was a clear drop in GPP in 1997. The crisis saw the collapse of many financial and industrial sectors due. Million people, mostly unregistered population, went back to their home as unemployment rate in the capital soared. Decreases in wealth and (unregistered) population inescapably affected the generation of MSW. But these are hardly considered as intended consequences of WMP.

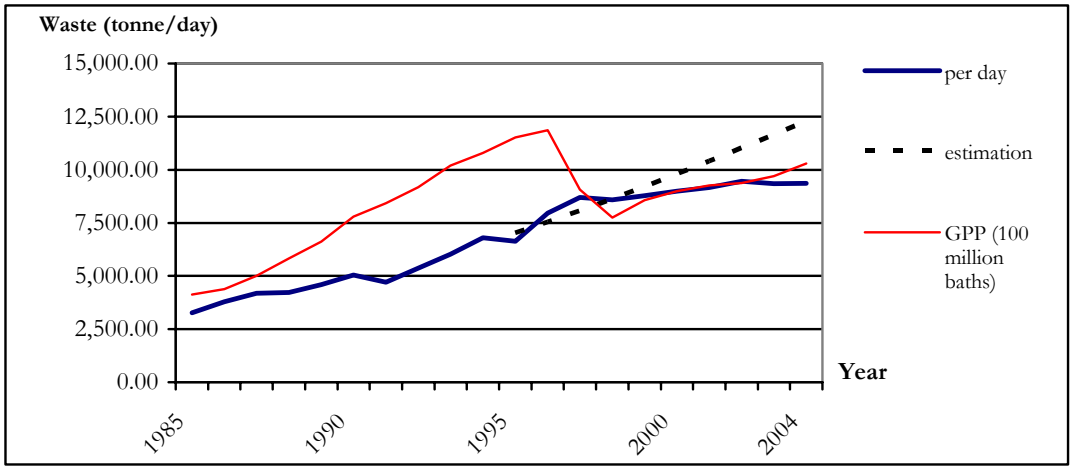

Figure 5-2 Changes in quantity of MSW and GPP in Bangkok

Source: (DOPC 2005b, 27; NESDB 2005)

But, the fact that the trend has not changed much since 1997, even when the economic growth rate was rather high in the last few years, might reconfirms the growth in recycling. As mentioned above, after 1997, there has been an increase in the capacity of the informal sector to absorb more MSW.

What are implications of the change outside the municipal system? There are winners and losers from the change in material recovery business. The winners are waste generators and some waste agents. In the past, the barrier was not the saleability of certain recyclables. Markets are always there. The emergences of CBM schemes and new-blooded waste agents reveal that the real barrier is the tradition arrangement of the business. Its bad image deters people from having a transaction with it, i.e. a social cost exceeds an economic benefit. CBM schemes perform the role of a media between individual households and the business. They

keep the business at distance, and in some cases even replace the business, while making people feel that they make a contribution to the community through participating in the project. On the other hand, waste agents can change their own image to be an (self-claimed) environmentally friendly business to fill up the gap. Either way is able to stimulate source separation of saleable recyclables. Households and/or communities recover some money once lost in the trash while some waste agents enjoy a greater market share.

There are also losers in the business. BMA's collectors and sa lengs are not the favourites of the change. The former and their partners are clear to have a big steak in mixed MSW. More source separation means less recyclables to sort and sell. Interpersonal communication with some of them show implicit negative attitude toward source separation. It is also reported that those who have a close relationship with them, including some District Directors, are also not totally convinced about the merits of source separation. On the other hand, the declining of sa lengs come with a surprise. According to the BMA designed system, they should otherwise be a beneficiary of source separation. However, the way the business develops itself in reality is not compatible to the operation of sa lengs. First, revisionist waste agents bypass them. These waste agents even compete with them effectively. This time a tidy bring collection system beats an untidy kerbside collection system. Second, most CBM schemes control a considerable amount of waste that sa lengs do not have enough money and carrying capacity to take care of. Last but not least, the promotion of source separation in general adversely affects the economy of sa lengs. In the past, sa lengs get their profit from (1) offering a low buying price to uninformed households, (2) scavenging waste bins for free, (3) adding value by further sorting brought materials, and (4) selling them at a rather high price. A decade ago, the profit could be as high as 600 – 700% (Chahleam 2005). The promotion of source separation means households (1) know more about the value of recyclables and (2) how to sort recyclables; (3) leave less saleable items in the waste bins for free scavenging, an activity that according to BMA 2001 Decree, illegal; and, (4) arguably more recyclables enter the market. In addition, though the price of recyclables is driven by mysterious hands, the general rule of demand and supply can still be applied under the *ceteris paribus* condition—more supply lowers the price. The business is now under a transitional period from the one based on a profit margin to the one based on the quantity. Unfortunately, carrying and storing capacities are the shortcoming of being a sa leng. Therefore, the seemingly winner turns to be a loser in the face of change. Traditional waste agents who partner with BMA's collectors and sa lengs are slightly affected by the situation. The fact that they normally control a considerable amount of recyclables is a buffer against the change in the short run, at least.

5.3 School Lessons: Do the city pass or fail?

ZWP at RAS emerged as a successful story in a short time. The school has changed its waste management system from one that was very primitive into a system that is very close to the zero waste concept within a period of over a year. This part identifies some factors contributing to this success and see whether these factors exist at the city level.

5.3.1 Lesson 1: Core business

Before ZWP, the core business of waste management at RAS was waste collection. Two units involved in the process. The first was BCD who provided the waste bins. The second unit was housekeepers who empty these bins on a daily basis. The disposal of mixed waste collected was "contracted" to BMA.

After ZWP, the core business shifts to the management of resources. Treatment of biodegradable waste and central sorting become the main activities in the system. The two

activities are compatible with the promotion of source reduction and source separation. Source reduction clearly improves the result of the project while source separation makes the processes at the central system easier. This repositioning was symbolised through the establishment of REMD. The prime mission of the division is to reduce the amount of waste exported to the environment, which serves as its key performance indicator.

Repositioning includes also image management. Health and safety of people working with waste are top in the priority at RAS. Ms. Pranee (2005) says that "no one will participate in the project if those working at the sorting plant look unhealthy." As mentioned above, the station is always kept tidy. There is also a uniform and protection equipments, e.g. a mask, gloves, boots, for working at the sorting and composting stations to safeguard any harm that may fall on the workers. The sanitary image convinces people that the new waste management system is for better environment compared to the old one perceived as an environmental problem itself.

In the city … Collection and disposal of mixed waste has still been the core business of BMA. A drastic reduction of MSW means a big drop in the budget for public cleansing of DOPC and the districts. The total budget for PR campaign in WMP is less than a per cent of the total direct costs of the system. In addition, BMA over employs but under paid its skilful collectors. These people perform both collection and sorting function. Only BMA salary would not be attractive enough for them. In the current arrangement, they earn a part their living with sorting saleable recyclables from mixed MSW. So, they have anti-source separation attitude. It is far from ideal if people at the contacting point with households do not appreciate what they should promote. It is not surprising that DOPC (2000b, 27) mentioned in its evaluation that "district officers regard the project as marginal and, hence, do not cooperate as much as they should." The implication for the city is to set the right goal and right incentive. Result-based budgeting, which does not punish any saving, might be a part of the answer.

Image is more an issue of the private waste collection business in its old form. Its bad image undermines positive attitude toward source separation and recycling. People are reluctant to perform this environmentally friendly activity because they perceive a loss in social status. Image management is, therefore, needed to make environmental and social cobsiderations compatible.

5.3.2 Lesson 2: Management support

Management support in ZWP is consistently high. The management seems to be very keen on solving the waste problem. Resources are allocated to the project sufficiently. This enables the project to materialise the designed system. The management also give a help at a higher level. Green procurement and regulatory approach toward producers are two examples that will be discussed further below. As a culture at RAS, the school administrators are under the system and they practice source reduction and source separation as others in the school. This has symbolic importance to the project.

In the city … MSWM is important but not high among political agendas. Compared to other investments such as building roads, investment in MSWM has less political gain (Sombat 2005). In additional, it is obvious that waste collection is a top priority. It is an aspect of MSWM that all Bangkokians are in direct contact. So, voters are most concerned over a problem of uncollected MSW (Samart 2005). For now, Bangkok is lucky enough to be able to export MSW (and its problem) out of its boundary. So, the political driver for change is not as strong as it should otherwise be.

5.3.3 Lesson 3: Waste audit

The first step in ZWP was an in-depth waste audit. The process identified the cause and the source of the waste problem. Biodegradable waste was identified as an immediate cause of most of local problems related to waste. Bad odour, pest animals, and leachate all came out from this fraction. But, the presence of biodegradable waste per se was not the root cause of the problem. Biodegradable waste could be managed in an environmentally sound way. Contamination of biodegradable with non-biodegradable wastes was the real difficulty in waste management. Contrary to other initiatives in the waste management in Bangkok, the school was interested more in biodegradable waste than recyclable. The initial review did not have a fraction named recyclable and paper was included under the title biodegradable. Recyclables came into the picture later as their values increased when they were separated from biodegradable waste.

The thoroughly waste audit also spotted a low hanging fruit in the system. At RAS, food residuals from school meals were identified as a low hanging fruit. The existing arrangement made it easy to keep a considerable amount of food residuals separate from other waste. Food residuals can be used as animal feeds without complicated process. The diversion of this fraction changed the parameter of the system dramatically. The fraction of biodegradable decreased from 77% to 27%.

In the city … DOPC conducts a waste audit at the city level on annually. The problem is on how data from this activity are incorporated into a decision-making process. For example, it is questionable why incineration was at the centre of the Middle Term Disposal Plan. The moister content of Bangkok's waste was considerably high for this method, average around 46% during 1987-1996, and this could lead to a system failure like those happened with other incinerators in Thailand.[18]

5.3.4 Lesson 4: Public participation

Public participation in the design phase is effective to build change agents. The environmental volunteers with their understanding gained from sorting and data gathering activities in the first phase are effective change agents. They are very active because (1) they understand the problem and the need to solve it and (2) they have a sense of ownership in the system. Many of them establish a small scale initiative in their own unit. The credit must also be given to the working team to select those who have influence over the development of the system in the later stage, i.e. teachers and staffs.

In the city … there was a public hearing process in a drafting of the Bangkok Development Plan. Key stakeholders like NGOs, community leaders, participated in the process. However, BMA has to make the process more substantive. In the past, it was more like a public "approval" process (Chadaporn 2005). People were invited to listen to the plan after it was already drafted and the consulting period was rather short, i.e. three days for the whole city plan. Not only this did not create any sense of ownership, but it also made people anger when they felt like they voice did not be heard.

5.3.5 Lesson 5: Sequence

The sequence in ZWP started from the set up of the central system toward the promotion of action at source. Readiness of the central system is the best justification for source separation.

[18] An expert in PCD comments that high moister content turns incinerators in Thailand into boilers. In addition, the process leaves damp residuals, instead of dry ashes, which are rather difficult to deal with (Rangsan 2005).

The school got its central system right from the beginning. Sorting and composting stations were installed and operated laboriously before the promotion of source separation. There was also a trial-and-error process going on. For example, Kru Duj and Kru Pui worked out on what could be sold. At the same time, Pee Jakchai had to solve the problem of bad odour in the composting process. During this period, there was no school-wide activity. Besides the working team, there were only environmental volunteers dedicatedly involved.

The choice between source separation and central sorting is illusive. The work at RAS shows that the two are complementary. This is especially true in the beginning of the project. To introduce the change, requirement on waste generators should be keep as simple as possible. This minimal requirement, however, rarely satisfies the need of subsequent treatments. Central sorting bridges the two together.

In the city … opposite happened. RAS BMA adopted a very different path. Households were asked to do source separation before the compatible collection and treatment methods were put in place (which has never been the case). This makes source separation looked like academic exercise rather than something pragmatic. Interpersonal communication reveals that every single person perceives source separation for BMA's collection as a *pointless* activity. Even people connected to RAS do not practice it and prefer to bring separated waste from their home to the school (*สานชุมชน* 2005).

5.3.6 Lesson 6: Children

Children are reported to be very active participants. Conviction about waste as something unpleasant has not taken its root in young children. In this respect, RAS has fortunate context. According to feedbacks from pupils at grade 4, the main barrier that keeps them away from waste in the beginning is bad odour. In ZWP, this barrier has been overcome to a certain extent. Children are also an effective change agent at their homes. Parents, it turns out, feel more shameful when their children tell them innocently what is the right thing to do.

In the city … there are a few CBM schemes target at children such as at Wat Klang scheme, Khlong Toei scheme. But most children, especially those in middle class families, are distant to the waste issue. Initiatives at schools like ZWP at RAS might be a critical change for the future. Lack of human resource is the barrier to overcome. Most schools do not have enough manpower to be reallocated full time. Can over employed workers of BMA with decent knowledge on sorting be relocated to the schools, especially to those under BMA's control?

5.3.7 Lesson 7: Waste bins

Providing waste bins in public area is another contentious issue. Different-colour waste bins are symbols of source separation. But, the past experience at RAS shows that if the central system does not have sufficient capacity to empty the bins and signify to the public that all waste will not be mixed together later, these bins turns to be a symbol of the failure of the system. At RAS, after ZWP, all bins are emptied daily. The presence of the sorting stations and hard-working operators there convince people that their attempt to separate waste will not be in vain. In addition, there is a peer pressure automatically supervise the use of "public" bins.

In the city … waste bins are provided inconsistently. For example, there can be two yellow bins for recyclables but none for biodegradable or the opposite. In practice, all BMA waste bins are for mixed MSW. Removing public waste bins is sometimes mentioned as a way to promote source separation (Wanlop 2005; Thirachai 2005).

5.3.8 Lesson 8: Integration of the private waste collection business

As other waste management scheme, RAS integrates the private waste collection business into its management of recyclables. It uses the service of traditional mobile collectors. The system is designed in a way that a transaction happens between the sorting station and the mobile collector. This arrangement results in an advantage on the part of the school. The sorting station has a considerable amount of various recyclables under its control. Quantity makes some materials, such as plastic bags, saleable. And the school also have enough power to negotiate with the partner mobile collectors to take all recyclables from the station regardless of their prices. A shift from sa lengs to those with a pick-up truck is the consequence of this requirement. This arrangement enables the school to fully utilise the capacity of the business to maximise recycling rate under traditional arrangement.

In the city … though they are a part of the designed system, sa lengs get almost no help from BMA. In addition, according to the article 11 of The BMA Decree on Waste and Nightsoil Collection, Transfer, and Disposal 2001, scavenging waste bin—one of the main activities of sa lengs—is prohibited. As mentioned before, direct contact between sa lengs and households can limit source separation. This might be an explanation why the majority of respondents in aforementioned DOPC survey said that *if* they separate waste, they will give them to BMA's collectors.

5.3.9 Lesson 9: Convenience

To overcome old habit and facilitate behavioural change, the school provides relevant facilities. The promotion of reuse is a good example. It might be too much to ask people to store reusable items on their own. Therefore, the sorting station also acts as a storage room for discarded items that can still be reused. Another example is the promotion of Zero Waste Transaction. In the beginning, before request people to bring their own containers, the school provides table wares on loan. In sum, convenience eases the transitional period.

In the city … nothing besides how-to information is consistently given to enhance convenience. Households in general and partner organisations in 14 target groups in particular asked BMA to supply them with sufficient waste bins or bags for separated waste (DOPC 2000b, 27). In addition, BMA does not have enough equipment to support those who interested in the production of liquid compost (DOPC 2000b, 27).

5.3.10 Lesson 10: Intervention

The school is able to handle biodegradable waste and the private waste collection business is able to handle a fraction of non-biodegradable. Increase convenience facilitates the change in consumption pattern to a certain extent. However, without any intervention on the markets, the promotion of source reduction is limited to a certain extent. In addition, there is a part of non-biodegradable waste that the school under the business-as-usual condition is not able to divert from final disposal. When the limit is hit, there are two options: to be content with the situation or to go beyond the realm of private market. The latter was chosen in the RAS case.

Three instruments are utilised at RAS to overcome the limitation. The first instrument is a subsidy to a reprocessor to expand his production line. The school guaranteed Green Board (Thailand) Co., Ltd. that it would be responsible for the pre-treatment of composite waste. The cost of these pre-treatment including washing, drying, and packing, is hardly financially worth the revenue gained at a rate of 1 bath (0.025 USD) per kg. Actually, there were some other schools that partnered with the company but then withdrew simply because the activity

did not make private cost-benefit sense. RAS seems to be willing to subsidy the activity with a higher aim, i.e. environmentally sustainable waste management and green education, in mind.

The second instrument is regulatory. Shops in the school are requested to cooperate in the Zero Waste Transaction campaign. This is possible when the school governing body ensured that all shops were under the same rule and that it would responsible in explaining with the people on the merit of such change. Timing was also critical to the campaign. The campaign did not take off until September 2004 when the school felt that there was sufficient support from the consumers. If the consumers were willing to give up receiving free packaging or using certain types of products, the producers would comply with their demands. As mentioned before, the school also facilitated the transitional period by providing table wares.

Green procurement is the last instrument used at RAS. RAS learns well during the project on recyclability of specific products. This knowledge is used in the procurement of the school. Now the school becomes a royal customer of Green Board (Thailand) Co., Ltd. New 20 washing stations are built from green board. In a near future, glass will replaced melanin in the school cafeteria.

In the city … nothing has been done yet. But now BMA is working with the central government to review the possibility of introducing take back responsibility for packaging (DOPC 2005b, 47).

6 Conclusions and Recommendations

6.1 Conclusions

Municipal solid waste management (MSWM) is an important aspect of sustainable development. A sustainable MSWM system is a system that (1) minimise waste, (2) maximise resources recovery, (3) minimise negative environmental impacts of the system, and (4) maximise its coverage (UNEP 2005). Sustainability calls for a move away from traditional arrangement of MSWM, namely, collection and disposal of mixed MSWM. Action at source becomes one of the main characteristics of sustainable MSWM.

MSWM in Bangkok before 1997 could hardly be classified as a sustainable one. The municipality, Bangkok Metropolitan Administration (BMA), provided a collection of mixed MSW which later disposed at the modified landfill sites. The city also faced rapidly growing MSW stream at the average rate of 9% per year. Under the 5th Bangkok Development Plan, BMA tried to make the system more sustainable. The plan incorporated a promotion of source reduction and source separation through the Waste Minimisation Project (WMP).

Even its continuation for 7 years, its impacts seem to be minimal especially in the area of source separation or BMA collection. Though the amount of MSW has grown at a decreasing rate since 1997, this is arguably a result of external factors, such as the 1997 economic crisis, more than intended consequences of the project. A lack of public cooperation has still been mentioned as one of the main problems in the system (DOPC 2000b, 27; DOPC 2003b, 1). However, Roong Aroon School (RAS) has worked with Bangkokians in its Zero Waste Project (ZWP) and within over a year has an absolute reduction of 90% of waste entering final disposal. Behavioural changes are reported among participants. But even these people do not cooperate with BMA's promotion of source reduction and source separation (*สานขุมชน* 2005). Thus, the difference might not have something to do with a real lack of public cooperation. The more likely cause is on the managerial side of the promotion of source reduction and source separation.

A comparison between the city and the school shows that, despite a similar system designed, the sequence of actions/inactions makes the two different. BMA started with the promotion of source reduction and source separation through intensive and expensive public relation campaigns. It has, however, never been able to materialise the central system it designed. This was largely due to political instability. Even in 2005, there is neither central sorting plant nor new alternative treatment methods available. Separate collection is obviously expensive and incompatible component in such a system. However, lack of separate collection and alternative treatment and disposal method render source separation pointless. The only justification for any action at source is the operation of the private waste collection business and emergence of several community-based management (CBM) schemes, both of which focus mainly on saleable recyclables. But their formal relationship with the central system is very weak. In sum, people do not cooperate with BMA because they see no good reason in doing so.

At RAS, things were done in a reverse order. Central system as designed was established right after a limited but intensive public participation in a design stage. In the beginning, the promotion of source reduction and source separation would not be done unless necessary such as in the case of food residuals, and most of the works were done in the central system. But when the performance of the central system was proved, a stint of campaign was made to

promote source reduction and source separation. Some are even similar to those happened in the cutting-edge developed country such as producer responsibility and green procurement.

Ten factors contribute to the success of ZWP. There are (1) core business of waste management, (2) management support, (3) initial review, (4) public participation, (5) sequence, (6) (working with) children, (7) waste bins, (8) integration of the private waste collection business, (9) convenience, and (10) intervention on the markets. BMA gets some of these to certain extent but still fails to get others right, especially the fifth one.

After the Middle Term Disposal Plan (1997 – 2006) fails to have its intended effects, MSWM in Bangkok goes into a certain direction. A lot of attention has been put into a management and source separation of saleable recyclables as a valuable resource. However, as the school case shows, this fraction is more like a bonus in the MSWM system. Biodegradable waste, on the other hand, is the cause of most of the problems related to MSWM but its importance has been played down to a certain extent in Bangkok. In the next section, some recommendations for the city are made with this trend in mind.

6.2 Recommendations

Recommendations are presented in accordance to BMA's categorisation of waste into four fractions. They are derived from experiences gained at RAS in combination with opinions of people in Thai waste management circle gained during the study.

6.2.1 Biodegradable: The problem

BMA is a responsibility body of MSWM in Bangkok. As a waste manager, it should focus more on the problem in the system, namely, biodegradable waste rather than saleable recyclables. It is absolutely fine if other stakeholders such as the business, communities, NGOs, etc. put a lot of attention on saleable recyclables and BMA should also help them doing so (see a recommendation below). But the main responsibility of BMA is how to utilise its resource in an efficient way to minimise negative impacts on the environment form its MSWM. In this respect, recyclables pose less problems than other fractions.

From RAS experience, there are two simple approaches which can be combined in the management of biodegradable waste. The first approach is to reduce biodegradable waste to the level that the central system can cope with. This is the case of a diversion of food residuals. The second approach is to have a sufficient capacity to handle waste at the central system. This is the case of the composting station.

BMA should promote the reduction of this fraction at source. In the past, it encouraged people to produce liquid compost from food waste which was a good idea. But there was a mismatch between local supply and local demand. The result was a mere production of liquid compost for local use but not a continuous source reduction process. To overcome this barrier, BMA can provide markets for the product. BMA can use liquid compost in (1) its public cleansing function, (2) maintenance of public parks, and (3) composting and/or landfill processes to reduce odour and pest problems. It might be able to get the products for free or by buying it at an *avoided* disposal cost.[19]

In addition, the use of food residuals as animal feeds can also be an effective source reduction, as RAS shows. But scale it up at the Bangkok level seems impractical. Instead, BMA can act as

[19] The avoided cost can be thought of as the amount saved because the ton of material was not disposed.

a coordinator between point sources of food residuals such as restaurants and cafeteria and animal feeders. It is recommended that BMA should provide subsidy to this activity, not in cash, but in kind. For example, BMA may provide waste generators with separate container for this purpose. In addition, it can even provide separate collection and storage of this fraction for animal feeders without charge. Again the logic of an avoided cost involves here. This utilisation must take consumer concern over sanitation into consideration.

At the central system BMA got its composting plant back in action in 2005. However, the plant has a capacity of only 1 000 tonne/day which is less than a fifth of the total biodegradable waste generated in the city. Moreover, the plant is located at TS 3. All in all, its existence is not sufficient to justify a city-wide source separation. But a pilot project to promote source separation of biodegradable in the districts sending waste to TS 3 is advisable. A separate collection to give positive feedback to households is highly recommended. In addition, frequent collection might increase public participation owing to a decrease in odour problem. Separate collection for biodegradable may not drive the collection cost of the system. Smaller and cheaper trucks without a compactor, instead of big and modern waste collection truck, can be used to collect biodegradable waste with high density.[20] If this is applied to Bangkok, the collection cost can even go down because (1) less investment cost, (2) less workers per shift, and (3) *no recyclable for BMA's collectors to sort.*

In the future, BMA needs to break through the vicious circle and scale up its capacity to deal with biodegradable waste. Alternative treatment and disposal technologies to modified landfill, including a state-of-the-art sanitary landfill, should be put in place. Of course, this requires resources. But, from interpersonal discussions, lack of resources is not a problem, or at least, the biggest one. Actually, the estimated cost per tonne in the biotechnology project was even lower than the tipping fee of (modified) landfill. The main barrier is political timeframe. But the situation now looks much better than before. Oil price is a main driver for the integration of waste and energy sectors. And the political and financial support from the central government is already there. An expert at PCD mentions that Bangkok should be a leader in this movement (Rangsan 2005). Now everything is boiled down on how fast and acceptable the present administration can get the new feasibility study done. DOPC has a potential to facilitate the process if it conducts a solid and impartial study on alternative method based upon the nature of Bangkok's waste, instead of does a feasibility study to legitimate certain technology. In addition, transparency and public consultation can prevent the difficulties once emerged in the integrated system project.

In addition, the city has an advantage over the school. The city has an influence over the operation of final disposal—landfill operators—while the school hardly has such power over BMA's operation. It is advisable that the two modified landfill sites should be upgraded into sanitary landfill sites as soon as possible. The costs of upgrade might reflect in higher bidding price of existing operators. However, this might be considered favourable since it makes the economics of controlled disposal such as biological treatment, thermal treatment, and state-of-the-art landfill more competitive (Sutthida 2005). In addition, BMA should manage the contract in a stricter way which beneficial to local health and the environment (Samart 2005). As the Rajatheva case showed, cheap tipping fee due to suboptimal caretaking today can mean liability, complicated remediation and rising cost in the future. Prevention is better than cure.

[20] This point was brought up during the discussion with the author's supervisors.

6.2.2 Saleable recyclables: The low hanging fruit

Saleable recyclables under current conditions are low hanging fruits in the system. But just few fruits are still left to pick, e.g. DOPC reported that they accounted for only 8% in the mixed municipal waste stream. As mentioned before, from a holistic view, any change in the management of this fraction will lead only to a marginal change. However, there are still issues of who and how to pick these fruits.

Many mechanisms are working at the city level to recover saleable recyclables: no source separation with BMA's collector and scavenging; limited source separation with traditional arrangement of the business; a commercial partnership between individual households and the business with a new arrangement; and CBM schemes. However, there is no attempt to integrate their capacity yet. Therefore, BMA can optimise the management of recyclables based on existing resources.

First and foremost, two hidden activities in its system need to be spelled out. It is too resource-intensive for BMA to let its collectors sorting mixed waste during collection. On the other hand, sub-optimal investment is evident in the case of scavengers working at the transfer stations. If these can somehow be integrated, the result might be the optimal use of resources. For example, BMA might provide a collection for mixed MSW (except for biodegradable waste sent to the composting plant at TS 3) with fewer crews in a collection team. One waste management company mentions that it uses *at most* 3 crews to operate the same kind of collection truck (Suthida 2005). Estimated saving from collection cost can be arguably more than 400 million baths (10 million USD) a year. This money can then be reinvested in modernised the transfer station into a labour intensive MRF. Insiders in the private waste collection business mention that if only a mechanic belt installed at the transfer stations, a gain in productivity can be enormous. Formalisation of a scavenging activity there can also improve the quality of life of these scavengers. Fair price and better working environment are expected. All in all, there is a wealth transfer from the sub-contractors and BMA's collectors to scavengers at the transfer stations.

Sa lengs can be integrated into the system to provide kerbside separate collection for recyclables. Waste agents can be seen as material collection banks in a bring collection system. . The cases of RAS and Wongpanit Group prove that better image—especially in term of sanitary and honesty—is a key to success. BMA might be able to help them improve their image. For example, a registration system may be introduced. BMA can provide uniform to registered collectors in returnIn addition, BMA must make clear in its PR where people can bring their separated recyclables to.

BMA should also provide some helps to CBM schemes. These schemes can also be seen as material collection banks in a bring collection system, especially those at schools. Nowadays, lack of resources, let it be man, money, and/or management, threatens the survival of these schemes. In most cases, leaders in these schemes, despite their dedication, have their own occupation to take care. Can BMA reallocate some of its over-employed collectors to help these schemes? These collectors have good understanding about the business in general and sorting in particular. Some schemes, not based on commercial basis, also face a financial problem. For example, recently the Khlong Toei CBM scheme, despite strong leaders and its own network with a few communities, has to hold its activity on ad hoc basis depended on an availability of external financial source (Wanlop 2005). Can the logic of an avoided cost also be applicable in this case?

In sum, rearrangement of the management of recyclables by integrating and reducing redundancy in the system is proposed. Source separation for recyclables is preferable since

there are well-established markets for these materials already out there. But BMA should not involve in the collection of these materials since there are many possibilities in the system to exploit. Central sorting already existing in the system should be formalised and upgraded.

6.2.3 Household hazardous waste and rest waste: Different challenges but similar solution

The last two fractions in accordance with BMA classification are HHW and rest waste. Each presents different challenges in relation to the MSWM. The problem of HHW is how to separate it from MSW. The problem of rest waste is how to reduce it. Though the problems are different, an answer to them is not likely in the market, as in the case of saleable recyclables, or in the control of waste manager, as in the case of biodegradable. One answer, as RAS shows, is public policy to intervene the business-as-usual conditions.

Many policy instruments in the three families, regulatory, economic, and informative, are available. Here, only three examples based on the experience of RAS are discussed. The first is governmental subsidy. If the government feels that some action should be encouraged, it can give subsidy to that activity. For example, RAS gives subsidy to Green Board (Thailand) Co., Ltd. to make recycling composite packaging (more) financial viable. BMA can do the same. Integrating items that have alternative treatment methods available such as composite packaging and HHW into the operation of the private waste collection business is advisable to keep the additional cost as low as possible. What is needed is economic incentive for the business to accept these items. So, BMA might provide a subsidy for the private waste collection business to add some rest waste and HHW into its transaction list. If this artificial market is created, the business will treat these items as other saleable recyclables. The problem is whether BMA has enough money to do.

Then, it comes to the second option: making the producers pay. Producers of these products can be requested to give the subsidy to the business instead of the local government. One item that might be suitable for such EPR scheme is plastic bags. One study shows that it constitutes around 15% by weight of the total waste at TS 3. It is recommended to internalise the waste management cost of plastic bags. The decision to make the additional cost visible by charging consumers can be left to the producers.

The last instrument is green procurement. Through green procurement, the productions of environmentally friendly products are encouraged. The effect of public green procurement is much larger than that of RAS.

6.3 Suggestions for Future Research

There are a number of issues related to MSWM in Bangkok in particular and in Thailand in general waiting for more studies. Recently there is a lot more attention put on the sector. However, it is still contentious which direction the city and the country will be directed. In the case of Bangkok, a decisive study on appropriate technology is in grave need. Other issues such as the role of the waste collection fee, politics in MSWM are also worth studying.

For non-governmental sectors, the private waste collection business is by its nature complex and under transition. Exploring this business can be a very challenging task. At the same time, each one of CBM scheme is special on its own right and full of story.

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Abbreviations

BMA	Bangkok Metropolitan Administration
CBM	Community Based Management
DOPC	Department of Public Cleansing
DSM	Demand Side Management
EIA	Environmental Impact Assessment
EPR	Extended Producer Responsibility
GPP	Gross Provincial Product
HHW	Household Hazardous Waste
ILGI	Institute for Local Government Initiatives
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NSO	National Statistical Office
PCD	Pollution Control Department
PPP	Polluter Pays Principle
RAS	Roong Aroon School
REMD	Resources and Environmental Management Division
RDF	Refuse Derive Fuel
SSM	Supply Side Management
TS 1	Tha Raeng solid waste transfer station
TS 2	Nong Khaem solid waste disposal and nightsoil treatment plants
TS 3	On-Nuch solid waste and nightsoil treatment
UCF	Urban Community Foundation
US EPA	US Environmental Protection Agency
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environmental Programme
WCED	World Commission on Environment and Development
WMP	Waste Minimisation Project
ZWP	Zero Waste Project

Appendix A Pictures from the study

A.1 Bangkok

A.1.1 Waste in the city

A.1.2 BMA collection

A.1.3 Traditional waste collection business

A.1.4 Wongpanit Group







A.1.5 CBM Schemes

A.2 Roong Aroon School

A.2.1 The sorting station, the liquid compost station, and the composting station










A.2.2 Waste bins at RAS

A.2.3 Source separation

Photographs: Panate Manomaivibool

(except that of the old collection room at RAS contributed by the school)

Appendix B Wongpanit Group's Leaflet

Source: (Wongpanit Group)

Appendix C WMP Campaigns in 1999

Media	Description
Television	• 34 episodes of 1-minute documentary, "*คิดก่อนทิ้ง*" [Think before You Throw], broadcasted between February – September 1999 in one channel at 2 p.m.; • 30-second spot, "*ขยะพิษต้องแยก*" [Separate HHW], broadcasted between March – May 1999 in 3 channels; • 30-second spot, "*ถึงเวลาต้องแยก*" [Time to Separate], broadcasted between October – November 1999 in 4 channels.
Radio	• 5 30-second spots on appointed collection and source separation broadcasted between December 1998 – March 1999 in 5 channels; • 30-second spot, "*ขยะพิษต้องแยก*" [Separate HHW], broadcasted between March – August 1999 in 6 channels; • 4 30-second spots on source separation broadcasted between April – September 1999 in 5 channels.
Newspaper	BMA advertised the project in several newspapers from time to time.
DOPC's publication	• 5 000 copies of DOPC quarter journals were given to other BMA service providing units.
Ad hoc media	• 562 small billboards (0.60 * 1.20 m) • 38 big billboards (1.20 * 2.00 m) • Posters and leaflets

Source: adapted from (Pimjai 1999, 53-57)