SOLID WASTE MANAGEMENT IN SOUTHEAST ASIAN COUNTRIES WITH SPECIAL ATTENTION TO MALAYSIA

M. N. HASSAN, T. L. CHONG, M. RAHMAN, M. N. SALLEH, Z. ZAKARIA AND M. AWANG

Department of Environmental Sciences, Faculty of Science and Environmental Studies , Universiti Putra Malaysia, 43400 UPM-Serdang, Selangor, Malaysia

SUMMARY: In Malaysia and other Southeast Asian countries, solid waste problem is one of the most debatable environmental issues. These include the ugliness of streets, parks and public places due to scattering of wastes, untidiness of areas surrounding garbage bins, irregular collection of wastes, indiscriminate dumping of wastes, and the more recent issue on the privatisation of solid waste management. These problems stem from the fact that the amount of solid waste generated in the country is increasing at a geometric rate especially in large cities like Kuala Lumpur and the increasing awareness among the general public on environmental issues.

Today, the discussion on solid wastes is becoming more distinctive when newer 'emerging' issues are brought up into the surface. Nevertheless, earlier issues that have not been resolved include the problem of getting consistent and reliable data on solid waste, sub-standard systems and poor service level for storage, collection and disposal and poor accounting or budgeting systems for solid waste services. The issue of recycling has never been resolved. At international level, solid waste management is also discussed.

Thus, where are the positions of the Southeast Asian Countries in particular Malaysia in regards to solid waste management? Have we solved the basics? What is the best system to treat solid wastes? Recycling of wastes–is it a myth? How much has solid waste management been an international issue? All these questions are discussed in this paper.

1. INTRODUCTION

In Malaysia, solid waste problem is one of the most debatable environmental issues. Other issues that have received extensive public attention are the problems of haze and air emissions from antropogenic sources, water problem both in terms of quantity and quality and indiscriminate dumping of toxic and hazardous wastes (World Bank, 1993).

People in Malaysia debates about solid wastes on many issues. These include the ugliness of streets, parks and public places due to scattering of wastes, untidiness of areas surrounding garbage bins, irregular collection of wastes, indiscriminate dumping of wastes, and the more recent issue on the privatisation of solid waste management (Hassan, 2000). These problems

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stem from the fact that the amount of solid waste generated in the country is increasing at a geometric rate especially in large cities like Kuala Lumpur and the increasing awareness among the general public on environmental issues (Hassan *et al*., 1997). In the past, we might not be so concerned of the impacts of open dumps on the environment. The attitude we might have was "As long as my wastes are collected, I don't care about where and how that wastes are disposed". Today, the discussion on solid wastes is becoming more distinctive when newer 'emerging' issues are brought up into the surface. The issue of recycling has never been resolved. At international level, solid waste management is also discussed.

1.1 Have We Solved the Basics?

Solid waste management encompasses six functional elements (Tchobanoglous *et al*, 1993). It starts with waste generation, followed by storage and processing at the source, collection, transfer and transport, treatment and transformation processes, and finally disposal. The elements which are considered as basic and fundamental is getting reliable and consistent data on the sources and types of solid wastes, along with the data on the composition and rates of generation. The amounts and composition of solid waste generated are affected by factors like the socio-economic development of the area, degree of industrialisation, and climate. Generally, the greater the economic prosperity and the higher percentage of urbanisation, the greater the amount of solid waste produced (Hassan, 2000).

Have we solved this 'basic' issue? The answer to this question is "no" as until today, periodical information about solid waste is not carried out satisfactorily. Even if it is available, the data is scattered and inconsistent, and the method for data collection has not been properly defined and thus is subjected to a lot of variations and uncertainties. Data gathered and reported by the private companies are different than those collected by local authorities and this could also be different to those reported by researchers. This is because there is a significant different between the amount of waste generated at source (normally reported by researchers) and the amount of waste collected (normally reported by local authorities) and these two figures are also different to the amount of waste disposed (normally reported by private companies).

1.2 How Much Waste We Generated

Data on solid waste generation rate in Malaysia was reported in 1991 (Hassan, 2000) and some of this data was published by the World Bank in 1999 (Hoornweg & Thomas, 1999). The most recent information on solid waste generation rate in Malaysia was in 1998 and they are summarised in Table 1. Results in the table indicate that amount of solid waste collected is 70 percent lower than the amount of waste generated. The remaining 30 percent not collected could be due to illegal dumping, waste diversion at source or diversion of wastes during collection for recycling purposes.

It is anticipated that the wastes generated both from the residential and commercial establishments will increase correspondingly with the increase in the total population, improvement of standards of living and changing life style of the people. Most major urban centres produce large quantities of wastes. In some industrialised urban areas, the amounts of wastes from industries were much higher than residential and commercial wastes combined (e.g. Shah Alam and Petaling Jaya). This is due to the increase in new housing developments, industrial activities as well as commercial activities.

Table 1 - Estimated Solid Waste Generation in Local Authorities in Malaysia

State	Estimated Population	Waste Generated (tonnes/day)	Amount Collected (Tonnes/day)
Perlis	77,650	62	43
Kedah	1,581,483	1,265	885
Pulau Pinang	1,290,924	1,033	723
Perak	1,618,483	1,295	906
Selangor	1,583,572	2,375	1,900
N. Sembilan	578,035	462	323
Melaka	611,481	489	342
Johor	1,612,650	1,290	903
Pahang	634,660	508	358
Terengganu	583,907	467	327
Kelantan	1,041,311	833	583
Kuala Lumpur	1,446,803	2,257	2,023
Labuan	66,146	46	32
Sarawak	2,007,528	1,405	984
Sabah	2,115,546	1,481	1,037
Grand Total	**16,850,179**	**15,268**	**11,369**

Source: Ministry of Housing and Local Government (1999)

1.3 Per-capita Generation Rates

Depending on the economic status of the area, the per-capita generation solid waste generation rate varies from 0.45 to 1.44 kilogram per capita per day (Hassan *et al*. 1998a). The national average generation rate estimated for 1991 to 1993 was about 0.711 kilogram per capita per day and this has increased to 0.8 kg/cap/day from 1994 to 1999 and in the year 2000, the per capita generation rate is expected to increase to about 1 kg/day.

1.4 Waste Composition and Characteristics

In the past, reports on solid waste composition were mainly on the physical characteristics (Ghazali (1997); Hassan (1998b); Hassan *et al.* (2000)). Statistics gathered by the government indicated that the average amount of organic wastes for high income areas was around 48.32 percent. This is followed by paper (23.56 percent), plastic and rubber (9.37 percent), metal (5.93 percent), wood (4.82 percent), glass and ceramics (4.03 percent) and textile (3.97 percent). This figure was constantly reported in most literature.

A recent study conducted for about a month in Kuala Lumpur has revealed different results. Samples were taken and analysis of wastes was carried out using a truck load method as recommended by Corbit (1998). In this method, trucks from designated residential areas in Kuala Lumpur were emptied in an enclosed area and wastes were sorted according to percentage weight of each component. This was one of the most comprehensive studies conducted on wastes characteristics and the first to investigate the calorific value of wastes.

1.5 Physical Characteristics

The physical sorting of waste was recommended by Corbit, 1998 and the results are presented in Table 2. The bulk density and moisture content of the wastes are also presented in the tables. The results are much different from those reported in previous publications (Hassan,

2000; Ministry of Housing and Local Government, 1988, 1999). The most obvious is the composition of organic and food wastes. The amount of organic wastes for residential area range from 62 to 72 percent compared to less than 50 percent reported in previous publications including the figures by the World Bank (Hoornweg and Thomas, 1999).

Table 2 - Physical Characteristics of Kuala Lumpur Waste According to Different Socio-economic Background of the Resident (Wet Basis as Discarded at the Landfill)

	Average Waste Composition as Wet Basis (Percentage Weight)				
	Residential High Income	Residential Mid Income	Residential Low Income	Commercial	Institutional Office
Combustible					
Food waste & organic	62.0	70.8	71.6	79.0	58.7
Mix paper	8.0	5.1	5.8	5.1	7.9
Mix plastics	9.3	11.3	13.3	9.1	16.1
Textiles	2.2	1.3	2.4	0.8	0.8
Rubber & leather	0.8	0.6	0.5	0.8	0.1
Wood	0.5	0.4	0.5	1.9	0.2
Other combustible	0.0	0.0	0.0	0.0	0.0
Yard waste	11.8	4.7	1.0	0.2	9.7
Fine	0.6	0.7	0.5	0.1	0.5
Sub-total	95.0	94.7	95.5	97.1	94.0
Incombustible					
Glass	1.6	1.2	2.1	1.2	1.1
Ferrous	2.8	2.4	1.9	1.6	4.8
Aluminium	0.1	0.1	0.1	0.1	0.1
Nonferrous	0.0	0.0	0.0	0.0	0.0
Other inorganics	0.0	0.0	0.0	0.0	0.0
OBW	0.6	1.7	0.5	0.0	0.0
Sub-total	5.0	5.3	4.5	2.9	6.0
Total	100	100	100	100	100
Bulk density (kg/m^3)	273.1	310.7	278.8	372.1	277.1
Moisture Content (Wet weight)	52.9	62.7	52.6	66.2	59.9

1.6 Energy Contents of Malaysian Wastes

Solid waste samples that were sorted at the landfill site were analysed further for energy contents using bomb calorimeter and the ultimate analysis (determination of the percent C, H, O, N, S and ash) as suggested by Tchobanoglous *et al*. (1993). Results from the ultimate analysis were used to calculate the heat value of waste using the modified Dulong formula. Both the low heat values and high heat values were evaluated and the results are presented in Table 3. The results have great implication on the technical feasibility of an incinerator or other thermal treatment plants in Malaysia. It is a known fact that the factors that could affect the efficiency of an incineration plant are the percentage of combustible components, the moisture content and calorific value of wastes.

Table 3 - Energy Content of Residential, Commercial and Institutional Solid Waste in Kuala Lumpur

	Energy Content (Kcal/kg) (wet basis)*				
	Residential			Commercial	Institutional
	High Income	Mid Income	Low Income		
LHV	1,750	1,570	1,957	1,390	1,650
HHV	2,370	2,230	2,770	1,910	2,414

** Energy content derive from ultimate analysis results using modified Dulong Formula*
LHV: Low heating value
HHV: High heating value

2. FUTURE PROSPECTS FOR CAPITAL INTENSIVE TREATMENT SYSTEMS?

2.1 What is the Best Treatment System?

To provide waste disposal systems that are technically feasible, reliable, cost effective, environmentally sound and socially acceptable, there are number of waste disposal technologies that have the potential for application in Malaysia. These include landfill, incineration, composting and the more recent systems such as pyrolisis and refuse-derived fuel. Using data published by Hassan (1991) and methods of evaluation introduced by Wilson (1982), a multi-criteria evaluation was carried out by comparing all the available technologies against a series of criteria, which are grouped under economics, technical and environment. The evaluation shows that the most appropriate waste disposal system for Malaysia is by sanitary landfill. Sanitary landfill is well established, easily acceptable to local conditions, reliable and flexible enough to cater for future requirements. In addition, the system has the lowest investment and operating costs which directly affects the affordability of the system. The environmental impacts of the system are relatively low and manageable. There are generally two major environmental concerns with sanitary landfills: the generation of leachate and obnoxious gases. As long as proper collection and treatment systems are provided, these problems can be reduced to acceptable international levels.

2.2 Recycling of Wastes – Is It a Myth?

Most municipalities in Malaysia are facing the problem of getting new disposal sites as most of the existing disposal sites are nearly exhausted. In 1990, out of the 230 waste disposal sites available, 80 percent of them have remaining operating lifetime of less than 2 years (Matsufuji and Sinha, 1990). Thus, waste managers should be flexible to accept new ideas and technologies particularly programmes of waste reduction and recycling in their waste management plans so as to conserve disposal space and resources.

There is no standard definition of recycling, but a widely accepted view is that recycling constitutes "the beneficial reuse" of products that would otherwise be disposed of. Recycling of municipal solid wastes (MSW) is capable of meeting several objectives. On one hand, it reduces the amount of waste introduced into the environment; on the other, it reduces the use of primary commodities and increases energy recovery.

2.3 Recycling Systems

At present, there is no organised programme for recycling in Malaysia. Stakeholders are now working on their own programme and objectives. Measures need to be taken to integrate the segregated efforts of the individual stakeholders into a single recycling programme. As such, measures have to be taken of both short-term and long-term perspectives. Aim of short-term measures shall be to mobilise the stakeholders towards active recyclable generators and enhance their participation. Long-term measures aim toward increased diversion of wastes for recycling, efficient recyclable collection system and organised end-market. The process of the whole recycling collection system is illustrated in Figure 1.

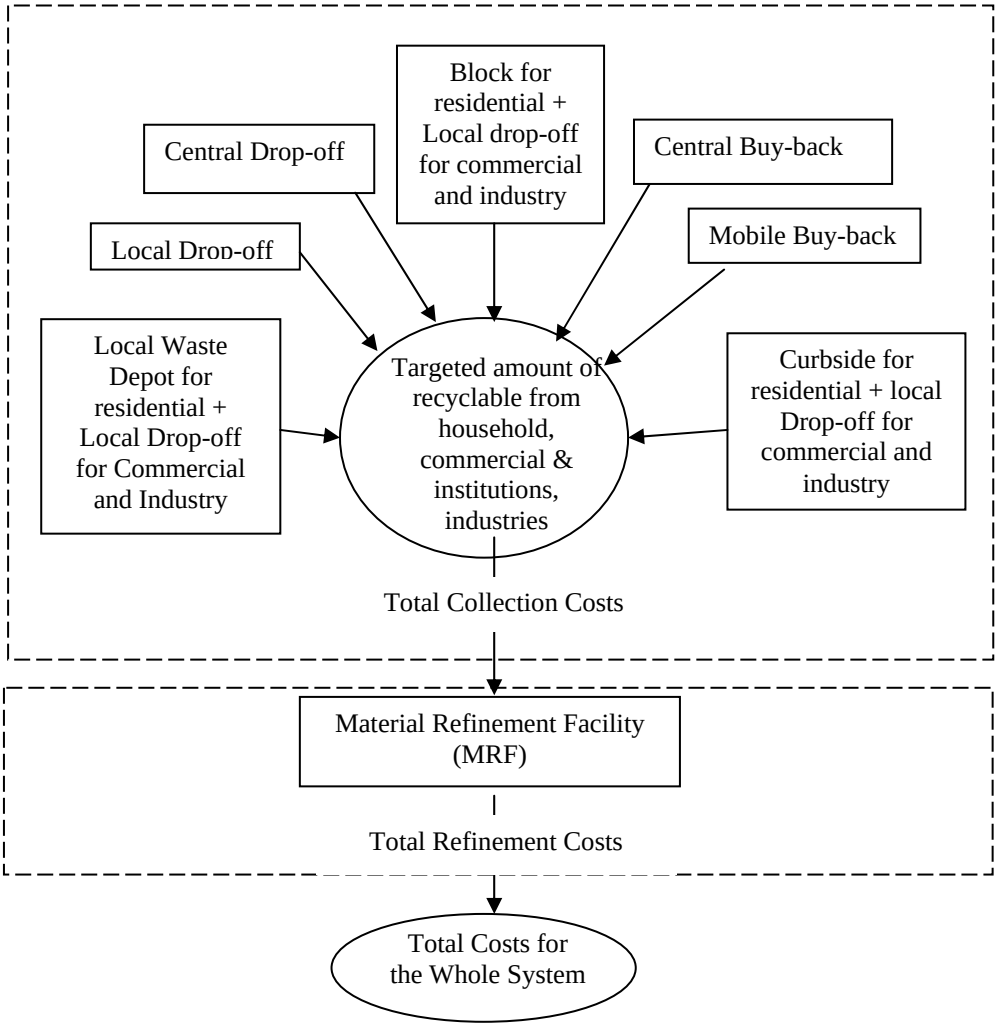

Figure 1. Various Options of the Whole Recycling Collection System

2.4 Economic Benefits/ Potential Analysis

Economics of the recycling operation is governed by four main factors, namely:

- Costs associated with recyclable collections system and recycling rate from the beginning of the waste generation point;
- Revenue gained by selling of the recycled materials,
- Costs associated with the transportation and disposal of waste materials, and
- Costs associated with the resource savings due to recycling

It should be recognised that a recycling operation alone cannot be either economically viable or self-sustaining in the present market mechanism unless the above-mentioned factors are considered altogether (Gotoh, 1989).

A case study on the recycling potential in Kota Kinabalu city has been carried out. This city is currently producing about 238 MT solid wastes daily. The city has a population of about 350,000, over 60,000 households and currently about 238 tonnes of wastes is generated everyday. At present, there is no formal recycling program in existence by the City Council (DBKK). However, there are about 18 scrap traders who buy more than 18000 tonnes of metal and metal scraps. Besides, there are 6 companies that trade paper and cardboards. Scavengers and municipal collection crews provide paper recyclables for these companies.

The study shows that if a recycling program is run for a project life of 15 years, a considerable amount of revenue can be generated from the recycling activity. USD16.8 to USD23.2 per tonne can be saved from savings in landfill space and waste transportation to the landfill site. Aggregated average profit per tonne ranges from a loss of USD13.9 to profit of USD59.7 (inclusive of indirect benefits through cost savings). A summary of the economic and financial benefits of the recycling activity for the whole country has been estimated based on the aggregated figures for the whole period of project life and shown the Table 4.

Table 4 - Summary of Economic Analysis of the Recycling Options

Items (RM/Tonne)	Curbside Collection	Local Drop Off	Central Drop Off	Local Buy Back	Central Buy Back
Investment	108-130	61-73	15-18	61-73	15-18
Operation Cost	25-30	20-24	19-23	210-217	199-204
Cost Savings	64	64	88	64	88
Revenue Earning	174	174	174	174	174
Profit before Tax (Cost Savings included)	104-78	156-140	227-220	(34) - (53)	39-(49)
Profit before Tax (Cost Savings included)	41 - 14	93-77	139-132	(97) - (117)	(41) -(49)
Daily Grand Total for Whole Malaysia (RM million)	0.042-0.23	0.23-0.42	0.40-0.66	(0.35)-(0.16)	(0.15) -0.12

Notes: a. Commingled recyclable including paper, cardboard, metal, glass and plastics;
b. Figures in the parenthesis indicate loss.
c. USD 1.00 = RM 3.80

Findings of the above table reveals that a recycling operation program can be run in a feasible manner if recyclable collections are carried out either by central drop-off or local drop off method where the public participate voluntarily and the target 15% of the waste stream could be recycled.

2.5 What's Wrong with Recycling in Malaysia and Ways to Improve

2.5.1 Legal Aspects

Lack of regulations and guidelines are one of the most serious problems that hinder the success of a recycling programme in Malaysia. National, state and local authorities should formulate regulations, policies and programmes that would be sustainable. As an example, the

programmes in Japan are carried out both through private and public systems (Ogawa, 1994); recycling is carried out through retailers' trade-in systems, barters' activities and community-based systems. About 3,254 municipalities in Japan are involved in separation at source programmes. On the other hand, Germany has in place regulations on deposit system, waste disposal tax and amount of waste to be utilised in production.

2.5.2 Setting Recycling Goals and Priorities

Strategic planning is critical to the success of recycling programmes. The central issue facing planners will be to determine ways to incorporate recycling into the existing solid waste management. As with any new venture, short-term and long-term goals need to be developed so that the process can be guided and monitored along the way (Bullock and Salvador, 1993).

Short-term goals for a recycling programme will be oriented toward planning and implementation. These include developing a recycling plan; determining which recyclable materials will initially be targeted for and how the residential, service commercial and institutional sectors of the community; and securing market agreement and processing capacity. Long-term goals normally pertain to program expansion and attainment of a mandated and self imposed waste reduction-recycling goals.

2.5.3 Strengthening Key Players

Consumers

Community participation is critical to the success of any recycling programme. The recovery of large volumes of high quality recyclable depends on citizen involvement. Wastes separation at household would reduce collection time, hence the collection costs. The two bins or “green bin” system has been very effective for separate collection and retrieval of materials in Germany. More than 5 million households are now using green bins (Lockley, 1989). Effective implementation of the separation of waste at source requires continuous efforts from government and non-governmental organisations to create effective educational programmes which are able to reach man on the street and which stresses not only the importance of recycling but also the protection and conservation of the environment as a whole.

Scavengers

For some, scavengers are considered as nuisance at the disposal sites as they could hinder the effective flow of disposal operation and may pose danger to the environment by increasing risk of fire at the dumping site. However, scavengers are in fact undertaking separation at no cost to the formal recycling system. This comparative advantage may be utilised by having more systematic scavenging activities such as by allowing only scavengers registered with the authority at the disposal site, equipping scavengers with at least safety boots, gloves, mask and health education and setting up of scavenger’s co-operative.

2.6 Is it True that Solid Waste Issue has Gone International?

The way we approach environmental protection has changed. From 1960s to 1980s, the focus was on remedial measures or “end-of-pipe” and this has changed to preventive measures in 1980s and 90s. The challenge faced in environmental protection in the next millennium has gone beyond the companies themselves. The “spotlight” has even gone to “eco-design”. Environmentally sustainable production and process involve producing goods that could have minimal environmental impacts including minimal consumption of energy, pollution on land, air and water, and loss of amenity (White *et al.*, 1995). Today’s corporate environmental strategies should include life-cycle assessment (LCA), design for environment (DFE) and environmentally conscious design and manufacturing (ECDM) as their decision-making tools.

DFE integrates environmental aspects or environmental considerations into the product development. The choices designers make during the development of a new or improved product will have an influence on the environmental impacts during each stage of product's life cycle – from acquiring materials to manufacturing, use, reuse, and ultimately to the product's final disposal (Canadian Standard Association, 1995).

4. CONCLUSION

Unlike its economic growth and industrialisation, the level of solid waste management in Malaysia is still left behind. We are still struggling with basic issues of having reliable and consistent data on waste generation rate and its characteristics. Although this paper has presented the latest information solid waste characteristics including its calorific value, more consistent time-series data are required. Without basic understanding of our wastes, the task of formulating and implementing future waste management programmes and strategies would be difficult. We should strengthen basic research on the waste we generate.

The level of solid waste storage, collection and disposal practices are still poor. This would affect future implementation of recycling. Inefficient storage and collection systems would increase the overall waste management costs and this would eventually being transferred to the consumers. Research activities should be strengthened in optimising waste storage and collection systems. Optimisation techniques and mathematical modelling approaches should be explored in the future.

Finally, any effort to reduce wastes either through waste minimisation or recycling should be planned properly. Solid waste management in Malaysia has a long way to go and this does not mean that we have to switch to capital-intensive and sophisticated systems because they are not necessarily more effective and efficient. At the end of the day, we may have to go back to the basics.

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