ANNALS of Faculty Engineering Hunedoara – International Journal of Engineering
ISSN: 1584 - 2665

WASTE MANAGEMENT STRATEGY IN DEVELOPING COUNTRY: A STUDY CASE OF WASTE MANAGEMENT OTIONS IN KOTA KINABALU SABAH, MALAYSIA

Mohammad Tahir MAPA, Aliakbar GULASAN, Nordin SAKKE

School of Socail Sciences, Univeristi Malaysia Sabah, Sabah, MALAYSIA

ABSTRACT
Much has been said in recent years about *waste management* policy, and recently the *management* of *waste* has found itself moving up the political agenda. The government is beginning to demonstrate some political leadership in its announcement of the Cabinet Office study into *waste* strategy. The need for change is more pressing than ever, and we are now in a position where we have to ensure that words become deeds. This research primarily focuses on the issues of sustainability and waste management in developing countries. For this study Malaysia is chosen as a country where waste management has become a major problem. Blessed with favourable natural resources, the Malaysia has traditionally been reliant on landfill sites as a low-cost *waste* disposal option. However, for the sake of intergenerational equity, such end-of-pipe solutions to the Malaysia's ever increasing volumes of *waste* are unsustainable in the long-term. The challenge of moving towards a more resource efficient society is multifaceted and must be tackled on several levels. The result from the life cycle assessment analysis shows that depending on landfill alone are not sustainable in long term. Landfill must be cooperating with other method of waste management such as recycling or landfill with energy recovery.
Keywords: Waste management, Strategy, Developing countries, Kota Kinabalu, Sabah, Malaysia

1. INTRODUCTION

Wastes and pollutants from economic activities can directly cause damage to the environment if released in an uncontrolled manner or treated improperly before disposal, or if treated wastes are discharged into inappropriate environmental media. Sustainability is not the inherent property of any one particular waste or secondary resource management option. It is vital that the waste management industry is enabled to provide a spectrum of sustainable solutions within an integrated framework, based upon the waste hierarchy and Best Practicable Environmental Option (BPEO). However, strict adherence to the waste hierarchy is not necessarily BPEO in all circumstances as the external environmental impacts of options further up the hierarchy may be greater than those options less favoured by the structure of the hierarchy. The waste industry in Malaysia wants to move waste and secondary resources management away from low cost waste disposal and more towards resource management actively contributing to the Malaysia's resource efficiency and the broader aims of sustainable development. Malaysian industry wants to build its future not on rising quantities of waste but on managing diminishing amounts of waste by recovering secondary materials and energy and returning these to the productive economy. Despite exceeding its proportions share of the total waste arising in the Malaysia, it is the visibility of municipal waste, which claims the limelight and the coveted place on the political hierarchy.

However, the Malaysia's historically poor performance in recovering value from the municipal waste stream ensures that it remains one of the major challenges of more sustainable waste management. It is essential that we reduce the amount of waste produced and its hazardousness. Therefore, as a first step, waste production must be de-coupled from economic growth if we are to move towards a more sustainable society. However, even the best efforts of government and waste producers are unlikely ever to lead to a time we can claim to be producing Zero Waste. Therefore, in order to manage waste which will continue to be produced more sustainable, our industry is increasingly investing in new state-of-the-art infrastructure designed to return more of the materials and energy contained in waste back into the productive economy.

2. WASTE COMPOSITION

The waste composition characteristic is reflected by it sources. In agenda 21, solid waste is defined as all domestic refuse and non hazardous waste such as commercial and institutional wastes, street sweepings and construction debris (UNEP, 2002). Peter, et.al (1996) define municipal solid waste includes refuse from household, non-hazardous solid waste from industrial, commercial and industrial establishment, market waste, yard waste and street sweepings. Most middle and low income countries have a high percentage of organic matter in urban waste stream, ranging from 40 to 85 percent**,** even though the total of waste generation is 0.4 to 0.9kg per capita per day (Table 1). Shekdar (2009) also found that most developed countries more recyclable and more organic waste is produced in countries that have low GDP Malaysian solid waste contains very high organic waste and consequently high moisture content and bulk density of above 200kg/m^3. A study conducted in Kuala Lumpur has revealed that the amount of organic wastes for residential area ranging from 62 to 72 percent (CAP 2001).

Table 1: Components of Solid Waste (Solid waste composition (%) in some South China Sea countries Country)

Cou	Paper	Glass	Metals	Plastics	Organics	Others
Brunei	26	6	11	13	41	3
Indonesia	2	1	4	3	87	3
Malaysia	25	3	6	8	56	2
Philippines	10	2	3	9	70	6
Singapore	28	4	5	12	44	7
Thailand	19	6	4	10	55	6

Source: Diaz & Savage (2002)

3. OBJECTIVES

There are two main objectives in this paper, that is:

- To quantify the amount of emission produce in relation to various activity in waste management system.
- To uncover the importance or benefit of several waste treatment methods that could be apply in a small city such as Kota Kinabalu.

4. METHODOLOGY

This section provides an overview of the methodology used in this study. Three GHG are selected that is CO_2, CH_4 and N_2O as these are main gasses generated by waste management and also the interest under the Kyoto protocol. The LCA is applied in this study and divided into three stages: the definition of goal and scope, where the functional basis for comparison was chosen; identification of the emissions to the atmosphere from selected boundaries; and the impact assessment, in which the emissions generated are grouped and quantified into a limited number of impact categories. It should be noted that ISO 14040 neither does describe the LCA-related tools, in detail, nor does it specify which methodology should be used for each phase. It mainly provides a framework within which these elements can be developed and used Generally, Life Cycle Assessment (LCA) is a tool used to evaluate the potential environmental impact of a product, process, or activity throughout its entire life cycle by quantifying the use of resources (inputs such as energy, raw materials, water) and environmental emissions (outputs to air, water and soil) associated with the system being evaluated (Powell et al., 1996, Azapagic 1999, Bolaane et al., 2005).

5. OPTION FOR THE ANALYSIS

Currently, solid waste management is a major government concern and one of the environmental problems faced by government of Malaysia. The amount of waste generated in the country is continuing to increase but despite this problem, the country is still facing low standards of solid waste management. In addition to this, many local authorities are desperate to find new sites to dispose of their waste since 80% of the existing landfill in country will expire in the 2 years. Therefore, this is important in giving alternative on how the waste management could improve and at the same to contributing in reducing GHG. The total amount of waste generated is an important aspect of deciding the type of waste treatment to be adopted. This study uses the figure for the waste generated in 2001 as a base of comparison between options – functional unit. The data comes from two main sources: KKCH and the private sector. The functional unit refers to the basis on which products or services are compared (McDougall *et al.*, 2001). The output for this analysis is calculated from the transportation of material, material recycling, composting and landfill. The environmental parameters chosen for this

Table 2: Impact category:
Global warming Potential (kg CO2)

Emissions	Equivalence factor
CO_2	1
N_2O	296
CH_4	23

Source: Mendes et al., (2003)

study are CO_2, CH_4 and N_2O. These emissions were grouped into global warming potential (GWP) (Table 2).

The comparison of waste management performance in this study is based on three different types of management options. The main differences between the options are the proportion of materials collected for recycling; (10% in Option 1 and 20% in Option 2), composting in Option 1 and energy recovery from landfill in Option 2. The methods of waste treatment considered in this study consist of landfill of all fractions of waste (current option) and recycling of main recyclable materials and composting of food waste and paper. The main differences between the options are the proportion of materials collected for recycling; (10% in Option 1 and 20% in Option 2), composting in Option 1 and energy recovery from landfill in Option 2.

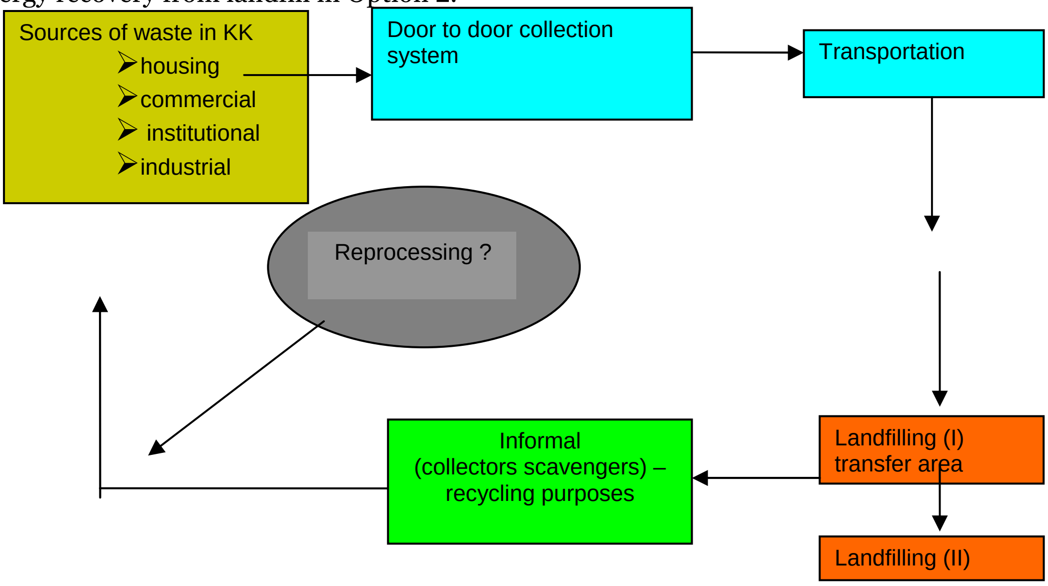

Figure 1: Current Waste Management Practice in Kota Kinabalu City

6. RESULTS

6.1 RECYCLING

Many studies show that using secondary material in material production apparently reduces not only the cost of operation but emission to the atmosphere. Similarly, this study proved that emissions are reduced due to increasing recycling. The air emissions saved by recycling are directly linked to the amount of energy saved by using secondary instead of primary materials, although this varies between materials (Figure 2).

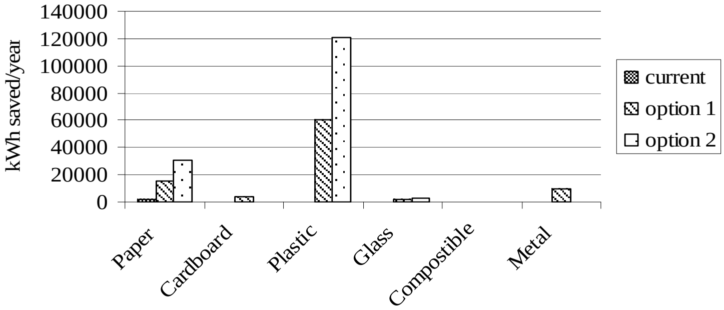

Figure 2: Emission saved between materials

6.2 Landfill

In the study area, although a gas collection facility has been installed at the landfill site information regarding the amount of gas generated and collected is not available. This study shows that by diverting biodegradable waste from the landfill site a significant reduction of total GWP (49%) from the site is anticipated (Figure 3). By implementing energy recovery, 1047 tonne of methane emissions are reduced from option 1 to option 2. In relation to organic waste, composting is one alternative to deal with it. Composting reduces the CH_4 from landfill site by 49% and to the total GWP a year. Natural waste decomposition during composting produces only a small amount of GHG gaseous (N_2O), showing that the contribution of composting to global warming potential is substantial.

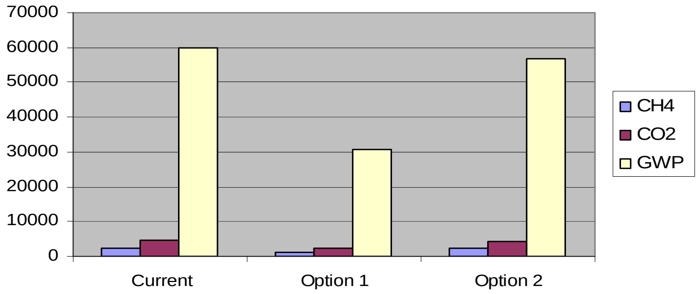

Figure 3: Emission between options

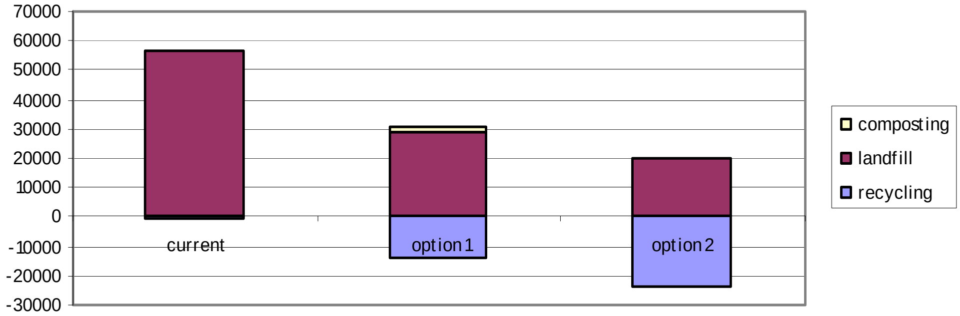

Figure 4: Overall Performance between options

The differences between greenhouse gas emissions in the management options are mainly due to the amount of compostable and paper waste disposed of in the landfill site and the implementation of energy recovery (Figure 4). Even if wastes are managed properly, secondary wastes and pollutants from their transportation, recycling, and treatment are an inevitable consequence of waste generation. These impacts can only be prevented by elimination of wastes at the source--pollution prevention.

7. CONCLUSION

The study highlights the benefits of LCA for exploring various environmental aspects of waste management. The differences in environmental performance between the options are due to the choice of waste treatment method. A better environment for future generations could be achieved; the decision as to which of these options is most suitable for the area is subject to government preference (environmental consideration) and the economic ability to execute the option.

REFERENCE

[1] *CAP. Malaysian Country Report. Taiwan, Consumer Association of Penang, 2001.*
[2] *Diaz, L.F. and Savage, G.M. "Developing landfilf-guidelines for sites in developing countries." World Management World **2**(4), 2002.*
[3] *McDougall, F. "Life Cycle Inventory Tools: Supporting the Development of Sustainable Solid Waste Management Systems." Corporate Environmental Strategy **8**(2): 142-147, 2001.*
[4] *Mendes, M.R., Aramaki, T. and Hanaki, K. Assessment of the environmental impact of management measures for the biodegradable fraction of municipal solid waste in Sa?o Paulo City. Waste Management. **23:** 403-409, 2003.*
[5] *Powell, J.C., Craighill, A.L., Parfitt, J.P. and Turner, R.K. A lifecycle assessment and economic valuation of recycling. Journal of Environmental Planning and Management. **39:** 97-112, 1996.*
[6] *Rau, E.H. Trends in management and minimization of biomedical mixed wastes at the National Institutes of Health, Technology: Journal of Franklin Inst 334(A):397-419, 1997.*
[7] *Rau, E.H. Minimization and Management of Wastes from Biomedical Research, Environmental Health Perspectives Supplements, 10780475, Dec2000 Supplement 6, Vol. 108, 2000.*
[8] *Reinhardt, P.A. Leigh, L.K. Ashbrook, P.C. eds. Pollution Prevention and Waste Minimization in Laboratories, Boca Raton, FL: CRC Press, 1996.*
[9] *Shekdar, A.V. Sustainable solid waste management: An integrated approach for Asian Countries. Journal of Waste Management. **29** (4),1438-1448.*
[10] *UNEP, 2002, http://www.unep.or.jp/publication*
[11] *Wagner, K.D. Defining and characterizing the waste stream of healthcare facilities. In: Environmental Management in Health Care Facilities (Wagner KD, ed), Philadelphia: W.B. Saunders, 9-17, 1998.*