MUNICIPAL SOLID WASTE COMPOSITION ANALYSIS AT KAYU MADANG LANDFILL

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THIS DISSERTATION IS SUBMITTED IN PARTIAL FULFILLMENT FOR MASTER OF SCIENCE (ENVIRONMENTAL MANAGEMENT)

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ABSTRACT

MUNICIPAL SOLID WASTE COMPOSITION ANALYSIS AT KAYU MADANG LANDFILL

A significant problem facing the world and Malaysia was the increasing solid waste generation by the population. A fundamental prerequisite for the successful implementation of solid waste management plan is the availability of sufficient and precise information about the quantities and composition of the waste generated. The objective of this study was to determine the quantity, generation rate and composition of Municipal Solid Waste generated by three municipalities which are Penampang, Kota Belud and Kota Kinabalu districts from Kayu Madang landfill, Telipok, Sabah. Waste samplings were done from September till November 2009. During this period, three samples were collected randomly from each of the districts municipalities. The result indicated that there were 7 categories of waste composition found in the three municipalities which are glass, paper, plastic, metal, organic waste, textile and other. From the result, it shows that the organic waste and plastic were the main component in MSW where 24.5% for Penampang, 29% in Kota Belud district and 31.6% for Kota Kinabalu district. Kota Kinabalu recorded the highest percentage in plastic with 32% following Kota Belud with 29% and Penampang with 23.2%. The generation rate of the Penampang district is 0.83 Kg/Capital/Day, Kota Belud district was 0.77 Kg/Capital/Day and Kota Kinabalu showed 0.86 Kg/Capital/Day. The composition analysis study is essential for the development of sustainable municipal solid waste management in these districts.

ABSTRAK

Pada masa kini, masalah pengurusan sisa pepejal menjadi semakin ketara di Malaysia dan seluruh dunia disebabkan oleh pertumbuhan aktiviti-aktiviti secara meluas. Salah satu syarat untk menghasilkan pelaksanaan dalam perancangan sistem pengumpulan sisa pepejal yang berfungsi adalah dengan mengambil data dan maklumat yang cukup serta tepat dalam kuantiti dan komposisi bagi sisa pepejal yang dijanakan oleh manusia. Tujuan utama kajian ini, adalah menentukan kuantiti dan komposisi sisa pepejal yang dijana oleh tiga daerah iaitu bagi daeah Penampang, Kota Belud dan Kota Kinabalu di tapak pelupusan Kayu Madang, Telipok. Kajian ini dijalankan selama tiga bulan iaitu bermula bulan September sehingga November 2009. Dalam waktu ini, tiga contoh sisa pepejal dikumpulkan dari tiga daerah dimana contoh-contoh ini akan ditimbang dan dianalisa bagi mendapatkan komposisi dan berat setiap daerah. Hasil kajian ini mendapati terdapat 7 kategori sisa pepejal yang wujud di ketiga tiga daerah iaitu kaca, kertas, plastic, beg plastic, logam, sisa organik, tekstil, kayu dan lain lain. Melalui keputusan kajian tersebut,, sisa makanan dan plastic merupakan komposisi yang tertinggi hadir dalam ketiga-tiga daerah dimana sisa organik mencatatkan 24.5% bagi daerah Penampang, 29% bagi daerah Kota Belud dan 31.6% bagi daerah Kota Kinabalu. Manakala, Kota Kinabalu mencatatkan peratusan plastik yang tertinggi dengan 32%, diikuti oleh Kota Belud dengan 29% dan Penampang dengan 23.2%. Bagi daerah Penampang, sebanyak 0.83 Kg/Kapita/Hari dihasilkan oleh penduduk di daerah tersebut, daerah Kota Belud sebanyak 0.77 Kg/Kapita/Hari dan daerah Kota Kinabalu mencatatkan sebanyak 0.86 Kg/Kapita/Hari. Kajian komposisi sisa pepejal ini adalah penting dalam menjadi data maklumat sistem sisa pepejal bagi ketiga-tiga daerah tersebut.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

BMW	Biodegradable Municipal Waste
CWM	Community Waste Manager
DOE	Department of Environmental
DBKK	Kota Kinabalu City Hall
HDPE	High Density Polyethylene
Kg	Kilogram
KK	Kota Kinabalu
Km	Kilometer
LCA	Life Cycle Assessment
LIFE	Litter Free Event
M2	Square Meter
M3	Cubic meter
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
MDPg	Penampang District Council
MDKB	Kota Belud District Council
MHLG	Ministry of Housing and Local Government
NGO	Non Governmental Organization
SHOWS	Smart House Waste Solutions
SWM	Solid Waste Management

CHAPTER 1

INTRODUCTION

1.1Introduction

Owing to rapid urbanization, the population of Sabah state is booming. This follows with increase in commercial and industrial activities, which have caused and will continue to cause a corresponding increase in solid waste generation. It is predicted that Sabah will turn into a waste haven if no precautionary and management measures are taken within the next few years.

The problems with solid waste range from the issues relating to its generation, disposal and treatment. These issues must be well indentified and perfectly understood so as to come up with a corresponding plan which is able to yield the wanted results. Moreover, the issues are on-going but have become evident lately and thus, it is most advisory to come up with immediate plans to control the issues at present time. An appropriate waste management system would serve as a tool and medium for future developments and enhancement in every aspect.

Solid wastes is defined as any of a wide variety of solid materials, as well as some liquids in containers, which are discarded or rejected as being spent, useless, worthless or in excess. (Tchobanoglous *et al.,* 1993). In this study, the solid waste is refer to the municipal solid waste which can be identify as a domestic waste, industrial waste or grey waste in some other books and journal . A municipal solid waste includes all the wastes generated from residential households and apartment buildings, commercial and business establishment, institutional facilities.

Industrial solid waste refers to solid wastes generally discarded from industrial operations or derived from manufacturing processes. These wastes may be inert, hazardous or listed as scheduled wastes. Grey waste category includeconstruction waste and demolition waste, e-waste namely computers, televisions and used vehicles.

The state of Sabah is currently experiencing a rapid growth in population, mainly due to rapid urbanization of the state as a whole. Furthermore, the increase in the commercial and industrial activities have caused, and will continue to cause a corresponding increase in solid waste generation and if not properly managed, could result in adverse environmental impacts. Being a state of tourism potential, it is important that the environment is preserved and well maintained.

In the aim to develop the state of Sabah becoming an industrialized state, the presence of an appropriate Waste Management System is necessary in order to tackle on-going and future solid waste problems, this would also enhance and attract potential investors and allowing for diversification of the economy for the benefits of its people. On average, a Sabahan generates an average 0.5 kg to 1.1 kg of municipal solid waste each day. This is equivalent to 1 million ton per year for the entire state. What to do with this enormous amount of wastes? Where to dispose of it and how to reduce the amount we produce? - is an issue of great importance to all Sabahan and to the local authorities in Sabah.

In Sabah, an insignificant amount of solid waste is to be recycled or reused as most of it is sent to one of the many dumpsites scattered all over the state. The continuing reliance on dumping grounds to dispose of the state's waste will create many problems. Almost all dumpsites are sited in undesirable locations and are poorly maintained, which has brought about environmental concerns and community objections. To replace all these dumpsites with new and modern sanitary landfill will be quite impossible as the current annual funds for solids waste management allocated to the local authorities is too little to make this conversion a reality.

Table 1.1: Division and Local Authorities information

	Division	District	Area (Km^2)	Rated Area (Km^2)	Local Authority
1	West Coast	Kota Kinabalu	351	351	Kota Kinabalu City Hall
2		Tuaran	1166	62	Tuaran District Council
3		Kota Belud	1386	4.5	Kota Belud District Council
4		Penampang	466	23	Penampang District Council

Source: Yearbook of statistics, 2005 & Local Authorities, 2006

1.1 Study Objectives

The objectives of this study are as follows:

i. To determine and compare the waste composition of MSW (Glass, paper, Plastic, Plastic bag, metal, textile, wood, organic waste and other) for Kota Kinabalu, Penampang and Kota Belud municipalities

ii. To determine and compare the MSW generation (Quantity and rate) for Kota Kinabalu, Penampang and Kota Belud municipalities

iii. To determine the amount of plastic bags from MSW streams of Kota Kinabalu, Penampang and Kota Belud municipalities.

1.2 Scope of study

This study is to determine the MSW generated in Kayu Madang Landfill in Telipok from Kota Kinabalu, Penampang and Kota Belud districts and the composition of refuse that people disposed of. The result will provide more understanding in waste

characteristics generated in the districts of Kota Kinabalu, Penampang and Kota Belud

1.3 Needs of Study

It is important to understand the present of MSW in order to examine the municipal problem in the target area systematically and to formulate a well consideration waste management plan. Besides, data on quality variation and generation are useful in planning the collection and disposal system. Finally, the method of handling, storage and processing of solid wastes at the source will plays an important role in public health, aesthetics and efficiency of the municipal solid waste system. Waste characterization studies provide a baseline data for municipalities to measure their progress toward specific waste management goal. In addition, projections of the size and the composition of the future MSW stream helps the communities to plan the MSW management facilities which often have operating lifetimes of several decades.

CHAPTER 2

LITERATURE REVIEW

2.1 Solid Waste

Solid waste management is a complex process because it involves many technologies and disciplines. These includes technologies associated with the generation (including source reduction), on-site handling and storage, collection, transfer and transportation, processing, and disposal of solid wastes. All of these processes have to be carried out within existing legal, social, and environmental guidelines that protect the public health and the environment and are aesthetically and economically acceptable. (Salvato *et al.,* 2003)

Rapid urbanization, population growth and changes in lifestyles in developing countries contribute to increasing the per capita municipal waste generation. Keeping pace with the requirements of rapid economic development and continuing population growth, and because of its critical role in protecting the environment and public health, accomplishing effective and efficient municipal solid waste management should be a priority for cities in developing countries (Jin *et al.,* 2006).

Inappropriate waste handling, storage, collection and disposal practices will pose environmental and public health risks. In densely populated urban centres, for example, appropriate and safe MSW management is of utmost importance to create a healthy environment for the people. The collected waste is generally dumped on land in a more or less uncontrolled manner. (Mosler *et al.,* 2006).

Improper management of solid waste in most cities of developing countries leads to problems that impair human and animal health and ultimately result in economic, environmental and biological losses (Sharholy *et al.,* 2008).

Solid waste management in developing countries must deal with many difficulties, including low technical experience and low financial resources which often cover only collection and transfer costs, leaving no resources for safe final disposal (Collivignarelli *et al.,* 2004).

In general, there is a lack of organization and planning in waste management due to insufficient information about regulations and due to financial restrictions in many developing countries (Tınmaz and Demir, 2006). Due to resource limitations, increasing amounts of MSW are not accompanied with proper management practices. This situation poses serious public health risks and causes environmental degradation in many cities of the developing world (Diaz *et al.,* 1999). Improper management of solid waste has been reported by several researchers in different cities of developing countries (Sharholy *et al.,* 2008; Imam *et al.,* 2008; Chung *et al.,* 2008; Berkun *et al.,* 2005).

Recently, some developing countries have realized that the SWM policies they follow do not serve the objectives of sustainable development, and there is a need for a paradigm shift in dealing with MSW management problems (Agamuthu, 2003).

This paper presents an overview of current municipal solid waste (MSW) management in Kota Kinabalu city, Penampang and Kota Belud district. In addition, the major issues involved with the management of solid waste in Kota Kinabalu, Penampang and Kota Belud district are presented and discussed, applicable recommendations for system improvement is provided.

This study may be useful for authorities and researchers of developing countries to work towards improving their present municipal solid waste management system. One of the major consequences of rapid economic growth, urbanisation, and industrialisation and population growth is the massive generation of solid wastes. As a country that moving forward to achieve the industrialised country status by the year 2020, Malaysia cannot escape from facing the solid

waste management problems. As indicated in World Bank report (1993), solid waste is one of the major environmental problems faced by most municipalities in Malaysia. The municipalities are not only facing the increasing municipal solid waste and its rising complexity, they are also lacking of funding to carry out the sound solid waste management. The lack of a uniform national solid waste policy coupled with insufficient legislation has further complicated the solid waste problems in Malaysia.

The amount of solid waste has been increasing continuously since the 1980's. The per capital waste generation has increased 2 folds from 0.5kg/capital/day in the early 1980's to current volume of 1kg/capital/day (Agamuthu, 2001) The huge increased in solid waste generation attributes to the rapid economic growth, increasing urbanisation, rising living standard, changes in consumption pattern and increasing population.

For the past two decades, Malaysia has gone through a rapid economic growth and urbanisation process. The steady economic growth has led to an increase in per capital income and the living standard. This has changed the consumption patterns where more packaging and disposable products are consumed. This increased in production and consumption and the change in consumption patterns also attributes to the urbanisation process where more and more rural people move to urban areas where a huge portion of the generated waste is from the urban areas.

According to a survey done by Nasir, *et al.*, (1998) on 30 local authorities in Malaysia, it is found that the per capital generation rate varies from 0.45 to 1.44kg/capital/day which the lowest waste generation rate was from a rural area while the highest waste generation rate was from an urban area. This clearly shows that the urban population generates more waste than the rural population as they have different living standard and consumption patterns. The solid waste production has thus inevitably increased due to the urbanisation and economic growth. Population which grows at a rate of 2.6% per year also increases the solid

waste generation (Department of Statistics, Malaysia, 2001). Solid waste has increased from 2.5 million tonnes per year in 1991 to estimated 8 million tonnes per year in 2000 (Agamuthu, 2001).

Just as the per capital solid waste generation rate varies between different areas, the solid waste composition varies in different parts of the country as well. Generally, the solid wastes in Malaysia are mainly organic in nature and have low calorific value and high moisture. Basically, rural areas have higher organic waste compared to urban areas.

Plastic bags have emerged as one of the most successful products worldwide in recent decades. They gained increasing popularity amongst consumers and retailers due to the fact that they are functional, lightweight, strong, cheap and a hygienic way of transporting food and goods (Parliament of New South Wales, 2004, p.3; UNEP, 2004, p. 27). It is estimated that currently between 500 billion and one trillion plastic bags are used globally each year (Food Production Daily, 2004, p.1). Even flimsy plastic bags, which have been identified as the most prevalent post-consumer plastic waste, offer one spectacular advantage in that they are manufactured from as little material as possible without loss of functionality thereby exhibiting some element of efficiency in resource utilisation. Although they have excelled in functional and some environmental aspects, plastic bags have become one manifestation of present-day linear mode of production and consumption. As much as trillions are consumed, billions end in the litter stream soon after use. As this research will show in the subsequent sections, so great was the concern on environmental impacts of plastic bags that a number of countries felt compelled to take policy measures.

Strong focus has been placed worldwide on the environmental implications of plastic bags as they are: commonly given away for free in large numbers; designed as single-use disposable products; persistent in the environment resulting in adverse ecological- and visual litter impacts; potentially replaceable by other substitutes and methods; and neglected by recycling schemes (Nolan-ITU, 2002,

p.3). As regards their persistence, currently used plastic bags are known to take between 20 and 1 000 years to break down in the environment (PNSW, 2004, p.3). Their ecological and visual litter impacts include wasted resources in the form of useful material locked in landfills; aesthetic deterioration of landscapes and waterways; threats to wildlife; and toxic gas emissions through open burning (Zero Waste New Zealand, 2002).

Although not the focus of this thesis, the impact of plastic bags in the marine environment is also a matter of concern worldwide as aquatic life can easily be affected through entanglement, suffocation and ingestion. For instance, The 2003 International Coastal Cleanup (ICC, 2003) surveys for India and South Africa indicated that plastic bags are among the top ten marine debris items, i.e. second in India and third in South Africa. It is common knowledge that per-capita consumption of various products (including plastic bags) is very low in developing countries in comparison to developed nations. Nonetheless, the impact of MSW and that of plastic bag waste in particular has already become a major environmental issue in many countries, more so in their urban centres.

2.2 Legislation and Institution

Even though solid waste is one of the three major environmental problems that faced by the Malaysian government, it is still lack of legislation and policies in tackling the problem. Currently, there are three legislations relevant to municipal solid waste management, namely, Local Government Act (1976), Street, Building and Drainage Act (1974) and the Town and Country Planning Act (1976). There is another legislation, the Environmental Quality Act (1974), has provision for scheduled and hazardous waste, but it does not address the issue of municipal solid waste. It only indirectly touches on odour contributed by discharge of waste (Agamuthu, 2001). Since legislation is the backbone for policy formation and enforcement (Naane, 1998), the absence of basic legislation on municipal solid waste has restricted the formulation of national policy on solid waste management and thus has handicapped government's effort in implementing the sound solid waste management. Currently, a solid waste Act is being drafted for submission to

the Parliament but the scope and the content of the proposed Act are still unknown. (Agamuthu, 2001).

The other problem in relation to solid waste management is that there is no single agency responsible for solid waste management. According to the legal provision, it is managed fractionally by different agencies, i.e. Local Government Department and Department of Environment. This has resulted in inefficiency and unsound environmental practise. Thus a clear legislation and a sole responsible government agency are essential in government's effort to establish a sound solid waste management strategy.

2.3 Current Disposal Method

Landfill is the sole disposal method in Malaysia. Other methods such as incineration and composting are at a negligible scale. It is estimated that 95% of the municipal solid waste have gone for landfilling and only 5% are recycled (The Star, 6 January 2001). Even though there is a huge amount of municipal solid waste that goes to landfill, the landfilling practise in Malaysia is far from environmentally sounded. Among 230 landfills in Malaysia, only 10% are equipped with leachate treatment and gas venting facility while 51% are just open dumpsites (Ghazali, *et al.,* 1997) (Agamuthu, 2001). According to Ministry of Housing and Local Government (1999), out of 177 landfills in Peninsular Malaysia, only 6% are sanitary landfills and 50% are crude dumping sites.

Tables 2.1 Classification of Solid waste (Bhide & Sunderasan, 1983)

Types of Solid Waste	Sources	Description
Food Waste	Households and commercial	Waste form the preparation, cooking and serving of food. Market refuse, waste from the handling, storage and sale of produce and meats and vegetables
Rubbish	Households, institituions and commercial such as hotels, stores, restaurants and markets	Combustible (Primary organic), paper, cardboard, cartons, wood, boxes, plastics, rags, cloth, bedding, leather, rubber, grass, leaves, yard trimmings Non combustible (Primary inorganic), metals, tin cans, metal foils dirt, stones, bricks, ceramics, crockery, glass bottles and other mineral refuse
Ashes and Residues	Industry and power plant	Residues from fires used for cooking and for heating buildings cinders, clinkers, thermal power plant.

Tables 2.1 Classification of Solid waste (Bhide & Sunderasan, 1983) - continue

Bulky wastes	Households, industry and commercial	Large auto parts, tyres, stoves refrigerators, other large appliances, furniture, large crates, tree, branches, palm fronts, stumps, flotage
Street wastes	Street, sidewalks, alleys and vacant lots	Street sweepings, dirt, leaves, catch basin dirt, animal dropping and content of litter receptacles dead animals.
Dead animals	Small animals, cats, dogs, poultry and etc. Large animals: horses, cows and etc	Farm and street
Construction and demolition waste	Lumber, roofing and shealthing scraps, crop residues, rubble, broken concrete, plaster, conduit pipe, wire, insulation and etc	Construction and demolition sites, remodelling repairing sites
Industrial wastes and sludge	Solid waste resulting from industry processes and manufacturing operations, such as food processing wastes, boiler house cinders, wood, plastic and metal scraps and shaving and etc. Effluent treatment plant sludge of industries and sewage treatment plant sludges, coarse screening, grit and septic tank	Factories, power plants, treatment plants and etc
Hazardous wastes	Hazadous waste: Pathological waste, explosives, radioactive material, toxic waste and etc	Households, hospitals,institution, stores, industries and etc
Horticulture waste	Tree-trimmings, leaves, waste from parks and garden and etc	Parks, gardens, roadside, trees and etc

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