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**APPLICATION OF LANDFILL DEPLETION MODEL IN DETERMINING
THE LANDFILL LIFESPAN**

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**THESIS SUBMITTED IN PARTIAL FULLFILMENT OF THE
REQUIREMENT FOR BACHELOR OF SCIENCE WITH HONOURS**

PERPUSTAKAAN
UNIVERSITI MALAYSIA SABAH

**ENVIRONMENTAL SCIENCE PROGRAM
SCHOOL OF SCIENCE AND TECHNOLOGY
UNIVERSITY MALAYSIA SABAH**

MARCH 2005

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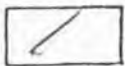
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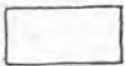
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I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a bachelor degree in any university; and that to the best of my knowledge and it does not contain any material previously published or written by another person where due reference has not made in the text.

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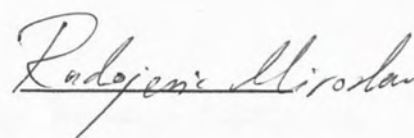
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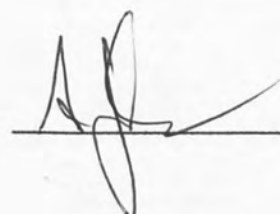
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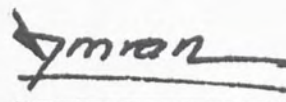
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DEDICATION

I would like to thank Dr. Vun Leong Wan for his help in my thesis. All the kindness, guidance and taught from him I will always bear in mind.

Besides that, I will like to thank Mr. Jack Lo, an engineer in DBKK who has given me a lot of information in order to complete my thesis.

Not forget my dearest family members and friends who have always lift me up when I am stress with my project. Special thanks too to my room mates from SSMP and SKTM who had walked with me during the period too.

Finally but not lastly, I will like to thank to The School of Science and Technology and the all the organizers for this final year project.

HO SOO LING

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ABSTRACT

The purpose of this study is to discuss the estimation of Kayu Madang landfill lifespan by using a Landfill Depletion Model in various scenarios of solid waste management. The various scenarios are the different scenarios in recycling and compacting rates. All the data were collected from the various environmental departments in KK. The data for the year 1999 were used as the base year data and the past years data are used to verify the results, whereas two more years had been postulated which are year 2006 and year 2007. The result has shown that the landfill will be filled up in the year 2007 according to the data from the DBKK department of Kota Kinabalu while the landfill supposedly to have a total of 13 years lifespan. The lifespan of the landfill has decreased by five years due to the uncontrolled of rubbish generation and the inefficiency of the management. However, under different scenarios of compacting and recycling rates, the lifespan would possibly be extended to another two to seven years. If implemented, the prolong lifespan would benefit the authorities in making a well planning to solve the landfill issue.



APPLIKASI MODEL PENIPISAN TANAH PELUPUSAN DALAM MENGIRA JANGKA HAYAT TANAH PELUPUSAN

ABSTRAK

Tujuan kajian ini dijalankan adalah untuk menganggar jangka hayat tanah pelupusan Kayu Madang dengan menggunakan model penipisan tanah pelupusan dengan mengambil kira pelbagai keadaan yang berbeza dalam pengurusan sisa-sisa pepejal. Pelbagai keadaan yang berbeza ini terdiri daripada pelbagai keadaan yang berbeza dalam kadar kitar semula dan compaction. Semua data yang berkenaan akan diambil daripada pelbagai bahagian pengurusan persekitaran di KK. Semua data akan dikumpul bermula dari tahun 1999 sebagai data piawai dan projek ini telah pun menganggar dua tahun lagi iaitu tahun 2006 dan tahun 2007. Keputusan telah menunjukkan bahawa tanah pelupusan akan diisi penuh pada tahun 2007 mengikut bahagian DBKK, tetapi sebenarnya tanah pelupusan Kaya Madang sepatutnya mempunyai jangka hayat selama 13 tahun. Jangka hayat tanah pelupusan telah berkurang sebanyak 5 tahun yang disebabkan oleh pembuangan sampah yang tidak dikawal dan ketidakberkesanan dalam pengurusan. Pada hal yang lain, dengan kadar berbeza dalam kitar semula dan compaction, jangka hayat tanah pelupusan dapat dipanjangkan dari 2 tahun ke 7 tahun. Jikalau kaedah ini dijalankan akan menguntungkan banyak pihak yang berkenaan.



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LIST OF SYMBOL

Kg	Kilogram
DBKK	Dewan Bandaray Kota Kinabalu
EIA	Environmental Impact Assessment
Ha	Hectare
C	Compaction
R	Recycling



CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The twentieth century and particularly the period post World War II experienced not only the biggest urban population boom of the history, but also unprecedented global levels of economic activity. A new culture of production and consumption was followed by a dramatic increase in the production of urban solid waste. The management of waste disposal is closely linked to the dynamics of urban development. Urban growth affects both the demand for land for landfill and the supply of suitable land to attend the demand. Population growth generally leads to increasing waste production. Disposing of this waste involves increasing demand for land in most urban regions. On the other hand, the spreading of urban areas outwards progressively decreases the availability of land for waste disposal. In this context, shortage of land becomes a potential problem (Peavy, 1985).



1.2 GENERATION OF WASTE

The generation of waste by society may be viewed as a manifestation of the inefficient use of resources, and the root cause of pollution and the associated environmental degradation. Whichever way one looks at it, increased waste generation is an inevitable consequence of development and must be systematically managed in order to conserve resources and protect the environment (DEAT & DWAF, 1999). An expanding economy, increased production of goods together with an expanding population are seen as the main drivers for waste generation. The rapid urbanization and industrialization has increased the pollution load on the urban environment to an unmanageable and alarming proportions. The existing landfill sites are full beyond capacity. It is difficult to get new dumping yards and if at all available, they are far from the city and this adds to the exorbitant cost of transportation. It is high time the municipal corporations, state governments, and policy makers take up the matter seriously. The best option is to reduce the volume by effective treatment of the waste. In recent years, the waste-to-energy project has gained attention due to its double benefit of resource generation and pollution abatement (Vesilind, 2002). Due to the importance of landfill in our daily life, it is important to know the landfill lifespan in order to sustain a healthy development of our society and maintain a smart waste management system in Malaysia. So here I have chosen landfill Kayu Madang as my study site as this landfill has a favourable location and surroundings of the landfill, and the considerable investments and resources required to locate, secure permits, design and build a new landfill.



1.3 RESEARCH OBJECTIVE

- 1) To estimate lifespan of Kayu Madang Landfill by using the Landfill Depletion Model in various scenarios of solid waste management.



CHAPTER 2

LITERATURE REVIEW

2.1 GENERATION OF WASTE

The generation of wastes, which result from human activities, varies in different types of dwellings, as well as in different socio-economic groups. The type produced depends upon various factors, such as the standard of living, occupation and habits of the contributing population, which in turn are affected by climatic and dietary habits. The characteristics, both physical and chemical, also vary within the same geographic location in different seasons. Although man has produced wastes ever since the beginning of civilization, in recent years the problem has been aggravated by the rapid industrialization of many developing countries. As the industries become more and more sophisticated, so are the wastes produced which require at times specialized techniques to treat and disposed of (Agamuthu, 2001).

Waste is defined in the Environment Conservation Act No. 73 of 1989 as all undesirable or superfluous by-products, emissions, residues or remainders of any process or activity, whether gaseous, liquid or solid, or a combination of these (RSA, 1989). Waste can be divided into two categories, general waste and hazardous waste. Hazardous waste is then



further divided into nine different classes based on the type of risk involved (DWAF, 1998).

Waste is a predictable consequence of development, and it must be managed in order to conserve natural resources and protect people and the environment. Waste is driven by three primary factors: the increasing production of goods; an ever expanding population and a growing economy (DEAT, 2002). It is well-known that developed countries produce far more waste per person than developing countries. The United Kingdom produces an average amount of 0.73 kg of waste per person per day whereas Kathmandu produces only 0.30 kg of waste per person per day (DWAF, 1998). In addition, higher income households have a higher average per capita waste generation rate than lower income households (1.07 to 1.28 kg/capita/day in high income households as opposed to 0.14 to 0.29 kg/capita/day in low income households) (DWAF, 1998).

Waste generation within Malaysia was found to depend very much on the sources of municipal solid waste (MSW). The rate of generation varied greatly depending on the premises (house, shop, etc.), housing area generates the largest amount of waste. Figure below shows the different sources of waste which contributed to the generation of waste in Malaysia (Agamuthu, 2001).



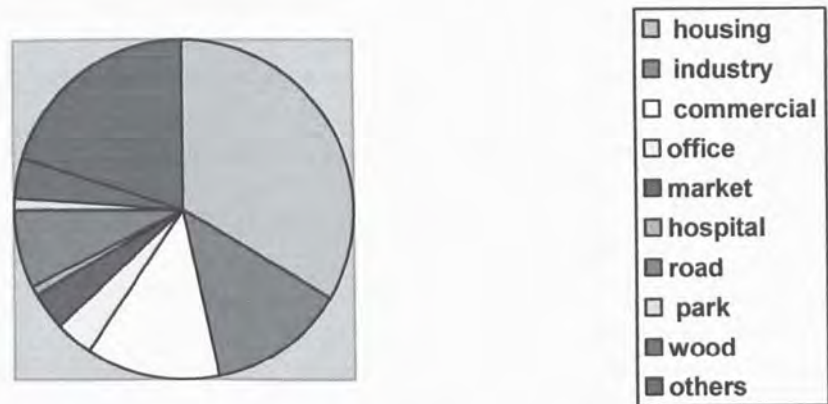


Figure 2. 1 Waste generation in Malaysia (Agamuthu, 2001).

2.1.1 Waste Classification

In a typical household waste there will in general three distinct phases present which are solid, liquid and gas. There may also be a need to distinguish between mobile liquid in large drainable pores; liquid in small pores; and liquid that is trapped, absorbed or otherwise bound to the solid fraction.

Different types of “particles” may be present, and are conventionally classified as follows (e.g. Landva and Clark, 1990; ETC8, 1993; Grisolia *et al*, 1995).

- Class A: Inert Stable Materials
- Class B: Highly Deformable Materials, crushable, breakable particles (e. g. cans and bottles), may release trapped gas or liquid, resulting in an apparent decrease in the volume occupied by the solid phase when crushing or breakage

occurs. Compressible, bendable or otherwise deformable particles, which change shape and possibly volume when the stress is increased.

- Class C: Readily Biodegradable Materials, change in volume or change from the solid to the liquid or gas phase on decomposition.

2.1.2 Types of Waste

Table below shows the different types of waste which exist in our environment.

Table 2.1 Types of waste according to Bradshaw, Southwood, Warner, 1992.

Types of waste:	Definition:
Domestic waste	The composition of domestic waste must be known to evaluate the required treatment and disposal systems. The proportion of organic material present may determine if composting, incineration or digestion are appropriate methods. In addition, evaluation of the feasibility of incineration depends upon the chemical composition of the solid waste.
Commercial solid waste	The composition of commercial solid wastes depends entirely upon the source. They may include: office buildings; restaurants; markets, and hotel and motels.
Industrial solid waste	Since the term industrial solid waste could cover an extremely wide spectrum of waste materials, it is valuable to classify wastes into three broad categories: non-hazardous industrial solid waste; hazardous waste; hospital waste.

Non-hazardous industrial solid waste	Many industries produce solid waste materials from fabrication, chemical, refining, quarrying, power generation and other processes. If they are classified as non-hazardous then they may be stored, collected, treated and disposed of along with urban solid waste by either private or public sector operations. The type and quantity will be dependent upon the nature of the industry and the types of production process.
Hazardous waste	The term hazardous waste is used here to describe a range of materials which often are described by using other terms such as difficult waste, toxic waste or special waste.
Hospital waste	For many years the World Health Organization has advocated that hospital wastes should be regarded as hazardous wastes. It is now commonly acknowledged that certain categories of hospital (or clinic) waste are among the most dangerous of all wastes arising in the community. As the volume and complexity of health care wastes increase, the risk of transmitting disease through unsatisfactory disposal practices also increases

2.1.3 Solid Waste

Solid waste is invariably a by-product of human activity. It becomes a useful by-product when a value is added to it. Solid wastes are defined as wastes arising from human and animal activities that are normally solid and unwanted. The classification of solid waste uses a variety of schemes i. e. physical (solid, liquid, gaseous), original use (packing



waste), material (glass, paper, plastics), physical properties (combustible, compostable), origin (domestic, commercial, industrial, agricultural) and safety parameters (hazardous, radioactive) (Agamuthu, 2001).

2.1.4 Hazardous Waste

Hazardous waste is divided into different classes based on the type of risk involved. The SABS 0228 Code of Practice for the Identification and Classification of Dangerous Substances and Goods (SABS, 1995) recognises nine broad classes of hazardous waste:

- Explosives;
- Gases;
- Flammable liquids;
- Flammable solids; substances liable to spontaneous combustion; substances that on contact with water, emit flammable gases;
- Oxidising substances and organic pesticides;
- Toxic and infectious substances;
- Radioactive material;
- Corrosives; and miscellaneous dangerous substances and goods.



2.2 HISTORY OF SOLID WASTE MANAGEMENT

Solid waste has been an issue for humans from the moment that people began to live together in permanent settlements. About 3500 B.C. in the city of Ur, the sweepings from house floors and the contents of rubbish bins were flung into the street. Such a great amount accumulated that the street levels were gradually raised and from time to time new doors were cut to maintain access to houses. In 1300 B.C. Mosaic Law referred specifically to public sanitary practices. Everyone was expected to act as his or her own scavenger, removing refuse and burying it in the earth. In 500 B.C., the people of Athens, Greece developed the first municipal dump. The Rome collection of solid waste was probably better organized than any other civilization of the time. Yet, the Romans were not able to overcome the problem of dealing with the large accumulation of waste. Throughout history, European cities struggled to manage the trash produced by their citizens. As the United States increased in population and urbanization increased, waste disposal also became a problem. Today we think our throw away society is unique. But, examining any industrial society, it becomes apparent that civilizations have always struggled to properly dispose of their trash (Tammemagi, 1999).

2.3 SOLID WASTE MANAGEMENT

The solid waste management can be divided into three basic elements, there are collection and transportation, disposal, and resource recovery. Collection and transportation involves primarily an economic problem. Collection of municipal solid waste has, in



recent years, become a major national industry, both in cost and size. Some 80% of a city's solid waste management costs are expended to collect and transport municipal refuse. It ranks with education, streets and highways, and police and fire protection as one of the largest municipal expenditures (Richard, 1972).

The majority of these funds are allocated for labor. And, as pay scales rise and the volume of waste generated increases, total collection costs will climb proportionally. In many instances, a significant amount of this expense can be traced directly to outmoded equipment and systems. This is unfortunate, as new technology and methods are available today to both reduce costs and increase efficiency of collection operations. For example, at an intermediate disposal site or transfer station, refuse from smaller collection trucks is transferred to larger vehicles for more efficient long-distance hauling. Mathematical models can be used to determine the most efficient and least expensive collection routing for a specific city (Yufeng, 2003).

New collection equipment and systems include compactor trucks that grind, crush, or chop refuse as it is loaded, increasing the vehicle's hauling capacity and reducing the number of trips required. Another compactor truck innovation incorporates a mechanical arm operated by the driver from the truck's cab, netting major savings in both personnel salaries and time (Yufeng, 2003).



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