



UNIVERSITI PUTRA MALAYSIA

***LANDFILL SITE SELECTION USING GEOGRAPHICAL INFORMATION
SYSTEM AND MULTI CRITERIA DECISION ANALYSIS
IN JOHOR BAHRU, MALAYSIA***

MUHAMMAD AMAR BIN ZAUDI

FPAS 2015 6



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By

MUHAMMAD AMAR BIN ZAUDI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfillment of the Requirements for the Degree of Master of Science**

October 2015

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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October 2015

Chairman : Mohammad Firuz Ramli, PhD
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Rapid economic growth and urban transformation played a major role to solid waste management problems in Malaysia. Solid waste management is one of the most challenging environmental problems. Despite the enormous amount effort and management strategies the government is applying in recent years, yet the waste management standards in Malaysia did not yield significant impact. Johor Bahru is one of most developing city and also highest of populations in Malaysia. This fact led to increase in waste generation. Instead of using 3Rs which represent reuse, reduce and recycle to diminish waste, the landfill has been identified as the most cost-effective system of solid waste disposal for most urban areas in developing countries. The objectives of this study is to determine the suitable parameters for landfill siting, to delineate and characterized the suitability of various areas and also to optimized the landfill site selection technique using GIS and MCDA methods. Data used in this research were collected from various government agencies. Data such as map were converted into digital map and undergo GIS overlaying process to identify the suitable new landfill sites. Several guidelines from government agencies and local authorities were used to guide in selecting suitable site for new landfill. The final overlay process produces four possible areas for new landfill in Johor Bahru. Furthermore, to enhance these possible sites, MCDA techniques which are Analytical Hierarchy Process and Simple Additive Weighting were used. The method sets the factors clearly and helps experts and NGOs to participate so that the lack of information or any opposition can be discussed, scored and weighted separately. AHP is a tool that has broad applicability in waste management and particularly makes assessments, prioritization and selection among waste management options more readily measurable. Even more, combining GIS and AHP techniques became more effective since this combining techniques mix all possibilities and between technologies and also human logic.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

**PEMILIHAN TAPAK PELUPUSAN MENGGUNAKAN SISTEM MAKLUMAT
GEOGRAFI DAN ANALISIS KEPUTUSAN MULTI KRITERIA DI
JOHOR BAHRU, MALAYSIA**

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Pertumbuhan ekonomi yang pesat serta transformasi bandar menjadi faktor utama kepada masalah pengurusan sisa pepejal di Malaysia. Pengurusan sisa pepejal adalah salah satu masalah alam sekitar yang boleh dikatakan mencabar. Kebelakangan ini, pelbagai usaha dan pengurusan strategi telah dilakukan oleh kerajaan, namun standard pengurusan sisa di Malaysia masih tidak memberangsangkan. Johor Bahru merupakan salah satu bandar yang semakin membangun dan mempunyai kepadatan penduduk yang tinggi. Hal ini menjadi penyebab peningkatan sisa pepejal di Johor Bharu. Selain menggunakan kaedah 3R (*Reuse, Reduce, Recycle*) untuk mengurangkan bahan buangan, tapak pelupusan telah dikenalpasti antara sistem yang kos efektif untuk melupuskan sisa pepejal bagi kebanyakan negara membangun. Objektif kajian ini adalah untuk menentukan parameter yang sesuai untuk pemilihan tapak pelupusan, menilai ciri-ciri setiap tapak yang dipilih serta dan mengoptimumkan pemilihan tapak pelupusan sampah baharu dengan menggunakan kaedah GIS dan MCDA. Data yang digunakan dalam kajian ini diperolehi daripada pelbagai agensi kerajaan. Data seperti peta telah ditukar ke bentuk digital dan menjalani proses tindakan GIS untuk mengenal pasti tapak pelupusan baru yang sesuai. Garis panduan daripada agensi kerajaan dan pihak berkuasa tempatan juga telah digunapakai sebagai rujukan dalam pemilihan tapak pelupusan yang baru. Proses tindakan akhir menghasilkan empat kawasan yang berkemungkinan sesuai untuk tapak pelupusan baru. Manakala, untuk menambahbaik kawasan-kawasan tersebut, teknik MCDA seperti *Analytical Hierarchy Process* dan *Simple Additive Weighting* telah digunakan. Kaedah ini menetapkan faktor yang jelas dan membolehkan pakar-pakar serta badan bukan kerajaan untuk mengambil bahagian untuk berbincang mengenai kekurangan maklumat atau melakukan sebarang bantahan dengan memberikan pemarkahan secara berasingan. AHP adalah teknik yang mempunyai kebolehgunaan luas dalam pengurusan sisa dan terutamanya membuat penilaian, serta menentukan keutamaan bagi setiap pemilihan. Bahkan menggabungkan GIS dan AHP menjadikan teknik ini lebih berkesan memandangkan ia menggabungkan pelbagai kemungkinan antara teknologi dan logik manusia.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory were as follows:

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LIST OF ABBREVIATIONS

°C	Degree Celsius
AHP	Analytical Hierarchy Process
CI	Consistency Index
CR	Consistency Ratio
DEM	Digital Elevation Model
DOA	Department of Agriculture
DOE	Department of Environment
DOS	Department of Statistics
dwg	AutoCAD file format
GIS	Geographical Information System
JMG	Jabatan Mineral dan Geosains
JMM	Jabatan Meterologi Malaysia
JUPEM	Jabatan Ukur dan Pemetaan Malaysia
km ²	Kilometer square
m	meter
MCDA	Multi Criteria Decision Analysis
MHLG	Ministry of Housing and Local Government
mm	millimetres
MOH	Ministry of Health
MSW	Municipal Solid Waste
NIABY	Not In Anyone's Backyard
NIMBY	Not In My Backyard
SAW	Simple Additive Weighting
SWM	Solid Waste Management
TCPD	Town and Country Planning Department
WLC	Weight Linear Combination

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Rapid economic growth, especially in the industrial, economic and urban infrastructural sectors, played a significant role in wasting management problems in Malaysia. Besides, the process of development cannot be separated from urbanization thereby increasing more pressure upon the environment through attracting larger number of people within metropolitan areas in search of a job and a better life, which eventually leads to higher waste generation. There are many legal definitions of “waste” which bring about different views as to what should consider as waste. In simplest term, waste is defined as any material, which is unwanted by the holder and intentionally thrown far for disposal. Thus, this does not take in another place the fact that certain waste materials may eventually be reused or become valuable resources to others (Lau, 2004). Solid Waste Management has attracted much attention in recent time due to the growing need to address urban environmental problems, especially in lower income countries (Iscan *et al.*, 2008).

In Malaysia, solid waste is one of the most challenging environmental issues. Despite the enormous amount effort and management strategies the government is applying in recent years, yet the waste management standards did not yield significant improvement. Lau (2004) categorized the following factors as the biggest challenges in waste management which are composition, uneconomic storage and collection systems, disposal of municipal wastes with toxic and hazardous waste, indiscriminate disposal or dumping of wastes and wasteful utilization of dump site space. One of the most widely accepted sustainable waste management techniques is the concept known as 3Rs, which represent as reduce, reuse and recycle (Damgaard *et al.*, 2011). Thus, even with this 3Rs technique, a final disposal element is still required given that no existing method or technology can put a stop to the generation of all waste products, or to eliminate the already accumulated waste. For that reason, sustainable landfill became a necessary component of an efficient and sustainable waste management (Fauziah & Agamuthu, 2012).

Landfill has been identified as the most cost-effective system for disposing of solid waste (Nas *et al.*, 2009). One of the major issues in waste management is choosing the most appropriate site for waste disposal (Iscan *et al.*, 2008). Leakage from landfills usually contains significant amounts of contaminants such as ammonia, nitrate, chloride, and metals. These contaminants may reach aquifers, degrade the water resource, and become hazardous to human health (Berkay, 2008). Landfill site selection is a critical issue in town planning process because of its enormous impact on the economy, ecology and the environment (Akbari *et al.* 2008). Urban expansion as well as the desire to live in cities, has led to a tremendous amount of waste's generation and, unfortunately, the problem gets bigger day by day (Akbari *et al.* 2008). The landfill technique is the most common method of the disposal as solid waste (Komilis *et al.*, 1999). Several factors such as distance from community, public health issues and operation cost have been discussed in order to select an appropriate site for the landfill (Komilis *et al.*, 1999; Akbari *et al.* 2008; Berkay, 2008; Nas *et al.*, 2009). Hence, there is a need to evaluate these factors to identify the most suitable site. The planning and design of a landfill management system involved selection of treatment and disposal

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