CHAPTER 4

RESEARCH METHODOLOGY

4.1 Introduction

As it is mentioned in Chapter 1, in this project, 4 main aspects are designed to achieve the scope and find answers to the research problems.

The data were mainly collected from Department of Environment (DOE), Ministry of Housing and Local Government (MHLG) and one local environmental service provider. The information was obtained through interviews, emails, site visits and online database. For any type landfills, the data of two crucial phases are required – technical information and economic aspects. The study of landfill construction and operation processes can help to understand the unique structure and procedures in sanitary landfill.

This study will be able to conduct an economic evaluation model for Malaysian landfill, which can be an indicator for the efficiency of landfill operation system. Through the comparison of different types of landfills, it also can assist to decision-making when constructing new landfills in Malaysia or other southeastern areas.

4.2 Information Required for Economic and Efficiency Evaluation

In this project, there are 3 main aspects of costs required to evaluate the economic efficiency of landfill: capital cost, operational cost and closure cost. The data of benefit consists of tipping fees, recycling and energy recovery. Benefits include the net profit, health and environment benefit.

4.3 Studies on A Selected National Landfill

Fukuoka Method is a well-known cost-effective and environmental friendly disposal method. To analyse the current efficiency level of landfill in Malaysia, an economic efficiency evaluation can be done with the standard use of FM as a baseline. It is suggested to choose the same level of landfill with FM landfill. After a series of selection, one landfill offers the information for the economic evaluation. For confidentiality, it refers to the landfill selected as Landfill B.

One of a national well-known company is chosen after survey and comparison, and it is a leader in property and environmental management services. To meet current demands, the company manages to offer high quality housing and commercial properties, sanitary landfills, power generation and medical services. Massive solid waste has been disposed and treated in sanitary landfills built and maintained by this Malaysian company. It promises to bring in the best technologies to improve the quality of solid waste management services.

Landfill B is one of the successfully operated sanitary landfills under this corporation. It was opened in 2007 and designed to contain 8.5 million tonnes of solid waste. Landfill B is chosen because:

1) This landfill is an active operational sanitary landfill at the same level of standard with FM landfill (Landfill A).
2) The data is recorded systemically and partial information is available for research purpose.

The information was gathered mainly through 4 interviews with the landfill operating engineering department (around 2 hours for each interview), 6 times of site visit to landfill B, email requirements and historical data records from Local Authority and database, such as Department of Environment (DOE).

4.4 The Role of Economics in Environmental Management

Based on the basic economic theory modelling – *circular flow model*, the distinct relationship between the ecosystem and economic activities can be clearly illustrated by the following Figure 3.8 – *materials balance model* (Kneese *et al.*, 1970). The materials balance model (MBM) places the circulation within a vast schematic diagram to illustrate the linkages between economic development decision-making and the environment.

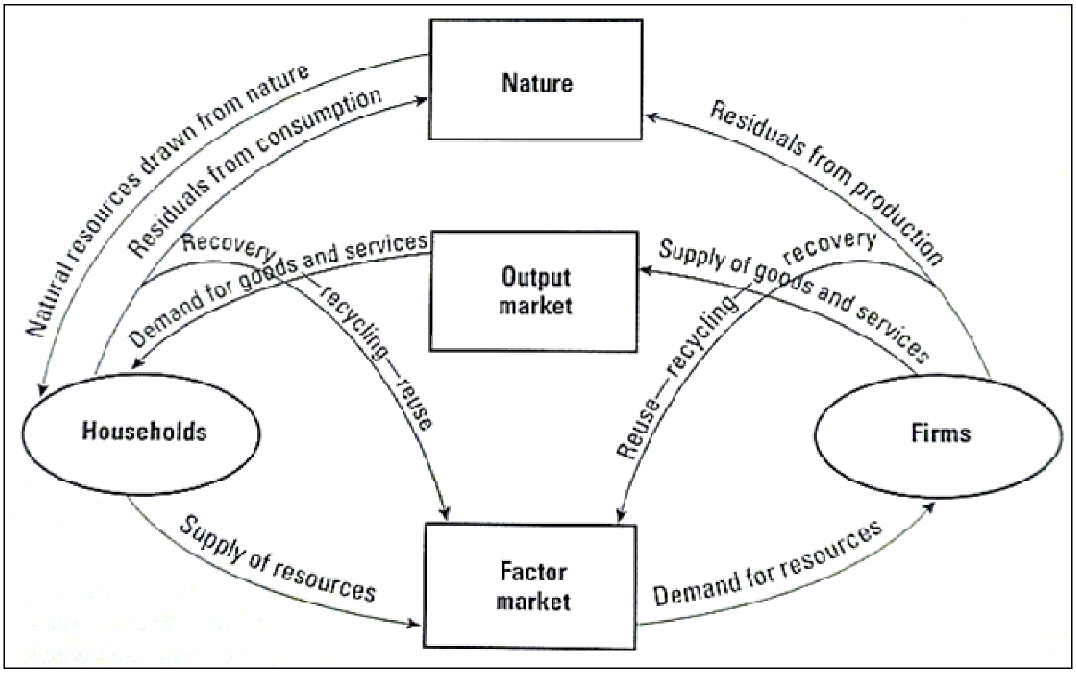

Figure 4.1 Materials Balance Model

(Source: Thomas and Callan, 2007)

There are two main flows in MBM. One is the *flow of resources* which indicates the *natural resource economics* (NRE). NRE is a research field that is concerned with the flow of resources from nature to economic activity (Thomas and Callan, 2007). This flow indicates how economic activity utilizes the elements of ecosystem, like water and soil. It is the primary focus of natural resource economics, a field of study concerned with the flow of resource from nature to economic activity (Thomas and Callan, 2007).

The other is the *flow of residuals* (Thomas and Callan, 2007). It focuses on environmental economics. "Residual" presents the amount of a pollutant remaining in the environment after a natural or technological process has occurred. Environmental economics normally involves a research area connected with the flow of residuals from economic activity back to nature (Thomas and Callan, 2007). It is possible to defer the flow of residuals back to nature through recycling, reuse and recovery.

Environmental economics is concerned about identifying and solving the problems of environmental damages, or pollution, associated with the flow of residuals. Environmental economic evaluation and modelling is aimed to solve conflicts between ecosystem and economic activities.

4.5 Economic Criteria of Efficiency

Some specific criterion conducts the economic analysis. One norm defined as *allocative efficie*ncy refers to appropriate allocation of resources among alternative usages (Thomas and Callan, 2007). *Technical efficiency* is another criterion that relates to the effective use of resources in economic activities effectively (Thomas and Callan, 2007). All the criteria as applicable to economic disciplines, environmental economics are included (Thomas and Callan, 2007).

In *allocative efficiency* criterion, it is necessary to allocate resources that ensure that additional benefits are equal to additional costs in society (Thomas and Callan, 2007). MBM indicates that in the market system it is important to know how to use resources. It mentioned not only production and consumption, but includes ecosystem as well. The evaluation of resource allocation can be separated into two stages (Thomas and Callan, 2007):

- Benefits and costs analysis
- The application of marginal analysis

There is another economic criterion applied commonly called *technical efficiency* (Thomas and Callan, 2007). It is about production decisions to generation of maximum output with given resource. In another word, this criterion refers to generate a given output level with minimum resources consumption (Thomas and Callan, 2007). In the illustration of the MBM, there are two main important aspects to achieve technical efficiency – preserving the environment and minimizing the generation of residues after raw resource consumption (Thomas and Callan, 2007). Besides that, based on the relationship between production and costs, technical efficiency indicates that economic costs can achieve lowest point when producing a given level of output.

As long as competitive conditions can run successfully, it is possible that the market forces achieve technical efficiency. Since competitive firms cannot increase the products price to cover the additional expense of inefficient production, it requires that companies have to minimize cost to survive in this competitive market (Thomas and Callan, 2007). Under an ideal competitive market conditions, technical efficiency can help economists analyse reasons why this situation is not able to form in other market illustration. What's more, it is possible to evaluate the effects of inefficient decision by the comparisons of costs and benefits results under a hypothesis which companies can be operate freely in this market (Thomas and Callan, 2007).

4.6 Environmental Evaluations

Some general information is required in this research, including population around researching landfill area, total area, and total waste production. Based on previous researches, three environmental indicators are selected for the environmental and health valuations: gas reduction, leachate generation and lead reduction. There are some limitations to obtain long-term records of above data. Therefore, a Water Balance Method (WBM) maybe considered to be implemented in following research to conduct the estimation volume of leachate generated annually. The WBM can be applied by the following Eq:

$$L=[ER \times A + LW + IRCA + ER \times (l)] - [a \times W]$$

Where:

L= Leachate produced (m^3);

ER=Effective rainfall (use actual rainfall (R) for active cells) (m);

A= Area of cell (m^2);

LW=Liquid waste (also include excess water from sludge) (m^3);

$IRCA$=Infiltration through restored and capped areas (m);

l= Surface area of lagoons (m^2);

a= Absorptive capacity of waste (m^3/t);

W= Weight of waste deposited (Tonne)

4.7 Framework of This Research

Based on all these concepts and aspects, the framework of this research is built as in Figure 4.2:

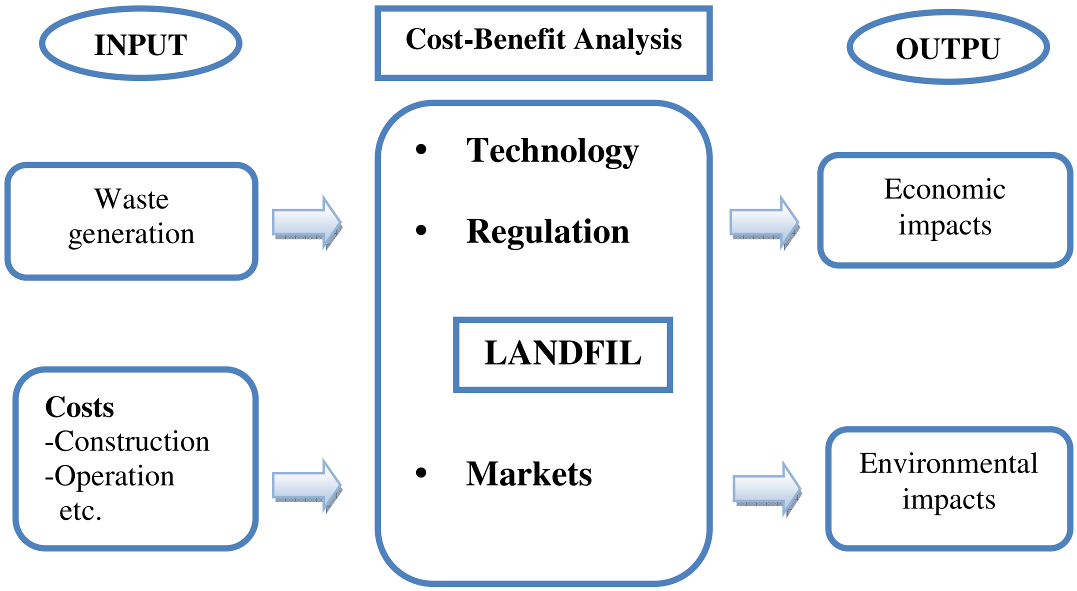

Figure 4.2: The Framework of This Study

Some main study areas are included, such as the economic performance and environmental performance. Meanwhile, the cost-benefit analysis will be simulated in the markets performance.