A STUDY OF THE PLASTIC LIFE CYCLE ASSESSMENT

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To my beloved father, mother, brother and also my supportive friends…

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ABSTRAK

Secara tradisi, rawatan sisa pejal mempunyai perhatian yang terhad berkaitan dengan penilaian kitaran hidup (LCA). Biasanya, hanya jumlah sisa pejal sahaja diambilkira. Ini adalah tidak memadai sedangkan rawatan sisa pejal, contohnya, tambak tanah atau penunuan ialah operasi yang memerlukan input dan menghasilkan output yang perlu diterangkan dalam pengenalan LCA. Kertas kerja ini menganalisis tentang plastik dari perspektif LCA, menentukan tanggungan utama alam sekitar dan mengembangkan analisis dalam bidang pembaikan produk untuk tujuan mengurangkan tanggungan alam sekitar. Dalam lingkungan had dan sempadan yang dikenakan pada penyelidikan ini, anggapan dibuat, kertas kerja ini menerangkan pelbagai kaedah pelupusan tiga jenis komponen plastik dalam sisa pejal perbandaran. Penyelidikan ini juga memberi pengurus-pengurus sisa pejal dan ahli-ahli penyelidikan alam sekitar dengan idea untuk menilai pelan pengurusan sisa pejal dan memperbaiki prestasi alam sekitar dalam strategi pengurusan sisa pejal. Keputusan mengilustrasikan kitar semula bahan plastik lebih dicadangkan dengan penggunaan plastik digantikan dengan plastic yang diperbuat daripada bahan asal, membimbing kepada pengurangan penggunaan jumlah tenaga dan penghasilan gas yang mendorong kesan pemanasan global.

ABSTRACT

Traditionally, treatment of solid waste has been given limited attention in connection with Life Cycle Assessment (LCA). Often, only the amounts of solid wastes have been noted. This is unsatisfactory since treatment of solid waste, e.g., by landfilling or incineration, is an operation, requiring inputs and producing outputs, which should be described in the inventory of an LCA. This paper analyses the plastics from the LCA perspective, determines the main environmental burdens and expands the analysis on the improvement areas of the product for the purpose of lowering the environmental burdens. Within the constraints and boundaries imposed by the study, assumptions made, this paper describes different ways of disposing three plastic fractions in municipal solid waste. This study also provides solid waste decision-makers and environmental researchers with a mind set to evaluate waste management plans and to improve the environmental performance of solid waste management strategies. The results illustrated that recycling of plastic material, preferably combined with the use of plastics replacing plastics made from virgin materials, leads to decreased use of total energy and emissions of gases contributing to global warming effect.

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CHAPTER I

INTRODUCTION

1.1 Overview

Nowadays, world population has been increased rapidly especially in developing country like Malaysia. The rapid growth of population in a country has contributed to high production of waste. Municipal waste and industrial waste can bring unhealthy and unpleasant environment or even diseases to human being if the wastes are not managed properly.

As a government, it is unreasonable to limit the number of children for a family just in order to control the high production of waste. Therefore, one of the methods to reduce the production of waste is by understanding the Life Cycle Assessment of the products itself. Basically, Life Cycle Assessment is not a tool to reduce the production of waste. Instead, by conducting a Life Cycle Assessment, the researcher can be more understand on the environmental attributes of a product from raw materials to landfill disposal or recycle as a new product, across its entire life.

Life Cycle Assessment (LCA) is a process to evaluate the environmental burdens associated with a product, process or activity by identifying and quantifying energy and materials used and wastes released to the environment, and to assess the impact of those energy and material used and released to the environment (Allen et. al., 1993). The assessment should include the entire life cycle of the product, process or activity encompassing materials and energy acquisition, manufacturing, use and waste management. In the inventory analysis component of an LCA, data on inputs

and outputs to and from the system under study are compiled and presented. Solid waste may be treated by different processes where landfilling and incineration are the most common. Through Life Cycle Assessment, researcher will be able to know which things contribute to pollution and how the pollution happens finally take an appropriate way to solve the problem.

In this case, plastics are a thoroughly investigated material because plastic waste is one of the components in municipal solid waste management. Besides, this is because there is least past research discussing on Life Cycle Assessment of plastics production. In addition, plastics are predominantly employed in packaging, construction and consumer products. The first commercial plastics were developed over one hundred years ago. Now plastics have not only replaced many wood, leather, paper, metal, glass and natural fiber products in many applications, but also have facilitated the development of entirely new types of products. The plastic fraction in municipal solid waste consists mainly of polyethylene (PE), polyethylene terephthalate (PET), polyvinyl chloride (PVC) and polypropylene (PP) and polystyrene (PS). Different types of plastics will perform differently in the environment, e.g. polyvinyl chloride (PVC) has caused concern because of their potential to cause environmental harms.

Plastic products are durable, which although having functional benefits, can cause problems at the end of products' lives. As plastics have found more markets, the amount of plastic produced become increases. This phenomenal growth was caused by the desirable properties of plastics and their adaptability to low-cost manufacturing techniques. The life cycle of plastic products includes production, transportation, use and disposal which have contributed to the release of waste emissions. This results in toxins existing in the water, air and food chain, bringing the people around the polluted area severe health problems. Recently, environmental groups are voicing serious concern about the possible damaging impact of plastics on the environmental. Plastics end products and materials eventually contribute to the solid waste stream.

Since reliable scientific data have been lacking, an experimental investigation was required. According to life cycle thinking (LCT), potential burdens arising

during end-of-life management must be prevented in the course of the entire product chain. The question arose whether landfilling is an acceptable waste management option for plastics products. Landfills and deposited waste need to meet requirements with respect to the protection of human health and the environment. Any environmental impacts may either be due to landfilling practices, or due to inherent product properties and the resulting product-specific emissions.

By improving either products or end-of-life schemes, impacts and risks could thus be mitigated and investigated. Life cycle assessment (LCA) intends to aid decision-makers in this respect, provided that the scientific underpinning is available. Strategic incentives for product development and life cycle management can then be developed.

1.2 Problem Statement

In the last decades, with the increment of the world population and the society of consumption, the amount of waste generated has exponentially increased. Waste accumulation centres have been created culminating with the generation of epidemics and rodents, besides increasing the environmental contamination level. These facts generate the necessity of developing and using more rational methods for final waste disposal.

Over the past 20 years, environmental issues have gained greater public recognition. Production, use and disposal of virtually all goods present potential health and environmental impacts. The general public has become more aware that consumption of manufacturing products and marketed services, as well as daily activities of our society, adversely affects supplies of natural resources and the quality of the environment. These effects occur at all stages of the Life Cycle of a product, beginning with raw material acquisition and continuing through material manufacture and product fabrication. They also occur during product consumption and a variety of waste management options such as composting, biogasification, incineration, burning, landfilling and recycling. At each of these steps, pollutants

may be released into the environment with ecological consequences. Ecological consequences among other things also include the effects on the environment. The impacts because of the environment releases can occur during the life cycle stages, particularly manufacturing and disposal, for all consumer and commercial products. As public concern has increased, both government and industry have intensified the development and application methods to identify and reduce the adverse environmental effects.

1.3 Objective of the Study

The aim of the study is to compare the environmental performance of three polymer-based plastics which are polyethylene terephthalate (PET), polyvinyl chloride (PVC) and polypropylene (PP) in different disposal treatments.

The further objectives are:

a) to evaluate environmental burdens associated with plastic product, process or activity by quantifying energy and wastes released to the environment.
b) to determine the main environmental burdens.
c) to expand the analysis on the improvement areas of the plastic product for the purpose of lowering the environmental burdens.

1.4 Scope of the Study

Scope of the study covers the entire life cycle of the product encompassing raw material processing, manufacturing, transportation, use, recycling and disposal. This study concentrates only on air emissions released within the life cycle of plastic which contributes to the impact of global warming. Therefore, this paper focuses on the plastic from the LCA perspective. Plastics are chosen because lack of plastics life cycle flow is being investigated and performed previously.

Life Cycle Assessment (LCA) is a tool to evaluate the impacts associated with all stages of a product's lifecycle from cradle to grave both downstream and upstream. The basis of an LCA study is an inventory of all the inputs and outputs of industrial processes that occur during the life cycle of a product. This includes the production phase and the life cycle processes including the distribution, use and final disposal of plastic product. In each phase the LCA inventories the inputs and outputs and assesses their impacts. Once the inventory has been completed, a LCA considers the impacts. This phase of the LCA is called the impact assessment: LCAs can be very large scale studies quantifying the level of inputs and outputs. This LCA is limited in scope to a basic inventory.

1.5 Significance of the Study

An LCA will help decision makers select the product or process that resulting the least impact to the environment. This information can be used with other factors, such as cost and performance data to select a product or process. LCA data identifies the transfer of environmental impacts from one media to another and from one life cycle stage to another. If an LCA was not performed, the transfer might not be recognized and properly included in the analysis because it is outside of the typical scope or focus of product selection processes.

The ability to track and document shifts in environmental impacts can help decision makers and managers fully characterize the environmental trade-offs associated with product or process alternatives. LCA also allows the plastic companies to identify an effective ways of designing and manufacturing the products themselves. LCA helps companies to keep a step ahead of rapidly changing regulatory requirements on solid waste, persistent toxic chemicals, emissions and effluent discharges. In addition, life cycle strategies for pollution prevention and minimizing energy costs are beginning to reveal economic benefits in term of more efficient production, improved product quality and minimization of the environmental risks.

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