

PERPUSTAKAAN UMP



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A STUDY ON COMME

TION AND GENERATION

RATES IN INDERA MAHKOTA 16, KUANTAN

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ABSTRACT

The rapid population growth and broad urbanization and industrialization in Malaysia have resulted in the increasing of the solid waste generated from year to year. As people have been living in settled communities, the generation and dumping of solid waste, or garbage, has become a very noticeable issue. The objectives of this study are to determine the characteristics of commercial solid waste generations and generation rate in Indera Mahkota 16, Kuantan. Other than that, this study also aims to study the factors affecting commercial solid waste generation in the studied area. This study was conducted at the commercial area of Indera Mahkota 16, Kuantan. The commercial premises at the area were divided into two categories; service and product with 15 premises for each category. During this study, two different sampling methods were conducted to collect the required data. To obtain data for the solid waste characteristics and generation rate, a waste collection method was conducted. This method included waste separation, weighing the waste collected and the data were recorded in the prepared form within the duration of 28 days. The second method used was questionnaire distribution. The data gained from the questionnaire were to determine the factors affecting commercial solid waste generation. Based on the data collection, solid waste generation was highly produced by service type premise with the total of 463.7 kg/month for the 15 premises compared to the product type premise with the amount of 251.8kg/month for the 15 premises. The generation rates of solid waste at this studied area were also in the suitable range for urban area which were 0.53 kg/premise.day for product type category meanwhile 0.82 kg/premise.day for service type category. The attitude of the residents and also seasonal variations such as festive season are the main contributor to the amount of solid waste produced at the area.

ABSTRAK

Pertambahan jumlah penduduk dan pembangunan pesat dalam proses urbanisasi serta beberapa factor lain secara tidak sengaja telah menghasilkan sisa pepejal komersial. Selagi manusia memnetap di dalam sesuatu komuniti, masalah pembuangan dan penghasilan sisa pepejal akan berlanjutan. Tujuan kajian ini dijalankan adalah untuk menentukan karekter sisa pepejal komersial dan kadar penghasilan sisa pepejal di Indera Mahkota 6, Kuantan. Selain daripada itu, kajian in turut memfokuskan untuk mengenalpasti faktor yang mengakibatkan penghasilan sisa pepejal di kawasan tersebut. Kajian ini dilakukakn di kawankomersial Indera Mahkota 16, Kuantan. Premis-premis di kawasan komersial tersebut dibahagikan kepada dua kategori utama; kategori produk dan kategori servis dengan jumlah premis terlibat sebanyak 15 premis bagi setiap kategori. Sepanjang kajian ini dijalankan, dua kaedah pengumpulan data telah digunakan untuk mendapatkan data-data yang diperlukan. Bagi mendapatkan data untuk karekter sisa pepejal komersial dan kadar penghasilan sisa pepejal, satu sesi pengumpulan ssa pepjal telah dijalankan. Kaedah ini meliputi pengasingan sisa pepejal, menimbang dan merekod data ke dalam jadual yang disediakan bagi tempoh masa selama 28 hari berturut-turut. Kaedah kedua yang digunakan ialah kaedah soal selidik untuk mendapatkan maklumat berkenaan dengan faktor yang mengakibatkan penghasilan sisa pepejal komersial. Berdasarkan maklumat yang diperolehi, penghasialn sisa pepejal adalah didominasi leh kategori servis degan jumlah keseluruhan 463.7kg/bulan untuk 15 buah premis berbanding dengan jumlah yang dihasilkan oleh 15 buah premis di bawah kategori produk iaitu 251.8kg/bulan. Kadar penghasilan sisa pepejal di kawasan tersebut juga berada di dalam lingkungan yang sesuai untuk kawasan urban di mana produk kategori memncatatkan kadar sebanyak 0.53 kg/premis.hari manakala kadar penghasilan sisa pepejal untuk kategori servis ialah 0.82 kg/premis.day. Sikap yang diamalkan oleh penduduk setempat dan aktiviti bermusim seperti musim perayaan menjadi salah satu penyumbang kepada penghasilan sisa pepejal di sesuatu kawasan.

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LIST OF ABBREVIATIONS

C & D	Construction and Demolition
EPA	Environment Protection Act
HDPE/2	High-density polyethylene
MSW	Municipal solid waste
ONP	Old Newspaper
PETE/1	Polyethylene terephthalate
RDF	Refuse-Derived Fuel
SWM	Solid Waste Management

CHAPTER 1

INTRODUCTION

1.1 Preamble

Solid waste as stated in Solid Waste and Public Cleansing Management Act 2007 can be defined as any scrap material or any other unwanted surplus substance. It also can be defined as any substance that is required to be disposed of as being broken, worn out, contaminated or otherwise spoiled; or any other material that is required by the authority to be disposed. The knowledge in solid waste generation and composition is a vital for the precise decision making in the management strategy of modern solid waste. Improper solid waste operation, storage, collection and disposal practices can cause a negative impact on the environmental and public health (World Resources Institute 1996).

The rapid population growth and broad urbanization and industrialization in Malaysia have resulted in the increasing of the solid waste generated from year to year. As people have been living in settled communities, the generation and dumping of solid waste, or garbage, has become a very noticeable issue. According to Kathirvale *et al.*, the average amount of municipal solid waste produced in Malaysia during year 2003 was 0.5–0.8 kg/person/day with 1.7 kg/person/day in a few major cities. Early solid waste management consisted of digging a pit and burying the waste. Householders that did not have any place to bury their rubbish would throw it into the streets or watercourses, encouraging rodents, contaminating water and jeopardising people's health.

The major problems of municipalities in solid waste management include the rapid increase in the accumulation of waste and its management, the use of open dumps that will create and spread health problems, contamination of underground water resources and the decreasing capacity of sanitary landfills along with the obstacles in establishing new dumpsites and the rising costs of wastes disposal. The handling and separation of wastes at the source is a crucial step in solid waste management. The amounts and composition of solid waste generated are influenced by a few factors such as tremendous population growth, rapid urbanization, and the rapid economic growth. Precisely, the greater the economic prosperity and the higher degree of urbanization, the amount of solid waste produced also will be greater (Hassan et al., 2001).

1.2 Problem Statement

Solid waste management generally can be defined as the discipline that involving with the control of solid waste generation. If solid wastes are not managed properly, it may cause harmful and danger to the environment and also human health. The amount of waste generation in Malaysia is rapidly increasing nowadays due to the certain activities that happen at the surroundings. It is also related to the economic level of different sectors in the community such as squatters, low, medium and high class residential area. The rate of solid wastes generated daily is depending on the type of waste generators and the land use.

Although a generous amount of solid waste can be recycled, unfortunately only less than 5% of the generated solid waste was actually been segregate and recycle. Plastics, paper and glass are among three main types of solid waste identified to be the highest possibilities for recycling. Thus, through this situation, it can be concluded that recycling in Malaysia has a long way to go, with major difficulty and obstacles to be solved, before a successful recycling program can be done and achieved. The characteristics of Municipal Solid Waste (MSW) elements also play vital roles to determine the suitability of the disposal systems. According to Visvanathan *et al.*, the solid waste composition in most Asian countries is detected to be highly biodegradable with the high moisture contents such as food waste, paper, plastic or foam, agriculture waste, rubber or leather, wood, metal, glass and textiles. In Malaysia, according to the

Government of Malaysia in the *Ninth Malaysia Plan* the average components of MSW are quite similar with the largest categories consisting of food waste (45%), plastic (24%) followed by paper (7%), iron (6%) and lastly 3% for glass and others. Therefore, a continuous and consecutive effort is required to identify the most precise alternative for long terms solutions to minimize the burden of existing MSW disposal systems such as open dumping and landfilling.

In reality, the MSW generation cannot be prevented completely as long as humans exist and this issue will always arise in the society. Therefore, all parties, including federal, state, and local authorities, industry as well as the citizens, should make substantial and considerable efforts through source reduction before loading into disposal sites.

1.3 Objectives

The objectives of this study are:

1. To determine the characteristics of commercial solid waste generations in Indera Mahkota 16, Kuantan.
2. To analyse the waste generation rate.
3. To study the factors affecting commercial solid waste generation in the studied area.

1.4 Scope of Study

Study area

The study will be conducted on the commercial area of Indera Mahkota 16, Kuantan. This commercial area is divided into 3 categories which are public, services and product. Since there is no public category for the studied area, all of the 30 samples will be divided equally among the 2 categories which are 15 samples for the product and another 15 samples for the services category.

Questionnaire, sampling and characterisation of the sample

A structured questionnaire was designed to collect the data on the types of premise, socio economic status and daily solid waste traits. The questionnaire also included a number of questions aimed at examining the households' awareness and attitudes toward the problem of solid waste management.

Plastic bags were supplied to each of the premise to place their commercial wastes during the distribution of questionnaire. The plastic bags were to separate between the biodegradable and non-biodegradable solid waste. Then the wastes within each bag were hand-segregated and was weighed separately and recorded according to the 6 types of waste generates which are food waste, paper, plastic, aluminum, glass and others. The same procedure was conducted each day for the 30 samples within 4 weeks time.

1.5 Significance of Study

This research is significant to be carried out to observe the municipal solid waste composition in the commercial area of Indera Mahkota 16, Kuantan. These results of the waste characterizations and the generation rates can be used to predict the future tendency towards reducing landfilling activities.

CHAPTER 2

LITERATURE REVIEW

2.1 Definition

2.1.1 Solid Waste

Solid waste can be literally defined as the wastes arising from human activities or daily routines. Solid waste is also can be defined as unwanted products in the solid state derived from the activities and discarded by the society. It is generated either by product of some certain production processes or can be arises from the domestic or commercial sector when objects are discarded after had been used. Tchobanoglous *et al.* (1993) stated that solid waste vary from all the solid or semisolid materials or substance that the owner no longer considers the sufficient value to keep the materials.

Solid waste as defined by Salvato (1992) includes any garbage , solid waste, sludge from a waste treatment plant, water supply treatment plant or air pollution control facility and other discarded materials including solid, liquid, semisolid or contained gaseous materials resulting from industrial, commercial, mining and agricultural operations and from community activities but does not include solid or dissolved materials in domestic sewage or industrial discharges.

The definition of solid waste by Solid Waste and Public Cleansing Management Act 2007 is any scrap materials or any other unwanted surplus s substance or any substance that required to be disposed of as being broken, worn out, contaminated or otherwise spoiled; or

any other materials that is required by the authority to be disposed. In daily life, a person may call the solid waste with different types of terms. Usually solid waste can be said as garbage that the term is given principally to the food waste, but it also including other degradable organic wastes. Other terms that normally used in daily life is rubbish that consists of combustible and non-combustible solid waste, excluding food wastes.

On the other hand, U.S EPA defined municipal solid waste (MSW) as to include wastes from residential, multifamily, commercial, and institutional (e.g., schools, government offices) sources. This definition excludes many materials that are frequently disposed with MSW in landfills including combustion ash, water and waste water treatment residuals, construction and demolition (C&D) waste and non-hazardous industrial process wastes (U.S EPA 2007).

2.1.2 Solid Waste Composition

Composition is the term used to describe the individual components that makes up a solid waste stream and their relative distribution, usually based on percent by weight. Typical data on the distribution of MSW are presented in **Table 2.1**

Table 2.1 Estimated distributions of all components of MSW generated in a typical community excluding industrial and agricultural wastes.

Waste category	Percent by weight	
	Range	Typical
Residential and commercial excluding special and hazardous waste	50-75	62.0
-Special (bulky items, consumer electronics, white goods, yard waste collected separately, batteries, oil, and tires.)	3-12	5.0
-Hazardous	0.01-1.0	0.1
Institutional	3-5	3.4
Construction and demolition	8-20	14.0
Municipal services		
-Street and alleys cleaning	2-5	3.8
-Tree and landscaping	2-5	3.0
-Parks and recreational area	1.5-3	2.0
-Catch basin	0.5-1.2	0.7
Treatment plant sludge	3-8	6.0
Total		100

Data on solid waste composition was mainly on the physical characteristics (Hassan, M.N. *et al.*,2000). Statistics gathered by the government indicated that the average amount of organic wastes for high income areas like Petaling Jaya and Kuala Lumpur was approximately 48.32 percent. This is followed by paper (23.56 %), plastic and rubber (9.37 %), metal (5.93 %), wood (4.82 %), glass and ceramics (4.03 %) and textiles (3.97 %). Generally, waste generation and composition vary with the degree of affluence and urbanization. Both the quantity and composition of solid waste vary widely from day to day and also seasons of the year not only between countries, but also between neighboring localities and between different types of properties in the same town.

2.1.3 Solid Waste Management

According to Salvato(1992). Solid waste management is the systematic administration of activities that provide the collection, source separation, storage, transportation, transfer, processing, treatment and disposal of solid waste. Solid waste management (SWM) is a method used for controlling, collecting, disposing and treatment of all the solid wastes or municipal solid waste (MSW) generated in the communities. SWM also can be any of solid waste treatment processes such as landfills, recycling, composting and others.

According to Tchobanoglous *et al.* (1993), solid waste management can be defined as the discipline associated with the control f generation, storage, collection, transfer and transport, processing and disposal of solid waste in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations, and that is also responsive to public attitudes. He also stated that the scope of solid waste management includes all administrative, financial, legal, planning and engineering functions for all solid waste problems. The overall objective of solid waste management is to reduce the adverse environmental effects caused by the indiscriminate disposal of solid wastes, especially hazardous wastes (Peave *et al.* 1985).

2.1.4 Solid Waste Generation in Malaysia

Waste generation encompasses activities in which materials are identified as no longer of value and are either thrown away or gathered together or disposal. Waste generation is, at present, an activity that is not very controllable. In the future, however, more control will be exercised over the generations of wastes (Tchobanoglous *et al.* 1993).

Chua *et al.*,(2011) as reported in his research stated that the generation of municipal solid waste by the public is a function of socio-economic background such as the buying power, cultural background, locality in example of urban or rural setting and the environmental awareness. Kathirvele *et al.*,(2003) cited that the generation and the

composition of solid wastes vary according to the status of income level of a certain household. He also stated that the generation rate ranges from 0.5-0.8 kg/person/day to 1.7/kg/person/day in major cities.

Urban population is a country's leading producer of solid waste. According to Imura, H. *et al.*, (2005), high population growth and urbanization combined with economic growth has changed peoples' patterns of consumption and contributes to increased waste generation and changes in the composition of waste.

2.2 Types of Municipal Solid Waste

Municipal solid waste (MSW) is defined to include refuse from households, non-hazardous solid waste from industrial, commercial and institutional establishments (including hospitals), market waste, yard waste and street sweepings (Ogwueleka, 2003). Tchobanoglous *et al.* (1993) has classified that the classification are from residential, commercial, institutional, construction, municipal services, treatment plant sites, industrial and agricultural. The types and sources of solid waste in a community are shown in **Table 2.2** and **Table 2.3**.

Table 2.2 Types of solid waste

Category	Types of waste
Organic waste	Waste from market places, food, etc.
Combustibles	Paper, wood, dried leaves, packaging for relief items, etc (contain high organic and low moisture content)
Non-combustibles	Metal, tins, cans, bottles, stones, etc.
Bulky waste	Tyres, leaves, tree branches, etc.
Ashes/dust	Residue from fire used in cooking
Dead animals	Carcasses of domestic animals and livestock
Hazardous waste	Oil, batteries, medical waste

Construction waste	Broken concrete, cement, roofing, etc.
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Source: Harvey and Reed, 2002

Table 2.3 General sources and types of municipal solid wastes

Source	Locations of wastes generation	Types of solid wastes
Residential	Single-family homes, duplexes, town houses, apartment, etc.	Food wastes, rubbish, ashes, special wastes, yard trimmings.
Commercial and institutional	Office buildings, shopping malls, warehouses, hotels, airports, schools, medical facilities, prisons.	Food wastes, rubbish, ashes, demolition and construction waste, special wastes, occasionally hazardous wastes, yard trimming.
Industrial	Packing of components, factory, oil plant	Office wastes, lunchroom and rest wastes (but not industrial process wastes).
Open areas	Streets, alleys, parks, vacant lots, playgrounds, recreational areas, highways, etc.	Street sweepings, roadside litter, rubbish and other special wastes.
Treatment plant sites	Water, sewage and industrial waste water treatment processes.	Treatment plant sludge.

Source: A. Franklin, 1994 and United Nation ESCAP, 2000

Residential and commercial solid wastes, excluding special and hazardous wastes as discussed in Table 2.3 consists of organic (combustible) and inorganic (non-combustible) solid waste from residential areas and commercial establishments. Typically, the organic fraction of residential and commercial solid waste consists of materials such as food waste, paper of all types, plastic of all types, corrugated cardboard, textiles, rubber, leather, wood and yard wastes. The inorganic fraction consists of items such as glass, tin cans, aluminium, ferrous metals and dirt.

Although there are more than 50 classifications for paper, the waste paper found in MSW is typically composed of newspaper, books and magazines, commercial printing, office paper, other paperboard, paper packaging, other non-packaging paper, tissue paper and towels, and corrugated cardboards. Special wastes from residential and commercial

sources include bulky items, consumer electronics, and white goods, yard wastes that are collected separately, batteries, oils and tires.

Institutional sources of solid waste include government centers, schools, prisons and hospitals. Excluding manufacturing wastes from prisons and medical wastes from hospitals, the solid waste generated at these facilities are quite similar to commingled MSW. In most hospitals, medical wastes are handled and processed separately from other solid wastes.

Wastes from construction, remodeling, and repairing of individual residences, commercial buildings, and other structures are classified as construction wastes. The quantities produced are difficult to estimate. The composition is varied but may include dirt, stones, concretes, bricks, plasters, lumbers, shingles, and plumbing, heating and electrical parts. Wastes from razed buildings, broken-out streets, sidewalks, bridges and other structures are classified as demolition waste. The composition of demolition wastes is similar to construction wastes, but may include broken glass, plastics and reinforced steel.

Other community wastes, resulting from the operation and maintenance of municipal facilities and the provision of other services, include street sweepings, road side litters, wastes from municipal litter containers, landscape and tree trimmings, catch-basin debris, dead animals, and abandoned vehicles. The solid and semisolid wastes from water, wastewater, and industrial waste treatment facilities are termed treatment plant wastes. The specific characteristics of these materials vary depending on the nature of the treatment process. Materials remained from the combustion of wood, coal, coke, and other combustible waste are categorize as ashes and residues (Tchobanoglous *et al.*, 1993).

2.3 Solid Waste Generation

Zainal *et al.*, (2002) cited that the progress of MSW generation in Malaysia had been reviewed since early 1980s. On the average the MSW generated will be increased 2 % annually and is expected to reach 2.5-3 % due to rapid population and economic growth during the Ninth Malaysia Plan (2006-2010). Based on the census data and Malaysia's

experience in waste study projected the residential waste generated in 20 studied municipalities would increase almost 100% from 1980 to 1990 due to the growing urbanization reaching up to 40% of population (Sekarajasekaran, 1981).

2.3.1 Characteristics of Commercial Solid Waste

The characteristics of MSW components also play important roles to determine the suitability of the disposal systems. As cited by Visvanathan *et al.* the solid waste composition in most Asian countries is highly biodegradable with high moisture contents such as food waste, paper, agricultural wastes, woods and textiles. In Malaysia, the average components of MSW are quite similar with the largest categories consisting of food waste (45%), plastic (24%) followed by paper, iron and glass each with 7%, 6% and 3% respectively as stated in the Ninth Malaysia Plan (2006-2010). Therefore, a continuous effort is required to identify the most suitable alternative for long term solutions to reduce the burden.

2.3.2 Factors Affecting Solid Waste Generation Rates

The contributing factors towards the increasing MSW generation in Malaysia are almost similar to other developing countries. Firstly, according to Ministry of Housing and Local Government (MHLG), in the Annual Report of 2002 stated that the rapid population growth is identified as one of the major factors that contribute to the solid waste generation. Secondly, the tremendous urbanization progress is another main contributing factor to generate more MSW in all cities throughout Malaysia. The urbanization growth in Malaysia was stated to be the most rapid in the Southeast Asia region in 1980 (Azahan *et al.*, 2002). Generally, the trend of urbanization can be linked directly to several federal government policies (Juzhar, J., 2002). Thirdly, the urban population showed a significant increase from 8.8 million or 28.7% in 1970 to 16.85 million or 63% in 2005 (Hock, S.S., 1998). Fourthly, the age structure of population Malaysia is relatively young, the category 0-14 years increased from 32.6 % or 8 million to 8.72 million from 2000 to 2005. It means

the labor in forces age group 15- 64 constitutes only 63.1% of total population as cited by Government of Malaysia in the Ninth Malaysia Plan (2006-2010).

Thus, Malaysia has somewhat of a high dependence ratio proportion. It is highly demanding for the government to provide schools, hospitals and other services. This implies that the government will face more challenges to provide funds for sustainable development and environmental improvement in the near future. Fifthly, rapid economic growth since gaining independence from United Kingdom in 1957 and it grew almost three times higher than the world's average annual economic growth rate at 2.5% per annum (Juzhar, J., 2002).

2.3.3 Previous Study on Waste Generation Rate

In 2001, Kuala Lumpur State Territory estimated the total solid waste at 2.500 tonnes per day or equal to 912.500 tonnes per year. The quantity of dwelling premises reached as many as 65% or 1.625 tonnes per day. With total population estimated around 1.5 million, then the average of solid waste generated from any person is as many as 1.7 kilogrammes per day. According to the solid waste accretion of 1.2 % tones a year, the 2020 estimation will be around 3.317 tonnes per day or 1,210,705 tonnes a year (Hassan M.N., 2002). In the year 2003. Amounted to 17.000 tonnes of solid waste generated on all regions of Malaysia peninsular. In 2005, Kuala Lumpur soid waste generation was about 3478 tonnes/day, with the population of around 2.150 million. The average of solid waste generated was as many as 1.6 kilogrammes per person a day (Sivapalan *et al.*, 2002).

2.4 Elements of Solid Waste Management System

Knowledge of solid waste composition is necessary for an effective management of urban solid waste (McDougal *et al.*, 2002; Zeng *et al.*, 2005). Inappropriate solid waste operation , storage, collection and disposal practices entail environmental and public health risks (World Resources Institute 1996). Decision making in solid waste management