MUNICIPAL SOLID WASTE MANAGEMENT OF INDIGENOUS COMMUNITY IN KAMPUNG KUALA PANGSUN, HULU LANGAT, SELANGOR

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DESSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF TECHNOLOGY (ENVIRONMENTAL MANAGEMENT)

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ABSTRACT

With the enactment of Solid Waste and Public Cleansing Management (SWPCM) Act, all solid wastes from household and business are subjected to the Act. However, information on municipal solid waste management of rural communities, especially Orang Asli is inadequate due to lack of research studies. The objectives of the study are to measure amount, types and composition of waste generated, to assess current solid waste management practices and the impact towards the environment, to identify the involvement of Majlis Perbandaran Kajang (MPKj) and Jabatan Kemajuan Orang Asli Malaysia (JAKOA), and to propose for better solid waste management practices. Waste collection, estimation and characterization were conducted in Kampung Kuala Pangsun involving 75 houses. Survey was conducted to assess their solid waste management practices and the impact towards the environment. Also, MPKj and JAKOA were interviewed to recognize their involvement. SPSS 20 software program was used for various statistical analyses. The study found that the daily average amount of solid waste generated per household is 0.57 kg, with per capita weight of 0.12 kg. Among the types of waste being generated are kitchen waste, plastic or high-density polyethylene (HDPE) and box paper. Most of the Orang Asli stores their household waste in plastic bags and choose for open burning to dispose the household wastes. Throughout the study, it was found that their solid waste management practices affect the environment as well as their lives. The study also found that MPKj and JAKOA have indirect and overlapped responsibility in term of providing solid waste management services, education and awareness to the Orang Asli. To improve their solid waste management practices, Orang Asli should be encouraged to store their household waste in plastic bin. Moreover, more communal bins should be provided to prevent open burning and open dumping.

ABSTRAK

Berikutan pewartaan Akta Pengurusan Sisa Pepejal dan Pembersihan Awam, semua sisa pepejal dari rumah kediaman dan bangunan perniagaan, adalah tertakluk kepada Akta ini. Walaubagaimanapun, maklumat pengurusan sisa pepejal oleh masyarakat luar bandar terutama Orang Asli adalah tidak mencukupi kerana kekurangan kajian tentangnya. Tujuan kajian ini dilakukan adalah untuk mengenalpasti kuantiti, jenis dan komposisi sisa yang dihasilkan oleh penduduk Kampung Kuala Pangsun, menilai amalan pengurusan sisa dan kesannya terhadap alam sekitar, mengkaji penglibatan MPKj dan JAKOA dalam pengurusan sisa, serta mencadangkan amalan pengurusan sisa yang lebih baik. Sisa yang dikumpul daripada 75 buah kediaman Orang Asli di Kampung Kuala Pangsun, ditentukan jenisnya dan kuantitinya. Kaji selidik dijalankan untuk menilai amalan pengurusan sisa mereka dan kesannya kepada alam sekitar. Beberapa pegawai MPKj dan JAKOA ditemuramah untuk mengetahui peranan mereka dalam isu ini. Program perisian SPSS 20 digunakan bagi tujuan analisis secara statistik. Kajian mendapati purata sampah harian yang dihasilkan oleh setiap rumah adalah 0.57 kg, dengan penghasilan per kapita sebanyak 0.12 kg. Antara jenis sisa yang dihasilkan adalah sisa dapur, plastik atau HDPE dan kadbod. Kebanyakan Orang Asli mengumpul sisa mereka di dalam beg plastik, kemudian membakarnya secara terbuka. Kajian juga mendapati amalan pengurusan sisa mereka memberi kesan terhadap alam sekitar dan kehidupan mereka sendiri. Peranan MPKj dan JAKOA dalam menyediakan kemudahan, pendidikan dan kesedaran pengurusan sisa kepada masyarakat Orang Asli adalah secara tidak langsung dan terdapat pertindihan pelaksanaan tanggungjawab. Justeru, bagi menambahbaik amalan pengurusan sisa mereka, Orang Asli perlu dinasihatkan dan digalakkan untuk mengumpulkan sampah tersebut di dalam tong sampah. Selain itu, lebih banyak tong sampah komuniti perlu disediakan untuk menghalang pembuangan dan pembakaran sisa secara terbuka.

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LIST OF SYMBOLS AND ABBREVIATIONS

BEDUCAT	Breadwinners' highest level of education
BFW	Book fresh weight
BINCOME	Breadwinners' monthly income
BOCCUPAT	Breadwinners' occupation
BPFW	Cardboard fresh weight
CBO	Community-based organizations
DIAFW	Diapers fresh weight
EQA	Environmental Quality Act
GDP	Gross domestic product
GHG	Greenhouse gaseous
GNI	Gross national income
GWFW	Garden waste fresh weight
HDPE	High-density polyethylene
HDPEFW	Plastic / HDPE fresh weight
HOMESIZE	Size of household
HWFW	Hazardous waste fresh weight
IMPROVE	Necessity to improvement of solid waste management
JAKOA	Jabatan Kemajuan Orang Asli Malaysia
JAS	Jabatan Alam Sekitar
JHEOA	Jabatan Hal Ehwal Orang Asli
JPSPN	Jabatan Pengurusan Sisa Pepejal Negara
kg	Kilogram
kg/L	Kilogram per litre
kg/m^3	Kilogram per cubic metre
KKLBW	Kementerian Kemajuan Luar Bandar dan Wilayah

KKM	Kementerian Kesihatan Malaysia
km	Kilometer
KPI	Key Performance Indicators
KPKT	Kementerian Perumahan dan Kerajaan Tempatan
KWFW	Kitchen waste fresh weight
L	Litre
LA	Local authority/ies
m^3	Cubic metre
MFW	Magazine fresh weight
MPFW	Mixed paper fresh weight
MPKj	Majlis Perbandaran Kajang
MRF	Materials recovery facility
MSW	Municipal solid waste
MSWM	Municipal Solid Waste Management
MTFW	Metal fresh weight
NGO	Non-governmental organizations
NIMBY	Not-in-my-backyard
NPFW	Newspaper fresh weight
ODA	Official Development Assistance
OFW	Other waste fresh weight
PBFW	Plastic bags fresh weight
POLYSTFW	Polystyrene fresh weight
PPSPPA	Perbadanan Pengurusan Sisa Pepejal dan Pembersihan Awam
RECOMMEND	Recommendations to improve waste management
RECYCLE	Involvement in recycling activity
RFW	Rubber fresh weight

RM	Ringgit Malaysia
SATISFY	Satisfaction towards current waste management practices
S.E.	Standard error
SPSS	Statistical Packages for Social Science
SWM	Solid waste management
SWPCM	Solid Waste and Public Cleansing Management
TFW	Tin fresh weight
TTFW	Textile fresh weight
UAE	United Arab Emirates
UFFW	Unconsumed food fresh weight
UN	United Nations
UNEP	United Nations Environment Programme
URENCO	Urban Environment Company
USD	United States dollar
WDENS	Waste density
WDISPOSE	Methods practice to dispose waste
WFW	Waste fresh weight
WIEGO	Women in Informal Employment: Globalizing and Organizing
WOFW	Wood fresh weight
WSTORE	Methods practice to store waste
WVOL	Waste volume

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CHAPTER 1: INTRODUCTION

1.1 Municipal Solid Waste in Malaysia

In tandem with our nation's goal of becoming a developed nation by the year 2020, while ensuring the emphasis on "Sustainable Development", Malaysia needs a complete and clear information regarding the trends in waste generation, as well as, benefits of source reduction, recycling, composting, land-filling and combustion of municipal solid waste (MSW) (Mohd & Fadil, 2004). Data on trends in urban-rural differences in attitude perceptions, recycling behavior, as well as, the householders' waste generating behavior are necessary to design and plan for an effective waste management system in the near future (Mohd & Fadil, 2004).

MSW generation in Malaysia has been increasing more than 50 percent per day per person as compared to two decades ago (Pek & Jamal, 2010) due to the population growth, changing consumption patterns, rapid urbanization, economic development, changing income, and industrialization (Chamhuri, 2008; Chang & Davila, 2008; Elmira *et al*., 2011; Nguyen & Schnitzer, 2009). These also results in variation of the forms of the solid waste produced. Department of Statistics Malaysia (2011) reported that an average annual population growth rate of Malaysian population is two percent for the period of 2000-2010 with population density of 86 persons per square kilometer.

About 71 percent of Malaysian population is urban inhabitants, where Selangor is the top three most urbanized after Kuala Lumpur (100%) and Putrajaya (100%) with 91.4 percent level in urbanization (Department of Statistics Malaysia, 2011). The state population has been growing at 2.7 percent since 2000 giving the total population of 5.46 million people in 2010 with population density of 674 persons per square kilometer (Department of Statistics Malaysia, 2011). The rapid urbanization in the state makes the study on solid waste generation crucial and timely (Mohd & Fadil, 2004).

On average, Malaysian urban population generates about 1.9 kg of solid waste per person per day while the rural population generates about 0.65 kg per person per day (Hamatschek *et al*., 2010). Moreover, Hamatschek *et al.* (2010) stated that the waste collection in urban communities covers nearly all inhabitants, but in rural regions only 66 percent of the population has access to a waste management system. Due to this, a lot of illegal dumpsites come to existence. Therefore, solid waste management (SWM) and disposal has become a serious problem for the government due to the institutional, financial, technical, regulatory, expertise and public participation shortcomings as well as land scarcity (Agamuthu *et al.*, 2009; Latifah *et al.*, 2009). Inadequate disposal of waste can cause environmental degradation.

Presently, most wastes are disposed into poorly managed control tipping with little or no pollution protection measures (Pek & Jamal, 2010). This conventional disposal routine is land dominance and poorly maintained. The disbursement for the use of it is made circuitously through the annual housing assessment fee (Pek & Jamal, 2011). The impacts of disposed waste include the contamination of surface and groundwater through leachate, soil contamination through direct waste contact or leachate, air pollution through burning wastes, spreading of diseases by different vectors like birds, insects, and rodents, odor in landfills and uncontrolled release of methane (CH_4) by anaerobic decomposition of waste (Nguyen and Schnitzer, 2009).

Basically, these trends and problems originate from the waste generators. So, an understanding on public behaviors need to be addressed systematically through more rigorous efforts to find ways to improve refuse management for a particular country (Mohd & Fadil, 2004). Comprehensive studies on public behaviors and solid waste generation in urban-rural areas are among few fields that demand endless emphasis if a sound management was to be reached.

1.2 Problem Statement

The issue of increasing wastes has been strongly linked to the health issues. Therefore, developing countries are further challenged to find the best economical and efficient way of resolving the waste management problem which include finance, collection and transportation, educational programs and institutional matters (Mohd & Fadil, 2004). In order to achieve an effective integrated waste management in the country, several issues have to be tackled like waste quantities and characteristics, generators' attitudes, behaviors and needs (Mohd & Fadil, 2004).

In general, MSW is related to income and socio-economic status whereby as economy grows, public consumes and produces more waste per person basis (Mohd & Fadil, 2004). Also, the attitude and recycling behavior of the society affects the amount of waste that finally goes to the landfill sites. So, through surveys, behavioral and waste characterization studies, the planning and designing of future systems may be made easier. To date, studies to characterize and quantify waste to understand the physical composition of solid waste in rural area particularly Orang Asli villages have yet to be conducted. Most past and current researches about solid waste in Malaysia only focus on urban areas population and international tourism attraction vicinities. Information on the SWM practices in rural areas especially Orang Asli is very inadequate. It is timely that information be made available to ease managers to make better decisions as to which alternatives to be used in a particular situation with specific waste composition at a particular location and time (Mohd & Fadil, 2004).

Normally, there is no solid waste collection service provided by the local authorities (LA) for the solid waste generated from rural settlements. According to a study conducted by Ling *et al.* in 2010, most the Orang Asli in Jempol district, Negeri Sembilan, do not have waste bins or disposal pits and the waste was seen to be littered on the ground or burnt, or fed to the animals like chickens and dogs. Also, there is no

collection services but storage of recyclables was observed as the Orang Asli sell the recyclable items to agents who come to their village for collection (Ling et al., 2010).

With the enactment of the Solid Waste and Public Cleansing (SWPCM) Act, all solid wastes from household and business are subjected to the Act, including wastes from areas outside LA service boundaries. Information based on solid waste generation, physical composition and current management practices will be useful in the development of municipal SWM alternatives, as well as, assisting the waste handlers to deal with diverse kinds of wastes in proper manners thus reducing the possible negative impacts related to its management. Hence, more local research works need to be done so that better understanding of the issues mentioned can be obtained. Therefore, this study can assist to provide invaluable data on the trends currently occurring within the study area, to develop more understanding on municipal solid waste management among Orang Asli community.

1.3 Objectives

The objectives of the study are:

1. To measure amount, types and composition of solid waste generated from the household of the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor.
2. To assess the current SWM practices by the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor, and the impact towards the environment.
3. To identify the involvement of MPKj and JAKOA towards SWM among the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor.
4. To propose for better SWM practices in Kampung Kuala Pangsun, Hulu Langat, Selangor.

CHAPTER 2: LITERATURE REVIEW

2.1 Background Information on Orang Asli

Orang Asli or the indigenous people are the descendants of the earliest inhabitants of Peninsular Malaysia. Legally, the Aboriginal People Act 1954 (revised in 1974), defined the Orang Asli as a member of an aboriginal ethnic group, either by blood descent or by adoption, who speaks an aboriginal language and who habitually, follows an aboriginal custom and belief (Nicholas, 2006). They are not a homogenous group but comprised of three subgroups named Negrito, Senoi, and Proto-Malay, which are then divided into several ethnics (Nicholas, 2006). This means that they have different physical characteristics, language and culture. It is believed that the ancestors of the members of Proto-Malay subgroup migrated from the Indonesian islands (Nicholas, 2006). The Proto-Malay is comprised of six ethnics i.e. Temuan, Semelai, Jakun, Orang Kanaq, Orang Kuala, and Orang Seletar (Nicholas, 2006). Physically, the Proto-Malay people resemble the Malays. Their languages remain as archaic variants of the Malay language except the Semelai and Temoq languages that have links to Senoi languages (Nicholas, 2006).

There was no specific administration for the indigenous people until 1954 where the Jabatan Hal Ehwal Orang Asli (JHEOA) was established (Nicholas, 2006). It was established to protect the indigenous people and their way of life from the sudden development of civilization and exploitation while preparing facilities for education and suitable environment (JAKOA, 2012). Since 2001, the JHEOA is under the control of Kementerian Kemajuan Luar Bandar dan Wilayah (KKLBW) but in 2010, JHEOA was changed to Jabatan Kemajuan Orang Asli (JAKOA) and the department strives to drive organizational excellence in the development of indigenous people communities on par with the public offering, as well as, implementing inclusive development to enhance the

socio-economic status and quality of life to the advancement of excellence to uphold the legacy of indigenous people (JAKOA, 2012).

2.2 Description of Solid Waste

Solid waste can be defined as useless and unwanted products in the solid state derived from anthropogenic activities and discarded by society (Smart Ranger, 2009). It is classified into two types, namely municipal solid waste (MSW) and hazardous waste, depending on their source of generation (Smart Ranger, 2009). The MSW comprises of household waste, construction and demolition debris, sanitation residue and waste from streets which are mainly generated from residential and commercial complexes (E-idaman, n.d.).

2.3 Municipal Solid Waste Generation

MSW generation is a natural phenomenon (Singh *et al.*, 2011). Ever since Stone Age, human being had been generating MSW. The MSW generated can either be bones, parts of animals or woods. With civilization, the amount of MSW generated are increasing as well as the types and complexity of the waste, with generation of non-biodegradable solid waste. Generally, the greater the economic prosperity and the higher percentage of urban population, the greater the amount of MSW produced (Nguyen & Schnitzer, 2009). Furthermore, the remarkable amount of MSW being produced is resulted from the increase in the world's population. Singh *et al.* (2011), further described that geographical factor such as level of economic development and urban population density influences the generation of MSW in a country.

According to the United States Census Bureau (2012), the total world population was 6 billion people in 2001. However, with the annual growth rate of about one percent, the total world population has exceeded 7 billion people in early 2012 (United

States Census Bureau, 2012). As reported by Singh *et al.* (2011), the amount of MSW produced is directly proportional to the population growth because less population means less demand for food and shelter, as well as, lesser pressure on other natural resources for their various needs. In term of urbanization, access to health, education, and other social and cultural services are more readily available and efficient in urban areas since the people living closer together (The World Bank, 2012). Therefore, as the rate of urbanization increases, demand on the services of SWM increases (Elmira *et al.*, 2011).

As reported by the Environment Protection and Heritage Council (2010), the indigenous communities in Warraber Island, Australia, generated about 130 tonnes of MSW yearly with each individual produced 500 kg every year. As quoted by UNEP (2009), the Global Waste Management Market Report estimated that the total amount of MSW generated globally in 2006 reached 2.02 billion tonnes, representing a seven percent annual increase since 2003. The UNEP (2009) further estimated that between 2007 and 2011, global generation of MSW will rise by 37.3 percent, equivalent to roughly eight percent increase per year. Data from developed countries are more accessible due to their well-established policies and proper waste management systems that make continuous improvement feasible as compared to weak enforcement, lack of technology and ineffective policy implementation that make the management of waste in developing countries inefficient with a very low possibility of improvement (Agamuthu *et al.*, 2009).

2.3.1 Municipal Solid Waste Generation in Developing Countries

Developing countries are those that have low or middle income economies. According to The World Bank (2012), income economies are divided to low income economies, middle income economies, and high income economies, according to 2010

GNI per capita. Since 30 years ago, most developing countries are experiencing the development in urban areas called urbanization process. Characteristically, the progress in urbanization is together with the growth of inhabitants living in urban regions. However, the progress in urbanization does not always couple with refining situations. Certainly, the unplanned urbanization progression will cause massive complications on managements particularly for fulfilling the escalating call for better municipal services. Besides, the progression will also be the occasion of rise in the amount and complexity of solid waste generated especially, MSW. As cities grow economically, business activity and consumption patterns drive up solid waste quantities (The World Bank, 2011).

The developing countries with lower GDP have lower MSW generation rates and so on. However, due to increasing population and economy, MSW generation is expected to grow in developing countries. Among developing countries, UNEP (2002), as observed by Troschinetz and Mihelcic (2009), reported that Maldives has the highest MSW generation rate which is 2.48 kg/person/day due to its greatest economic activity being tourism, making it an exception among developing countries with typical generation range of 0.3 to 1.44 kg/person/day. Troschinetz and Mihelcic (2009) further observed that Bhutan, Botswana, Mexico and Sri Lanka generate the least amount of MSW on a per capita basis at approximately 0.3 kg/person/day.

Moreover, according to Danbuzu (2011), it is estimated that an average Nigerian generates about 0.49 kg/person/day of MSW, and Issam *et al.* (2007) further reported that Palestinian produced approximately 0.89 kg/person/day of MSW. A study by Imad (2011) found that the increase in per capita daily generated waste is found linearly proportion to the per capita GDP. Low and medium income countries (developing countries) have low MSW generation rates which are about 0.3 to 0.9 kg per capita per

day while the MSW generation rates of high income countries (developed countries) are about 1.4 to 2.0 kg per capita per day (Imad, 2011).

A number of factors directly affect the amount of MSW produced in developing countries. These include lifestyle, number of people in a household, socio-economic development and the degree of industrialization, as well as climate and seasonal changes (Aquino *et al.*, 2008). The lifestyle, socio-economic development and degree of industrialization can affect the incomes thus manipulating the consumption rates and patterns. A study by Bolaane and Ali (2004) revealed that higher number of people in a given household results in less MSW generation per person per day. While, the quantity of organic material generated during the seasons or climates is influenced by the climate and seasonal changes.

2.3.2 Municipal Solid Waste Generation in Asian Countries

Asia is a very wide and heterogeneous continent. It holds developed countries such as South Korea and Japan, along with developing countries such as India, China and Malaysia. Six of the world's top ten most populous countries – China, India, Indonesia, Pakistan, Bangladesh, and Japan are in Asia (Shekdar, 2009). Asia is also one of the world's most densely inhabited zones with remarkable production of MSW due to extremely rapid economic growth and social change, but mostly is defectively handled.

Reliable data on MSW generation can be obtained from developed countries because they are recorded on a daily basis and made available, hence offer a rational basis for planning and implementing waste management processes. However, the data on MSW generation in developing countries are usually collected for the surveys purpose which are only deployed for some time and narrowed to some cities.

Cities in Asia generate a colossal amount of MSW, approximately 760,000 tonnes per day (United Nations Institute for Training and Research, 2011). United Nations Institute for Training and Research (2011) also expected that this figure will increase to 1.8 million tonnes of MSW per day in 2025. This has forced Asian cities to improve their SWM systems because there is no available space to upkeep a 'throw-away' consumer way of life. Therefore, more countries are making efforts to improve their infrastructure and services in term of SWM. Shekdar (2009) reported that the quantity of solid waste generation is mostly associated with the economic status of a society (Table 2.1).

Table 2.1: Information on GDP per capita and MSW quantity

Country	GDP per capita estimated for 2007 (USD)	Waste generation (kg/capita/day)
Hong Kong	37,385	2.25
Japan	33,010	1.1
Singapore	31,165	1.1
Taiwan	31,040	0.667
South Korea	23,331	1.0
Malaysia	12,702	0.5 – 0.8
Thailand	9,426	1.1
China	8,854	0.8
Philippines	5,409	0.3 – 0.7
Indonesia	5,096	0.8 – 1.0
Sri Lanka	5,047	0.2 – 0.9
India	3,794	0.3 – 0.6
Vietnam	3,502	0.55
Lao PDR	2,260	0.7
Nepal	1,760	0.2 – 0.5

Source: Shekdar, 2009.

2.3.3 Municipal Solid Waste Generation in Southeast Asia Countries

Since 1980s, Southeast Asia has been experiencing aggressive urban growth, increasing population, changing consumption patterns, economic development, changing income and industrialization (Nguyen & Schnitzer, 2009). These factors contributed to the increase in production of MSW as well as variation of the forms of

MSW produced. Typically, MSW generation rates are affected by socio-economic development, degree of industrialization and climate (Nguyen & Schnitzer, 2009). This means that the better the economic and the greater the ratio of urban population, more quantity of MSW will be generated.

According to Nguyen and Schnitzer (2009), Vietnam produces approximately 49 million tonnes MSW annually with per capita waste generation of 0.61 kg/person/day; Philippines generates roughly 36 million tonnes MSW every year with per capita waste generation of 0.52 kg/person/day in urban regions and 0.3 kg/person/day in rural regions; and Myanmar produced approximately 10 thousand tonnes of MSW annually with per capita waste generation of 0.45 kg/person/day. Due to economic growth in Southeast Asia countries, the trend in MSW production is expected to escalate too.

Table 2.2 shows estimated trends of MSW generation rate per capita by 2025 in Southeast Asia countries. Nguyen and Schnitzer (2009) predicted that, in high income country like Singapore, the per capita waste generation rate will remain relatively unchanged and then fall considerably to below its present level; while in middle income countries, the per capita waste generation will increase at about 0.3 kg because of bulky wastes and multi-material packing; and in low income countries, the per capita waste generation will increase by about four to six times the present amount.

2.3.4 Municipal Solid Waste Generation in Malaysia

According to the 2010 census conducted by the Department of Statistics Malaysia (2011), Malaysia population is approximately 28 million in 2010 and the per capita gross domestic product (GDP) is USD 14,731. The proportion of country's urban population increased to 71 percent in 2010 as compared to 62 percent in 2000 (Department of Statistics, 2011).

Malaysia is one of the most prosperous developing countries. It has steady economic growth, low unemployment rates, stable political conditions and plenty of natural resources (Latifah *et al.*, 2009). Instead, owing to rapid economic growth and growing population, the MSW generation quantities escalates fast and leads to severe environmental harms. Generation of MSW in Malaysia has increased more than 91 percent over the past ten years and the urban population is the main waste generator (Agamuthu *et al.*, 2009).

The National Strategic Plan on SWM estimated that the MSW generated is to increase by 3.59 percent per year based on the population growth projections for the period of 2002 to 2020 (Ahmad, 2010). Besides, it has been reported that in 2011, Malaysians produced more than 19,000 tonnes of MSW daily (Chin, 2011). It is anticipated that the amount will increase to 31,000 tonnes in 2020 per day with an average of 0.85 kg per capita per day (Anwar *et al.*, 2012). The average MSW generation per capita is between 0.5 to 0.8 kg/person/day for rural regions while urban regions generate almost 1.9 kg/person/day (Hamatschek *et al.*, 2010).

Table 2.2: The expected trends of per capita MSW generation rate in 2025 in Southeast Asia countries

Country	GNP per capita (USD)		Population		Waste generation rates (kg/cap/day)		Predicted urban waste generation	
	1995	2025	Total (millions)	Urban (% of total)	Generation rates (kg/cap/day)	Total waste (tons/day)	Municipal solid waste (kg/cap/day)	Total (tons/day)
High income								
Singapore	26,730	36,000	4.40	100.00	1.10	4,840	1.10	4,840
Middle income								
Malaysia	3,890	9,440	26.60	72.70	0.81	15,663	1.40	26,812
Thailand	2,740	6,700	62.80	39.10	0.64	15,715	1.50	36,738
Indonesia	980	2,400	212.00	60.70	0.76	96,672	1.00	127,200
The Philippines	1,050	2,500	87.00	74.30	0.52	33,477	0.80	51,504
Low income								
Myanmar	240	580	57.30	47.30	0.45	12,118	0.85	22,891
Cambodia	220	700	14.20	48.60	0.52	3,544	1.10	7,497
Laos	350	850	5.70	44.50	0.55	1,379	0.90	2,257
Brunei	260	750	3.80	59.00	0.66	149,140	0.95	216,931
Vietnam	240	950	84.00	39.00	0.61	19,983	1.00	32,760

Source: Nguyen & Schnitzer, 2009.

2.4 Municipal Solid Waste Composition

MSW composition undergoes changes as countries develop and become more urbanized (Rajendra *et al.*, 2012). The notable feature is the increase in the paper, paper packaging, plastics and multi material packaging items (Sastry, n.d.). The typical solid waste comprised of mixture of different materials such as food waste, papers, plastics, metals, woods and potentially hazardous substances which can be generated at different times during the extraction, manufacturing or consumption of the materials. Essentially, the waste stream reflects changing in economic activity, production and consumption patterns, as well as, influencing emissions during the solid waste treatment (Ministry for the Environment New Zealand, 2009).

By understanding what materials are in the waste stream, to what degree valuable natural resources are being thrown rather than reused, recycled or recovered to create other products, materials or energy can be identified (Ministry for the Environment New Zealand, 2009). The information on MSW composition is vital for the development of waste minimization policies, target waste minimization programmes and to improve recycling schemes (UNEP, n.d.). For instance, based on MSW composition data, the LA is able to target reuse or recycling schemes for materials that make up the big part of the waste stream in their area (Ministry for the Environment New Zealand, 2009). Also, if organic wastes make up the bulk of the local MSW stream, composting facilities would be favored, and if plastics and paper make up the bulk of the local MSW stream, choosing the incineration option may be bolstered by mildly high heating values (Chang & Davila, 2008). Besides, an improved understanding of the makeup of MSW stream will also contribute to economic, environmental and social benefits (Ministry for the Environment New Zealand, 2009).

MSW composition can affects the environmental and health impacts too. Hence, better MSW composition data will helps to improve understanding on the impacts and

also assist in the management of high-impact waste types (Ministry for the Environment New Zealand, 2009). For examples, hazardous waste has significant implications in a way it is managed and the composition of MSW being disposed to landfills influences the leachate generation which may cause odor, soil and groundwater pollution. Chang and Davila (2008), further described that a reliable MSW characteristics database may aid in the quantification of pollution prevention impacts, support the planning and design of waste management facilities, examine the management strategies and policies at federal, state, and local levels for MSW management, enables private sectors to reach a large, multifaceted SWM market, creating both operational value for the end-users and shareholder value for communities.

2.4.1 Municipal Solid Waste Composition in Developing Countries

Human kind has been generating waste since the beginning but the management of MSW was hardly an issue for old communities because the quantum and composition of MSW produced are easily decompose and revert to soil or be washed away by rivers without creating any serious environmental hazard (Firdaus & Ahmad, 2010). However, as civilization takes place, the nature of MSW becomes more complex. Ray (2003) as quoted by Firdaus and Ahmad (2010) assumed serious proportion only after the human concentrations became engaged in non-agricultural forms of production.

It is believed that the composition of MSW generated in developing countries is similar in composition but the variation between regions are dictated by the socio-economic status and socio-cultural factors of the dwellers within an area (Visvanathan & Trankler, n.d.). Troschinetz and Mihelcic (2009) also pointed out that seasonal effects, income level, domestic fuel supply, geography, living standards and climate are other factors affecting the MSW composition in the developing countries. Averagely, the developing countries generated about 55 percent organic waste (Figure 2.1). It is

assumed that high-income families produced extra inorganic waste from packaging material compared to low-income families which generated extra organic waste from preparing food. In addition, during summer, organic waste generation increases because fruits become a major part of a person's diet in developing countries (Troschinetz & Mihelcic, 2009).

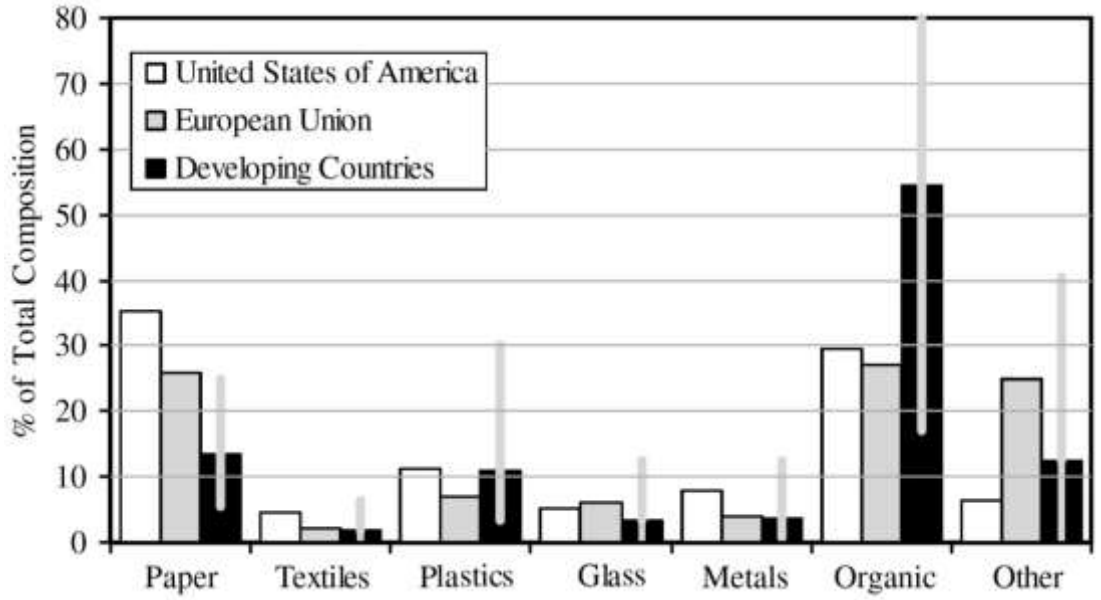

Figure 2.1: Comparison of MSW composition of developed countries (United States and European Union) against developing countries. Vertical bars provide the range of composition of each material type for the developing countries only

Source: Troschinetz & Mihelcic, 2009.

2.4.2 Municipal Solid Waste Composition in Asian Countries

MSW generated from Asian countries can have significant hazardous potential (Singh *et al.*, 2011). The difference in percentage MSW composition of low, middle and high income Asian countries is shown in Table 2.3. The proportion of recyclables like paper and plastic are high in the developed countries while those countries with low GDP have high proportion of organic waste. The low proportion of recyclables in

developing countries can be attributed to the market value of recyclables due to the fact that recycling occurs at every stage of the system, leaving only a small portion that ultimately reaches the landfill for disposal (Shekdar, 2009).

Table 2.3: MSW relative composition in low, middle and high income countries

Parameters (%)	Low-income country	Medium-income country	High-income country
Organic (putrescible)	40 – 85	20 – 65	20 – 30
Paper	1 – 10	15 – 30	15 – 40
Plastics	1 – 5	2 – 6	2 – 10
Metal	1 – 5	1 – 5	3 – 13
Glass	1 – 10	1 – 10	4 – 10
Rubber, leather, etc.	1 – 5	1 – 5	2 – 10
Other	15 – 60	15 – 50	2 – 10
Moisture content (%)	40 – 80	40 – 60	5 – 20
Density (kg/m^3)	250 – 500	170 – 330	100 – 170
Calorific value (kcal/kg)	800 - 1100	1000 - 1300	1500 - 2700

Source: Singh et al., 2011.

In India, studies by Gupta and Kumar (2011), Mohd and Iqbal (2010), Firdaus and Ahmad (2010), as well as Thitame *et al.* (2010) in four different cities i.e. Dehradun, Aligarh, Delhi and Sangamner cities observed that biodegradable organic waste have the largest share followed by inert material (sand, ash, stone and dust), paper and plastic waste, with high moisture content i.e. 38 to 50 percent,. The relative amount of recyclable material is quite small because householders or rag-pickers generally retrieve or recycle the marketable metals, papers, plastics, glass and cardboards to a

considerable extent (Joseph, n.d.). Also, other study on solid waste composition in India by Visvanathan and Trankler (n.d.) agreed with Shekdar (2009).

In Iran, studies by Mohammad and Touraj (2007) in Kurdistan Province, and Touraj *et al.* (2008) in Tehran city, identified that putrescible materials, plastics, paper and cardboard, and textiles constituted more than 90 percent of the total waste stream with high moisture content of 62 percent. Besides, a study on SWM conducted by Medina (2011) in Amman, a largest city in Jordan and one of the oldest human settlements in the world shows that organic waste constituted the largest fraction followed by plastics, textiles, and dirt and sand. It is said that dirt is common in MSW since the city is built on sandy soil and when residents sweep around their homes, sand ends up in the waste bins (Medina, 2011). Other than that, Visvanathan and Trankler (2003) agree with Shekdar (2009) that the major composition on MSW stream in China is organic waste, followed by inert and others, plastics and paper, while in Sri Lanka, organic waste made up the largest portion of solid waste generated followed by paper, and plastics.

2.4.3 Municipal Solid Waste Composition in Southeast Asia Countries

Quantifying and qualifying variety of wastes produced are fundamental to determine the best method to treat the waste. Typical composition of MSW in typical Southeast Asia countries consist of largest fraction of organic waste followed by plastic and paper cardboard. Table 2.4 further described MSW composition in Southeast Asia countries. Table 2.4 shows that Cambodia, Indonesia, Malaysia, Myanmar and Vietnam produced high percentage of organic waste. It is also noted that Brunei, Philippines, Singapore and Thailand generated high percentage composition of paper cardboard. Laos produced high percentage of metal while plastic and glass is fairly generated by all the countries. The other waste category mainly included inert waste, leather and rubber,

wood and textiles. In other MSW composition studies conducted in Thailand (Table 2.5), Chiemchaisri *et al.* (2007) agrees with Nguyen and Schnitzer (2009).

Table 2.4: MSW composition of Southeast Asia countries

Country	Waste composition (%)					
	Organic waste	**Paper cardboard**	**Plastic**	**Glass**	**Metal**	**Others**
Brunei	44	22	12	4	5	13
Cambodia	55	3	10	8	7	17
Indonesia	62	6	10	9	8	4
Laos	46	6	10	8	12	21
Malaysia	62	7	12	3	6	10
Myanmar	54	8	16	7	8	7
The Philippines	41	19	14	3	5	18
Singapore	44	28	12	4	5	7
Thailand	48	15	14	5	4	14
Vietnam	60	2	16	7	6	9

Source: Nguyen & Schnitzer, 2009.

Table 2.5: MSW composition in Thailand

Province	Waste composition (%)									
	Food waste	**Paper**	**Plastic**	**Glass**	**Metal**	**Rubber/leather**	**Textile**	**Yard waste**	**Ceramic**	**Others**
Bangkok	43.0	12.1	10.9	6.6	3.5	2.6	4.7	6.9	3.9	5.8
Angthong	42.0	13.5	12.4	4.0	3.5	4.1	7.2	9.8	1.9	1.6
Chiangmai	54.0	11.0	15.1	9.6	2.1	0.9	2.6	1.2	2.1	1.4
Chiangrai	45.0	10.0	12.0	10.0	5.0	2.0	2.0	10.0	-	4.0
Kanchanaburi	50.0	17.7	19.7	2.4	2.0	0.3	0.9	4.6	1.4	0.9
Nakornratchasima	44.0	20.1	21.0	6.4	2.6	0.5	2.3	1.6	0.9	0.6
Nakornsawan	53.0	13.2	13.7	0.3	0.4	0.1	0.2	15.7	0.6	2.9
Nonthaburi	52.0	6.8	28.4	4.3	0.6	1.9	2.1	1.3	1.4	1.2
Pattaya	41.0	25.0	17.6	4.5	1.3	-	2.6	6.0	-	2.0
Petchburi	55.0	11.3	19.3	0.6	3.9	4.0	2.7	2.6	0.3	0.3
Phitsanulok	58.0	5.0	26.2	1.7	1.1	0.7	2.2	3.5	0.5	1.1

Source: Chiemchaisri et al., 2007.

2.4.4 Municipal Solid Waste Composition in Malaysia

Malaysian MSW contains a very high concentration of organic waste and consequently has high moisture content i.e. approximately 55 percent and a bulk density above 200 kg/m^3 (Latifah *et al.*, 2009). Many studies on MSW composition have been conducted. Subjected to the studied area, the MSW composition may be relatively variable. However, Sanaz *et al.* (2009), and *Singh et al.* (2011) agreed that the major components of Malaysian MSW which constituted about 80 percent of overall weight are organic waste (processed kitchen waste and food waste), followed by paper and plastic. There are differences in MSW composition relating to people's background i.e. people with higher income generate more plastic and paper waste (Hamatschek *et al.*, 2010). Ahmad (2010) further reported that current MSW composition in Malaysia is 45 percent of food waste, 24 percent of plastic, 7 percent of paper, 6 percent of iron and 3 percent of glass, and others.

2.5 Municipal Solid Waste Storage and Collection

The source separation is a vital phase in waste management. Typically, waste at source is stored in small bins, communal bins, or hauled communal bins. These bins could be made of metal, plastic or concrete. The most used bins for housing areas is small bin while in high-rise building, communal bins are used. In SWM system, MSW collection activity is the most costly activity and its efficiency would have direct impacts on the level of municipal SWM services in an area (Zaini, 2011). The cost included expenditure incurred in the SWM in an area, resources used in the administration, development and operations of SWM and environmental damages resulted from storage, collection and disposal practices (Zaini, 2011). People are very sensitive to MSW collection services and most complaint received is about its quality

(Zaini, 2011). The regularity of MSW collection varies depending on the activity of an area.

2.6 Municipal Solid Waste Disposal

Ultimately, the generated MSW is thrown into MSW collection centers before being collected by the municipalities to be further disposed into the landfills or dumps (Teri, n.d.). Though, due to several reasons such as resource constraint and inefficient infrastructure, not all generated MSW is collected and transported to the final disposal sites in which, improper MSW management and disposal may lead to serious health impacts and hazards to the environment (Teri, n.d.) such as unattended scattered waste may attracts vectors that will spread diseases while decomposing wet waste releases bad odor.

The final disposal sites i.e. landfills and dumps require lot of land mass and incur costs associated with the consequences of waste disposal. There are large costs involved in providing conveniently located and environmentally responsible landfill facilities (Shakira *et al.*, n.d.) due to land scarcity. Suitable landfill sites are becoming more difficult to find as urban areas expand while people are not willing to accept having a new landfill site near them because of health and environmental problems while landfill can also cause reduction in the value of their homes (Nguyen & Schnitzer, 2009). Therefore, several technological means exist to divert MSW typically destined for a landfill, such as incineration with energy production, composting of organic wastes and material recovery through recycling, all having the potential to be more sustainable methods to manage MSW (Troschinetz & Mihelcic, 2008).

2.7 Municipal Solid Waste Management

The ever-increasing amount and complex composition of MSW generated resulted in the need for updated SWM system to suit the waste quality, quantity and composition. Integrated MSW management involves the management approaches to lessen waste at its origin before it goes into the waste stream. Specifically, sustainable SWM targets to propose a way to preclude MSW through designs. This is based on the full life cycle of the item which operate without generating waste. Waste materials generated can be thought as possible inputs for starting new processes and must be recovered for reuse and recycling to reach the aim of 'using everything, nothing left' (Nguyen & Schnitzer, 2009).

The overall goal of SWM is to collect, treat, and dispose MSW generated by people in an environmentally and socially satisfactory manner using the most economical means available (The World Bank, 2011). Research reveals that for an effective SWM, the processing needs to be carried out as close to its source as possible to save transportation cost, reduce efforts of locating newer landfills and ensuring quick processing of waste (Basu, 2010). Ladhar (1996), quoted by Kuniyal *et al.* (2003), emphasized that wise and sound management of MSW involves participation of each agency or person concerned, from segregation at source to proper collection, transportation and environmentally safe disposal, and finally recycling and reuse.

These MSW and its management issues bring about the need to have a clear and efficient policy on MSW management and legislation to realize that policy is imperative (Agamuthu *et al.*, 2009). Prior to the planning of environmental policies, it is vital to fathom the correlation between people's knowledge and theirs attitudes so that the designed policies are able to persuade the public to exercise positive environmental behaviors such as reuse, reduce, and recycle the wastes. White *et al.* (1995), as quoted by Mohd and Fadil (2004), stated that public perceptions and behaviors determined very

much the quantity and types of MSW generated, as well as, the success of any SWM programs. Furthermore, if environmental and health impacts are to be reduced, development of rules and regulation, together with the assistance of community support through well-organized and developed awareness activities in addition to willingness to pay for more effective service are vital.

Chen *et al.* (2010) further interpreted general MSW management system into a model (Figure 2.2). The main flow (shown as black arrows) and the primary waste management process (shown as shaded circles) of the model include consumption, source separation, collection, transportation, storage and treatment disposal. Concerned agents (shown as boxes), placed inside the system's boundaries are interrelated to each other, as well as, related to the primary process in term of rules and financial plan for MSW management. Aspects placed inside the system's boundaries are those that can be tackled by waste managers. While those placed outside the boundaries are contingent aspects in the system's surrounding environment (shown as white circles), over which the influence of waste management tools is limited but influenced both the generation of waste and the demand for recyclables (Chen *et al.*, 2010).

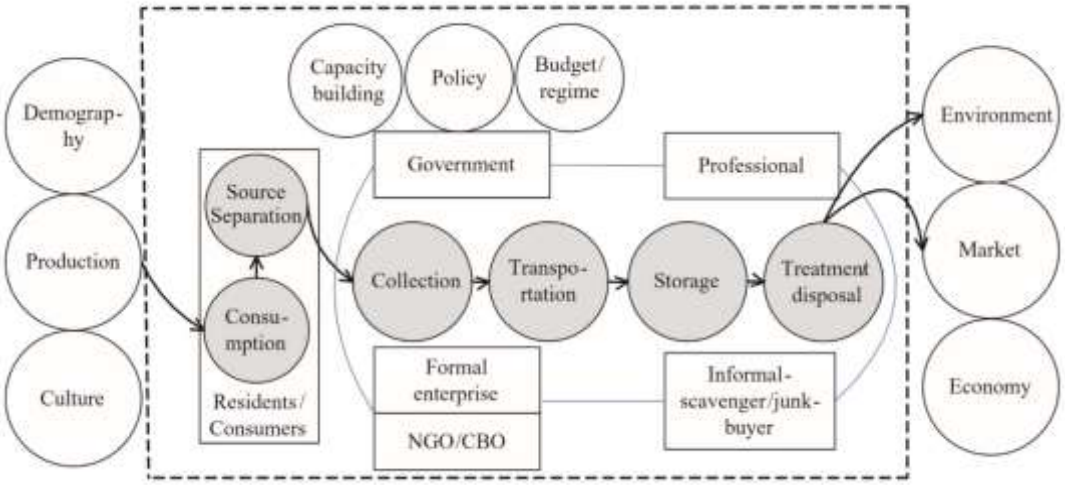

Figure 2.2: The system model of MSW management system.

Source: Chen et al., 2010.

Improper management of MSW not only will results in pollution of the natural environment but also may cause significant danger to public health and welfare (Mashhood & Arsalan, 2011). Chang and Davila (2008) pointed out that most SWM issues stem from the difficulty in selecting new landfill sites. This is due to the fact that landfill facilities are expensive to develop because population growth employs the existing landfill space available in an area. In addition, it is known that usually, local governments are responsible to provide SWM services. However, in order to expand services to a growing population, there come challenges to rationalize worker and vehicle performance.

In order to create and sustain effective MSW management practices in indigenous populations is often difficult due to several reasons. Among them are limited transportation choices, irregular MSW collection services, financial commitment to set up infrastructure is beyond the reach of many small communities, high ongoing costs to maintain the management of MSW, the location and natural features of the communities cause problems for the establishment of infrastructure and community perceptions of rubbish (Australian Indigenous HealthInfoNet, 2009). Besides, ordinary solutions to the particular problems experienced by remote communities maybe difficult to be put to practice, machinery required to manage waste and carry out maintenance may not be available, and recycling is often a costly option for many communities especially those in remote locations (Australian Indigenous HealthInfoNet, 2009).

2.7.1 Municipal Solid Waste Management in Developing Countries

As urbanization continues to take place, management of MSW has becomes a major public health, environment and management concerns in developing countries (Hisashi, 2000). This is due to the fact that many developing countries tend to put economics before the environment (United Nations Institute for Training and Research,

2011). Besides, there are several constraints classified into technical, financial, institutional, economic and social which restrain the development of effective SWM systems (Hisashi, 2000). According to Diaz (2011), the key issues of MSW in developing countries are substantial population growth in urban centers mainly due to rural-urban migration, lack of legislation and policies for realistic and long-term planning, inadequate storage and limited collection (services provided based on service fees), lack of proper disposal due to higher capital and operating costs to construct sanitary landfill therefore lead to existence of many dump sites, use of inappropriate technology and equipment, scavenging and insufficient knowledge of basic principles.

Typically, municipalities in developing countries spend 20 to 50 percent of their available recurrent budget on SWM (The World Bank, 2011). Yet, it is also common that 30 to 60 percent of all the urban MSW in developing countries is uncollected, less than 50 percent of the population is served and as much as 80 percent of the collection and transport equipment is out of service, in need of repair or maintenance (The World Bank, 2011). In contrast to developed countries like Australia, though MSW management in remote areas may be difficult and limited, more than 90 percent of indigenous communities in remote areas received organized rubbish collection service (Australian Indigenous HealthInfoNet, 2009). Among the types of rubbish disposal in indigenous communities in Australia are unfenced community tip, fenced community tip and rubbish tip outside community land (Environment Protection and Heritage Council, 2010).

Open dumping with open burning is typical in most developing countries. However, there are many MSW management options practiced by different developing countries. For example, in Egypt, the collection services of MSW in urban and rural areas only cover less than 30 percent, whereby 8 percent of the collected MSW is sent to compost plant while the rest is sent to dump sites scattered in the country open (Imad,

2011). These also happen to other developing countries such as Syria, Jordan, Palestinian Authority, Southeast Asia, Africa, and Latin America. However, in UAE, about 25 percent of the collected MSW is sent to compost plants or landfills (Imad, 2011).

In Kenya, MSW is disposed in open dumps hence makes both surface water and groundwater remain vulnerable to MSW pollution but plans are underway to shift towards sanitary landfill (Henry *et al.*, 2006). Most LA in Kenya used centralized municipal SWM systems, whereby every decision is made up after it is approved by all related departments thus causing suspensions in the liberation of services. Furthermore, participation of private sector is insignificant. So, in order to improve their SWM, several LA in Kenya has embarked on a city beautification program, and banning MSW disposal into water bodies (Henry *et al.*, 2006).

Few numbers of non-governmental (NGO) and community-based organization (CBO) are engaged in purchasing and reselling old office equipment, household wares, used industrial wares and producing inexpensive farm tools such as sprays and watering cans. They also collect recyclable materials such as paper, metal scraps and plastics, which are sold to generate some income together with composting of organic solid waste (food waste) which are sold to urban farmers or landscapers. Others are making mattresses from recycled polyethylene and making glue from bones and hooves (Henry *et al.*, 2006). These products have a huge market amid the low income people because the cost is low of which also contribute to lessening of MSW reaching drop off points.

In Amman, Jordan, the residents put their MSW into the community wheeled containers made of metal with a capacity of 1.1 m^3 placed at the curbside throughout the city (Medina, 2011). The MSW collected in the community containers will be loaded into the municipal collection vehicles at least once a day to be transported to the nearest transfer stations. Subsequently, the collected MSW will be taken to sanitary landfill.

The landfill meets international standards whereby it has a liner system, leachate collection and treatment, as well as, methane collection and utilization to generate energy, and it is 5 miles downwind from the nearest human settlements (Medina, 2011). It accepts about 2,300 tonnes MSW per day and is estimated to meet Amman's needs for at least another 17 to 18 years (Medina, 2011).

Amman municipality is also supporting private sector participation in MSW collection. For example, in Basman district, the Amman municipality provides the collection vehicles and the private company provides drivers and collection crews to collect about 40 tonnes per day of MSW (Medina, 2011). Besides, the recycling activities are mainly operated by the private entities and scavengers. At least two containers (one for wet waste and another one for dry waste) were placed at each community collection point whereby the organics would be composted, the inorganics are sorted and recycled, and residues would be sent to the landfill.

In Accra, Ghana, the SWM infrastructure is insufficient to serve large amount of generated MSW resulting in indiscriminate burning and burying of solid waste. Only 65 percent of the MSW generated daily is collected and door-to-door collection service is limited to high and medium income households (Boadi & Kuitunen, 2005). The low income households do not have home collection of MSW hence they dispose off their waste into communal containers, surface drains, open spaces, and water bodies (Boadi & Kuitunen, 2005). Although few numbers of communal containers are provided in some areas, it is still inadequate due to its small volume to serve large communities, as well as, irregular MSW collection by the municipality (Boadi & Kuitunen, 2005).

In Kurdistan province, Iran, open dumping is the only method in practice and citizens are not directly charged for the MSW management systems services provided (Mohammad & Touraj, 2007). The MSW collection methods commonly used are curbside collection and direct delivery collection (Mohammad & Touraj, 2007). The

MSW is collected by the municipalities or workers engaged on a daily-wage basis (Mohammad & Touraj, 2007). These workers collect the MSW by using old and low efficient hand trolleys, small vans, trucks, tractors, and self-compactor trucks and then transfer the MSW to temporary medium-sized metal containers in the cities of province, which mostly are improperly equipped (Mohammad & Touraj, 2007). Subsequently, the MSW is sent to the disposal sites which are more than 13 years old covering more than 13,000 hectares around the Kurdistan province (Mohammad & Touraj, 2007).

There are very few sanitary landfills, and about 100 open dumpsites in Palestin (Issam *et al.*, 2007). MSW in these open dumpsites are burnt to reduce the waste volume. Most of the dumpsites were not fenced and accessible to stray animals and scavengers which mostly are children. The recycling activities are very limited and focused only on metals, paper and glass, which are then sold to Israel for remanufacturing (Issam *et al.*, 2007). However, city like Nablu, sent off their collected MSW to landfill in Israeli-controlled areas for a fee (Issam *et al.*, 2007). The major cities are charged with higher MSW collection fees than the villages in the same area. This is due to the broader scale of services offered in the cities, including street cleaning and higher collection frequency. But, no fee is collected from the people in the refugee camps, as the costs of this service are completely covered by the United Nations Relief and Works Agency (UNRWA) (Issam *et al.*, 2007).

2.7.2 Municipal Solid Waste Management in Asian Countries

In developed countries like Japan, South Korea, Taiwan and Singapore, there are extensive literatures on SWM aspects, including established facilities for technical training, and well-established technologies. There are also dependable data collected on a regular basis which is used in SWM system planning and operations (Shekdar, 2009). Table 2.6 shows SWM programmes that have been implemented in Japan, South Korea

and Taiwan. In Japan, laws for SWM were enacted and implemented to promote a recycling-focused society and shared responsibility has been successfully used i.e. waste separation at origin. Then, the municipalities collect the separated recyclables and crush the bulky waste to be sent to recycling facilities or manufacturers. During 2005, around 1910 yen (120 yen = 1 USD) were spent to manage around 53 million tons of MSW, of which 19 percent was recycled, 68 percent was incinerated and 13 percent was landfilled (Shekdar, 2009).

In South Korea, the implementation of a volume-based waste fee system successfully reduces domestic waste generation and proportion of MSW landfilled, as well as increased the proportion of MSW recycle. In Taiwan, a similar system has also lead to the reduction of MSW generation and portion landfilled, while increase the portion of MSW incinerated (Shekdar, 2009). In Hong Kong, most of the MSW generated go to landfill and the rest is recovered, so thermal treatment has been introduced to prolong the life of existing landfills. In China, it was reported that in 2004, the country produced the highest amount MSW (Shekdar, 2009). However, the situation improved due to the enactment of a SWM regulation, increase awareness on resource recovery-based and sanitary landfilling practices, as well as, participation of private agencies in recovery and recycling industries (Shekdar, 2009).

Table 2.6: SWM programmes in developed countries in Asia.

Country	National program	Plan period	Waste generation	Recycling rate	Solid waste disposal
Japan	Establishing a sound material society	2000-2010	Reduction by 20%	Increase by 40%	Reduction by 50%
South Korea	Firm establishment of a sustainable and resource circulating socioeconomic foundation	2002-2010	Reduction by 12%	Increase by 53%	Reduction by 22%
Taiwan	Complete recycling for zero waste	Initiated in 2003	-	154 tons to be recycled in 2007, 199 tons in 2011 and 316 tons by 2020	No waste be landfilled in 2020

Source: Shekdar, 2009.

In India, the MSW is managed by the municipalities and disposed to three sanitary landfills (Ghazipur, Bhalswa, and Okhla) located in low lying areas on the outskirt of the city (Esakku *et al.*, 2007). But, there is still considerable part of the MSW generated remains uncollected causing flooding, breeding of vectors and the spread of illnesses due to outdated and inefficient practices, as well as financial constraint (Esakku *et al.*, 2007). So, municipal sanitation workers through street sweeping, waste pickers, waste dealers and recyclers complement the municipality's struggle to collect and dispose of solid waste. Generally, the MSW produced by households and commercial sectors is gathered in metal or concrete communal waste bins. Nevertheless, open sites, roadside and drains have also been identified in some areas as local garbage collection points due to lack of municipal receptacles (Firdaus & Ahmad, 2010). In Delhi, about 99 percent of the MSW collected are disposed of to the sanitary landfill and the remaining goes to semi-mechanical composting plant (low capital expenditure compared to mechanical composting plant) (Firdaus & Ahmad, 2010). Incineration is

not used because it is expensive and ineffective due to the low calorific value of the MSW since the MSW is mainly encompasses of organic waste while combustible materials like paper and plastic are already eradicated at source by the waste pickers.

2.7.3 Municipal Solid Waste Management in Southeast Asia Countries

The recycling and recovery activities are actively practiced by most of the Southeast Asia countries due to economically viable undertaking (Nguyen & Schnitzer, 2009). Nguyen and Schnitzer (2009) further reported that the high income countries, middle income countries and low income countries recycled about 44 percent, 12 percent, and 8 to 11 percent of MSW, respectively. The recycling activity is done mostly by the waste pickers before the MSW goes into the waste stream by removing materials like plastic, paper, glass and rubber, and then sell them to the recycle mills.

To further improve MSW management, countries like Singapore had formulated strategies on SWM like promoting recycling initiatives, as well as, public awareness programmes in 2000 (Shekdar, 2009). In Indonesia, MSW collection is carried out by ‘‘community neighborhood units,” a quasi-private enterprise formed by the community, and landfills are shared without any formal covenant although urban and sub-urban areas are independently managed by respective municipalities (Shekdar, 2009). However, by looking at other Southeast Asian countries, the regulations are made primarily to codify the responsibility and expectation associated with the municipality (Shekdar, 2009). In consequence, municipalities are hardly punished for non-compliance.

Thailand’s current SWM strategy emphasis on bulk collection and mass disposal with the application of transfer stations is not extensively practiced (Chiemchaisri *et al.*, 2007). Thailand spends an estimated USD 41 million a year on goods and services for MSW management (Chiemchaisri *et al.*, 2007). The local municipalities hire private

transporters to haul the collected MSW using 20 to 30 tonnes trailers for final disposal at the designated disposal sites (Chiemchaisri *et al.*, 2007). Most of the MSW collected is disposed in open dumping areas and recycling activities are widely practiced by the population either by the members of the collection vehicle or by the scavengers at the dumpsite (Chiemchaisri *et al.*, 2007).

In Vietnam, the rates and efficiency of MSW collection system vary from one area to another, depending on the proximity to the urban centers and the size of the city, due to the absence of standardized system (Nguyen & Themelis, 2006). In most of the cities, the local People's Committee contracted out Urban Environment Company (URENCO) to collects, transports and dispose of their domestic waste whereby the MSW collection fees are charged to the local residents based on the size of the family, while the hotels pay based on the total of their accommodations (Nguyen & Themelis, 2006). However, the fees are only enough to cover the bulk of operational costs and collectors' salaries. Hence, URENCO relies on fund by the central government to cover capital expenditures or investments. In recent years, much of the money for equipment and infrastructure improvement has come from Official Development Assistance (ODA) of developed nations (Nguyen & Themelis, 2006).

Citizens in the urban and suburban areas of Vietnam, put their MSW in the open gutters of the street in front of their house for the URENCO employees to pick up the MSW a few times daily and transport by handcarts that are push on foot door-to-door (Nguyen & Themelis, 2006). When the handcarts are occupied, they are pushed to the nearest designated transfer station or communal bins. Then, a waste truck will unload the MSW to the nearest landfill. A URENCO truck comes by daily to unload the communal container and transport it to the dumpsite (Nguyen & Themelis, 2006).

All types of MSW being collected are disposed in a landfill without source separation (Nguyen & Themelis, 2006). Open and controlled dumps are the main form of waste disposal facility. In Ho Chi Minh City, the existing sanitary landfill had been upgraded with the latest technology (a system for collecting and treating leachate water daily, a gas extraction system, composting plant and bio-gas recovery system), which was mostly funded by The Netherlands and the rest by the city itself (Nguyen & Themelis, 2006). The rates of recovery and recycling in Vietnam are high and can be seen through the involvement of scavengers, as well as many families gave away used items or sell them back to the used or repair shops (Nguyen & Themelis, 2006).

2.7.4 Municipal Solid Waste Management in Malaysia

The SWM in Malaysia is listed as an item under the concurrent list of Federal Constitution which means that both state and the federal governments have jurisdiction over items listed under the concurrent list (Ahmad, 2010). Principally, the Federal Government acts as an advisory and coordinating body. Among the agencies from Federal Government involved in municipal SWM are *Kementerian Perumahan dan Kerajaan Tempatan* (KPKT), *Jabatan Alam Sekitar* (JAS), *Kementerian Kewangan Malaysia*, *Kementerian Kesihatan Malaysia* (KKM), *Kementerian Sains, Teknologi dan Inovasi*, *Kementerian Pelajaran Malaysia*, and *Kementerian Kemajuan Luar Bandar dan Wilayah* (KKLBW). The State Government is mainly responsible to guide and support LA in reinforcing their institutional and financial capabilities for municipal SWM, as well, as allocation of land for landfills and other facilities (Ahmad, 2010). Next, the LA is the body which directly engages with municipal SWM and carried out the collection, transportation, treatment, and disposal of solid waste. The LA has the authorization to determine smaller SWM contractors to collect MSW, and coverage area for MSW collection.

SWM programs in Malaysia have developed in phases (Agamuthu *et al.*, 2009). Before 1980, municipal SWM was quite primitive. The streets and household wastes were cleaned and hauled away by district health officers to authorized dumping grounds (Agamuthu *et al.*, 2009). Nonetheless, the MSW collection services improved slightly with the rapid increase in MSW generation in order to prevent undesirable health impacts to the public. But, the SWM system was still insufficient. Therefore, in 1993, Malaysia government delegated SWM in Malaysia to four private consortia to increase efficiency, and technologically advanced SWM, as well as to resolve SWM problems like lack of fund and expertise faced by the LA (Agamuthu *et al.*, 2009).

Generally, the SWM by the LA has not been satisfactory and inefficient due to high cost of managing MSW, limited funding resources and shortages of expertise causing public outcry in many LA. Supposedly, having smaller SWM contractors to serve defined areas resulted in more efficient SWM. However, with the increasing costs of SWM, the situation resulted with subcontractors not being paid promptly, leading to drastically reduced efficiency (Agamuthu *et al.* 2009). Therefore, to improve and ensure high quality services in the SWM system, Malaysian Government has embarked on two approaches i.e. enactment of the SWPCM Act which provide executive power to the Federal Government to implement SWM and public cleansing, and privatize the collection and transportation of the MSW (Nadzri & Larsen, 2008). The SWPCM Act is applicable throughout the Peninsula Malaysia, and Federal Territories of Putrajaya and Labuan.

Following the enactment of the SWPCM Act and privatization on SWM, new organizations have been established i.e. *Jabatan Pengurusan Sisa Pepejal Negara* (JPSPN), and *Perbadanan Pengurusan Sisa Pepejal dan Pembersihan Awam* (PPSPPA). The former responsibilities are to recommend strategies, as well as, implement regulatory functions, grant permits and consent, and set standards,

specifications and codes of practices. The latter will recommend and implement policies, strategies and enforce the law and regulations (Abdul, 2010). Among the strategies that have and will be implemented are immediate safe closure of 16 landfills that are in critical areas, upgrading of non-sanitary landfills, building new sanitary landfills and building materials recovery facility (MRF) and incinerators (Nadzri & Larsen, 2008). Incineration is not new in Malaysia and it was mainly developed to dispose hazardous wastes. Six mini incinerators with a capacity of three to 20 tonnes per day are being used in islands like Langkawi, Pangkor, Tioman and Labuan with a total cost of nearly RM 17 million (Zamali *et al.*, 2009). However, only one unit of 3 tonnes capacity incinerator is currently being utilized in Tioman Island, and one unit of 10 tonnes capacity is used occasionally to burn some government classified documents in Langkawi (Agamuthu & Nagendran, 2010). The remaining incinerators are no longer used due to their design which is not suitable for high moisture content of Malaysian MSW. Even the incinerator used in Tioman Island consumes more diesel to sustain combustion, therefore is not economically viable.

The main objectives of the privatization of the collection of MSW are to reduce the high financial cost as well as to improve the quality of the management of solid waste via the key performance indicator (KPI) set into the concession agreement (Ahmad, 2010). So, the concessionaires are able to perform their duties in an efficient way. Moreover, forfeits levied based on the non-compliance of the KPIs are seen to be more reasonable and satisfactory, as well as the contractors will be eligible to more competitive payment rates. With the enactment of the SWPCM Act, the Federal Government involved in providing a mechanism for integrated planning and policy, centralized infrastructure and cross border activity will be made possible with financial support and decision making on matters pertaining to SWM (Ahmad, 2010).

The main strategies are to encourage waste separation at source to promote reduce, reuse and recycle, and to develop the public's sense of togetherness to manage MSW by charging punitive measures to the consumers who failed to pay waste disposal fees. Furthermore, the construction of new facilities, alteration, operation and closure require license so that only parties considered suitable may venture into the MSW business. This is to guarantee the quality of the services and compliance with enacted regulations of MSW management. Besides, in order to encourage the development of environmentally sound and cost-effective technologies, the National Solid Waste Technology Assessment Committee has been established to evaluate and recommend proposed SWM technologies based on the financial model and cost benefit analysis (Ahmad, 2010).

2.8 Municipal Solid Waste Management Challenge

Numerous countries in the world are facing SWM challenge due to rapid population and economic growth, scarcity of landfill space, urbanization, as well as, the imaginary aim of environmental sustainability (Sanaz *et al.*, 2009). Present days, many nations are having serious development challenges that will heightened if same conventional development strategies still prevail. Meanwhile, The World Bank (2011) reported that increase traffic congestion in urban regions adversely affects the productivity of the solid waste fleet. Since landfills and dumpsites are normally distant away from urban centers, productivity loss is worsened by extensive hauls needed of the fleet. Therefore, there are challenges to justify worker and vehicle performance, at the same time expanding services to the growing urban people.

2.8.1 Municipal Solid Waste Management Challenge in Developing Countries

Problems and issues of MSW management in rapid urbanizing cities of the developing countries are of immediate importance due to rapid population growth and the increasing generation of MSW. This overcomes the capability of most urban authorities to offer even the most elementary services, lack of understanding over a diverse factors that affect the different stages of MSW management and linkages necessary to enable the entire handling system functioning (Guerrero *et al.*, 2013). In developing countries, it is common for municipalities to spend 20 to 50 percent of their available recurrent budget on SWM (The World Bank, 2011). Nonetheless, it is also typical that one to two third of urban MSW in developing countries is not collected and less than half of the population is served (The World Bank, 2011). As a result, the uncollected MSW is often dumped indiscriminately onto the streets and into drains, so contributing to flooding, breeding of insect and rodent vectors and the spread of diseases (Zurbrugg, 2003). In other occasions, approximately 80 percent of the collection and transport equipment is out of service or in need of repair maintenance (The World Bank, 2011). In most developing countries, it is a norm that collected MSW is often disposed of in uncontrolled dumpsites and burnt, polluting water resources and air (Zurbrugg, 2003).

According to Hisashi (2000), technical constraint that restrain the development of effective SWM systems in developing countries include lack of technical expertise necessary for SWM planning and operation, as well as, overall plans for SWM at both the national and local levels. For example, an area with low MSW collection service coverage will caused MSW produced to be dumped at undesignated areas (Hisashi, 2000). Rather than improving the disposal site which would have little impact on the overall SWM effectiveness, it would be most cost-effective to offer resources to upgrade the collection service (Hisashi, 2000). Besides, the lack of study in terms of

geography, economy and demography acceptability, and development activities in SWM in developing countries lead to the selection of unsuitable technology, hence caused the technology selected to be wasted.

Hisashi (2000) also described that very limited funds are provided to the SWM sector by the local governments in developing countries. This causes the levels of services required for protection of public health and the environment are not attained due to the very low priority given to SWM. The weak financial basis for SWM of local governments occurs because of inefficient local taxation system, as well as, limited users' ability and willingness to pay for the services (Hisashi, 2000). Furthermore, there is also the absence of good planning and financial management that may cause resources unsustainability, and inefficient SWM services (Hisashi, 2000).

Other than technical and financial constraints, there is also institutional constraint. Agencies involved in SWM often have no clear roles and insufficient resources. Also lack of coordination among the relevant agencies due to lack of effective legislation and enforcement for SWM regularly caused duplication of efforts, wasting of resources and unsustainability of overall SWM programmes (Hisashi, 2000). In big urban regions where there is more than one LA, synchronization between the LAs is vital to reach the most economical approaches for SWM in that area. For instance, the siting of a MSW transfer station or disposal facility for more than one LAs is cost-effective due to its economy of scale. But, these facilities are usually considered unwanted installations and create not-in-my-backyard (NIMBY) syndromes among the residents that no LA is willing to locate them within its boundary (Hisashi, 2000).

2.8.2 Municipal Solid Waste Management Challenge in Asian Countries

The massive urbanization is forming an increasing pressure on overstrained infrastructure and greater demand on limited municipal services. As for example, China

is dominating with rapid financial growth and its massive population. Hence, this led to a demand for better municipal services. Nevertheless, urbanization still presents enormous challenges for a region in which extreme poverty and deprivation are all too common where current levels of basic physical infrastructure and urban services are extremely inadequate (Shekdar, 2009). For example, although India is aggressively developing with sustained technological and economic growth, it agonizes from having derisory capitals to attend its ever-increasing population.

The huge economic and industrial developments, as well as rapid increase in urban populations over the last decade in many Asian countries have put extreme pressure on their SWM systems (ISSOWAMA, 2011). Among the challenges related to SWM faced by the Asian countries are the municipalities unable to provide regular services to defined areas due to population expansion, scarcity of land for waste disposal, expensive SWM operations, excessive use of packaging materials, inadequate resources, inappropriate technology, societal and management apathy and inadequate strategic town planning (Shekdar, 2009). In developing countries, MSW produced in urban areas is collected by house-to-house collection system by garbage compactors. On the other hand, areas without house-to-house collection will see the MSW being deposited into the communal bins. Yet, it is common to see waste littered around the community bins because public participation, awareness and cooperation are very limited (Shekdar, 2009).

2.8.3 Municipal Solid Waste Management Challenge in Southeast Asia Countries

In some Southeast Asian countries like Singapore and Malaysia, incineration is practically used to treat MSW. The operating efficacy depends on the MSW features and composition. This treatment method requires high capital and operation expenditure hence it is inapt method for most low-income nations. Although this type of waste

treatment is effective, it contributes to the emission of persistent organic pollutants. Due to this, Philippines completely banned waste incineration treatment (UNEP, n.d.). As for composting, it is not well practiced in Southeast Asian countries because of the high operational and maintenance cost, and unavailable market for compost as compared to chemical fertilizers. But this method gained support by the governments (UNEP, n.d.).

2.8.4 Municipal Solid Waste Management Challenge in Malaysia

In Malaysia, 80 to 90 percent of the generated MSW is collected but about 66 percent of the rural population does not have any MSW collection service (Hamatschek *et al.*, 2010). This caused the existence of many illegal dumping sites. The common MSW collection system is door-to-door collection method. Waste stored in trash bins is collected from every home or in communal bins for high-rise buildings or informal settlements area. Because waste separation at source is not practiced in Malaysia, all kinds of MSW are collected in a bin (Hamatschek *et al.*, 2010). Nguyen and Schnitzer (2009) reported that 50 percent of the overall Malaysian MSW amount is open dumping, 30 percent is landfill, 10 percent is composted, 5 percent is incinerated, and another 5 percent is recycled.

Currently, there is no intermediate treatment for collected MSW before being disposed into the landfill. Disposal of MSW in Malaysia is totally into landfill (Zaini, 2011). Therefore, most LA are starting to have problem finding suitable land as the land is getting scarce and at very high cost of land acquisition. Composting method is another option for MSW disposal, however, the government presently has not given it a priority and it is still under thorough study for possible implementation in the future (Zamali *et al.*, 2009)

2.9 Recycling As a Sustainable Solid Waste Management Approach

Recycling is a series of activities involving collection, sorting and processing or converting used or discarded materials into useful products (Singh *et al.*, 2011). People tend to recycle waste when they really know the right way and the motives to do it. In developing countries, recycling activities are influenced by the availability of recycling industry (Hisashi, 2000). For instance, the recycling of waste paper is possible only when there is a paper mill within a distance for which the transportation of waste paper is economical (Hisashi, 2000). In developing countries, MSW collection and sorting for recycling activities are mostly handled by the scavengers, putting their health and safety at risk due to poor working conditions (WIEGO, 2012). In contrast to developed countries whereby such activities are made possible by curbside recycling programmes because the developed countries are able to deliver ample monetary and regulatory resources for recycling. But, in developing countries, recyclables are often sold for income, and recycling becomes a profitable activity for certain people. Shekdar (2009) further explained that it may not possible to spend money on expensive recycling systems in developing countries even there is growing awareness of the need for sustainable development. A study by Troschinetz and Mihelcic (2009) found that less than 70 percent of waste stream in developing countries consisted recyclable materials, and the recovery rates varying from five percent to 40 percent.

Since 2000, Japan had enacted laws for MSW management to promote a recycling-focused society in the context of a national drive for sustainable development (Shekdar, 2009). Ever since then, the citizens separate the waste and deposit them at the collection centers. Then, the municipalities will collect the recyclables from the collection centers to transfer them to applicable recycling facilities, while the bulky waste will be crushed before recycling. It has been reported that since the implementation of the law, the MSW generated had reduced by 20 percent and MSW

disposal by 50 percent, as well as, increase the recycling rate by 40 percent (Shekdar, 2009). In Singapore, variety of strategies and programs had been implemented since 2000 to promote recycling as well as to increase public awareness. As for the results, the recycling rate was increased to 49 percent and MSW generation was reduced by 8 percent in 2005 (Shekdar, 2009). In China, MSW recycling activity has been recognized since 1950s. Waste materials like iron and steel, non-ferrous metals, plastics, rubber, paper and glass are imported from many countries on a huge scale for reuse, recovery and recycling (Shekdar, 2009).

Troschinetz and Mihelcic (2009), discovered 14 developing countries (Table 2.7) that are actively practicing recycling. Troschinetz and Mihelcic (2009) further described factors that influence sustainable recycling of MSW in developing countries, and the degree to which those factors acts as barrier against recycling activities in developing countries (Table 2.8).

Table 2.7: Percentage of MSW recovery in selected developing countries

Country	MSW recovery (%)				
	Overall	Paper	Plastic	Glass	Metal
Botswana	♦		90		65
Brazil	41	30	20 [a]	20 [b]	49 [c]
China	7 – 10	♦			♦
Guyana	♦			♦ [b]	♦
India	♦		♦		
Indonesia	♦	♦	♦	♦	♦
Iran	♦	♦	♦		
Mongolia	♦				
Nepal	5				
Philippines	13	♦	♦	♦	♦
Sri Lanka	♦	♦	♦	♦	♦
Thailand	15	28	14	18	39
Turkey	♦	36	30	25	30
Vietnam	13 - 20	♦	♦	♦	♦

Source: Troschinetz & Mihelcic, 2009.

Percentage numeric values provide quantitative recovery rates. Diamond symbol (♦) qualitatively signifies recycling activity occurs either overall or for a particular material.

[a] Recovery of plastic beverage bottles only

[b] Recovery of containers only

[c] Recovery of aluminum cans only

Table 2.8: Factors influencing sustainable MSW recycling in developing countries

Title	Description	Percent of case studies as a barrier
Government policy	Presence of regulations, enforcement of laws, and use of incentive schemes	63
Government finances	Cost of operations, budget allocation to MSWM, stability / reliability of funds	77
Waste characterization	Assessment of generation and recovery rates, and composition of waste stream	67
Waste collection and segregation	Presence and efficiency of formal or informal collection and separation by scavengers, the municipality, or private contractors	79
Household education	Extent of knowledge of waste management methods and understanding linkages between human behavior, waste handling, and health / sanitation / environment within households	69
Household economics	Individuals' income influencing waste handling behavior (reuse, recycling illegal dumping), presence of waste collection / disposal fees, and willingness to pay by residents	22
MSWM administration	Presence and effectiveness of private and / or public management of waste (collection, recovery, disposal)	44
MSWM personnel education	Extent of trained laborers and skilled professionals in MSWM positions	83
MSWM plan	Presence and effectiveness of an integrative, comprehensive, long-term MSWM strategy	50
Local recycled-material market	Existence and profitability of market systems relying on recycled-material throughput, involvement of small businesses, middlemen, and large industries / exporters	36
Technological and human resources	Availability and effective use of technology and / or human workforce and the safety considerations of each	58
Land availability	Land attributes such as terrain, ownership, and development dictating MSWM	0

Source: Troschinetz & Mihelcic, 2009.

CHAPTER 3: METHODOLOGY

3.1 Study Area

According to JAKOA, until 2011, there are about 200,000 of Orang Asli residing in Peninsular Malaysia. Nonetheless, Pahang has the most number of Orang Asli. In Selangor alone, there are about 18,000 people of Orang Asli which are mostly Temuan ethnic from the Proto-Malay subgroup. They are mainly residing in the district of Hulu Langat, Hulu Selangor, Sepang, Klang and Gombak.

Kampung Kuala Pangsun is selected because it is situated in the rural area and holds the highest numbers of Orang Asli in Hulu Langat. The Kampung Kuala Pangsun is situated in the district of Hulu Langat, Selangor and is under the jurisdiction of *Majlis Perbandaran Kajang* (MPKj). It is about 45 km away from Kuala Lumpur and it is adjacent to the Hulu Langat Dam and famous recreational park in Hulu Langat, named Sungai Congkak. The Kampung Kuala Pangsun is inhabited by the Orang Asli people from Temuan ethnic of Proto-Malay subgroup. The village is led by a village head called Batin.

According to JAKOA, the area covered by Kampung Kuala Pangsun is approximately 167.593 acres. Furthermore, there are 86 houses and about 400 people of Orang Asli reside in Kampung Kuala Pangsun. However, only 81 houses are occupied. For subsistence, most of the Orang Asli are involved in farming, riverine fishing, and wild honey harvesting. Any extra goods obtained from these may be sold to middlemen as a source of income. Very few of them are employed in semi-skilled jobs or involved in retail business. Besides, most of them practice animism and it is very uncommon to see any of them practice other religions. The village has no sewerage system and the villagers receive water supply from the adjacent hill. Moreover, only several houses are equipped with electricity, telephone and internet utilities. Some are not equip because

they cannot afford them. Some part of the village road is paved while others are just unpaved dusty road. Also, most of the houses are guarded by dogs.

3.2 Sample Collection and Segregation

A total of 448 samples were collected from 75 houses in seven consecutive days since several houses did not produce any waste on some days. Sample from each household were segregated and classified (Figure 3.1) every day for seven continuous days (Monday to Sunday). The segregating and weighing process took place at the front yard or backyard of each house. The samples were sorted into 25 categories including:

a) kitchen waste;
b) unconsumed food;
c) mixed paper;
d) newspaper;
e) books;
f) magazine;
g) box paper;
h) plastic or high-density polyethylene (HDPE);
i) plastic bags;
j) polystyrene;
k) disposable diapers;
l) textile;
m) rubber;
n) wood;
o) garden waste;
p) glass;
q) metal;

r) tin;

s) hazardous waste;

t) sand;

u) bulky waste;

v) e-waste;

w) bricks;

x) tissue paper; and

y) ceramic.

Segregated samples were then weighed and the volume were determined (Figure 3.2). Random sample of waste from each house was collected during the seventh day to determine the moisture content. The data obtained on the types and quantities of wastes generated were recorded in the survey form. Finally, all the recorded data were organized and analyzed using SPSS 20 software.

Figure 3.1: Wastes collected are segregated and classified

Figure 3.2: Weight and volume of the waste is determined

3.3 Waste Generation Estimation

The quantities of MSW generated by each household in Kampung Kuala Pangsun were determined using the manual weighing, as well as, information provided by local authority. Besides weight, the volume of each type of MSW was also determined. The residents of each house were informed about the study and their assistance was requested. Although there are 81 occupied houses in the village, only 75 houses cooperate in this study. The remaining 6 houses refused to cooperate due to personal reasons.

All householders were told that during seven consecutive days, their waste will be collected for this study. They were given two 18 litres plastic bags each in which they were requested to deposit their daily waste; one plastic bag is for food waste (kitchen waste and unconsumed food) and another one is for other than food waste. When the given plastic bags containing their garbage were collected, the empty ones were given to them to deposit their trash on the following day (Figure 3.3). To ensure accurate data collection, all houses were numbered at the front door (Figure 3.4) and all samples collected were segregated and weighed.

Figure 3.3: Wastes are collected from the household

Figure 3.4: Houses are numbered accordingly

3.4 Interviews, Questionnaires, and On-Site Observation

Preliminary information on the village such as the population and location were obtained from the reports by JAKOA. Other relevant data was collected from official websites and published research journal articles. Government authorities and recycler middleman were interviewed on one-to-one basis. Interviews were held with pertinent authorities who involved directly or indirectly with the management of MSW in the Orang Asli village. The authorities involved are JAKOA, JPSPN from the KPKT,

KKLBW and MPKj. Information such as their involvement towards educating and improving the current solid waste management practices, as well as, the future plans were gathered.

Survey was conducted to develop a general idea on how MSW is managed in the Orang Asli village. A questionnaires form was designed to list significant information essential for assessing the existing MSW management practices. The questionnaires were completed during the face-to-face questionnaires with every representative of the household (Figure 3.5). The information requested in the questionnaires are personal information (occupation, monthly income, level of education), numbers and age of family members, MSW storage, collection, transportation, and disposal method, recycling activities, and opinions and suggestions. The personal information is referred to the head of the household who acts as the breadwinner of the family (respondent). Potential environmental impacts were identified and observed. A total of 75 questionnaires were distributed. The designed questionnaires were customized interactively over time. The questionnaires were prepared based on open-ended answers so that more and accurate information can be obtained.

Figure 3.5: Face-to-face questionnaires

The middleman who buys the recyclable items from the Orang Asli was also interviewed to obtain information on types and price of each recyclable item he bought, and his transaction activities of the recyclables. The result from the pilot field survey was anticipated to provide current practices of household waste management in the Orang Asli village from waste generation to disposal, and the practiced disposal methods. Furthermore, potential challenges to be taken into consideration for solid waste management in area outside LA service boundaries for improvement in the future under the new SWPCM Act were also recommended.

3.5 Moisture Content Estimation

To determine the moisture content of the waste collected, guidelines from United Nations Environment Programme (UNEP) (Mushtaq, 2009) was used. First, samples of food waste (kitchen waste and unconsumed food waste) were extracted from each collected household waste. Then, they were tagged and its weight was recorded. Next, the samples were placed in trays of ovens. The temperature of the oven was set to 85℃ and the samples were left heated in the oven for 48 hours. After 48 hours of heating process, the samples were left for cooling in 48 hours too. Next, the dried samples were taken out from the oven and weighed. The moisture content is calculated using the below formula:

$$\frac{[\text{Weight of raw waste (A), g} - \text{Weight of dried waste (B), g}] \times 100\%}{\text{Weight of raw waste (A), g}}$$

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Municipal Solid Waste Generation and Composition

With 75 houses involved in this study involving 374 people, the total weight of MSW generated by the houses in seven days was 300 kg. This information suggests that MSW generated by each household per day is 0.57 kg and the per capita waste generation rate is 0.12 kg. The total density of the collected MSW was 808.12 kg/L where each house produces 1.54 kg/L of waste per day or a person generates 0.31 kg/L per day. Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor, produces low density of waste daily because they generated quite a high proportion of paper and plastics, approximately 36 percent (Figure 4.4). These density information is crucial for the selection of MSW collection equipment. For instance, if the MSW has low density, compactor trucks will be the most effective waste collector.

According to MPKj, the average daily fresh weight of MSW produces by each household in the rural communities in 2010 is 3 kg. Besides, a study by Mohd and Fadil. (2004) reported that average MSW figure per household in rural area of Johor Bahru is 2.12 kg with per capita weights of 0.48 kg. From these data, it shows that the Orang Asli generated less MSW as compared to the average waste generation of the rural communities. This situation is due to most of them have low income which limits the ability to consume more goods. Also, the average moisture content of the Orang Asli's MSW is 61.26 percent, a value that is not far from the data provided by MPKj in which the average moisture content of MSW in Hulu Langat is 60 percent. Since the average moisture content is quite high (which is typical in Malaysia), this shows that the MSW produced by the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor, has low heating value. The waste can be burned but it will need additional auxiliary fuel to maintain adequate temperature as compared to the MSW with low moisture content.

Figure 4.1 shows the composition and percentage of MSW generated by the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor. The main MSW component is kitchen waste, represented by 38.0 percent, followed by 15.0 percent of plastic or HDPE, 7.9 percent box paper, 6.4 percent unconsumed food, and 6.1 percent plastic bags. Besides, tin made up of 5.6 percent, newspaper is 5.3 percent, garden waste is 4.0 percent, glass is 2.7 percent, diapers are 2.1 percent, mixed paper is 1.3 percent, e-waste is 0.6 percent, polystyrene is 0.5 percent, and hazardous waste is 0.3 percent. Others 4.0 percent encompasses of books, magazines, textile, rubber, wood, metal, sand, bricks, and ceramic. Generally, the findings agreed with Mohd and Fadil. (2004), Agamuthu and Nagendran (2010), and Elmira *et al.* (2011), who found that organic, plastic, and paper wastes were the most abundant.

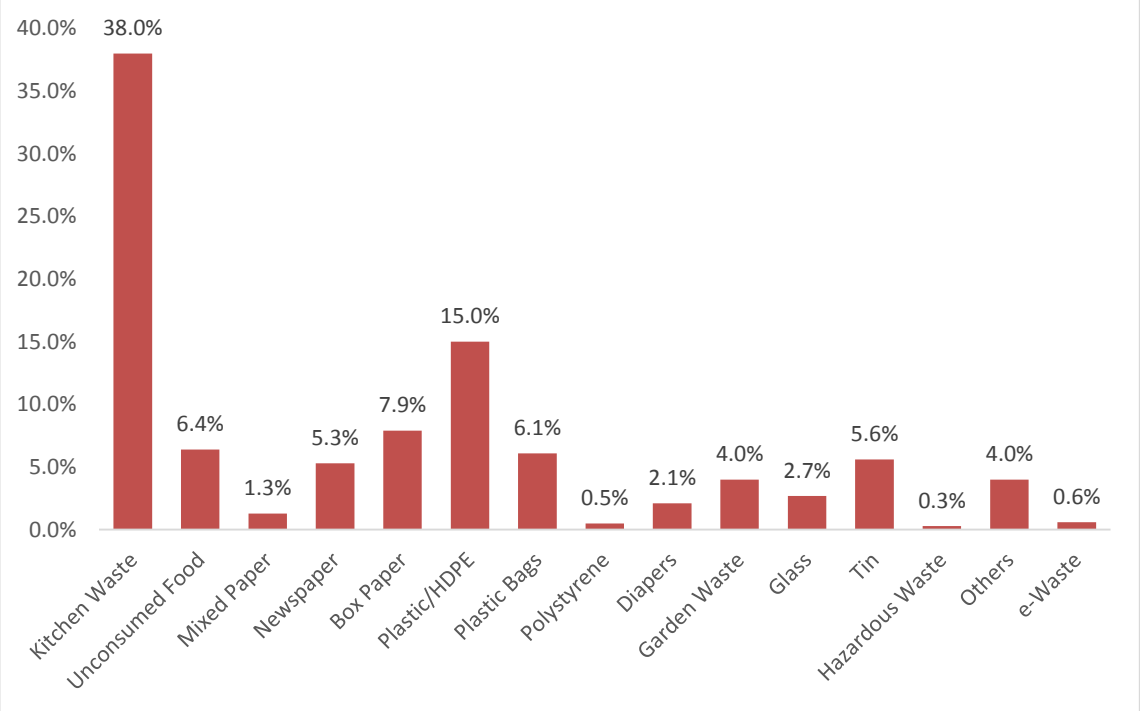

Figure 4.1: Municipal solid waste composition in Kampung Kuala Pangsun

The results support the previous study by Troschinetz and Mihelcic (2009) in explaining low income households generated higher organic waste and lower inorganic waste from packaging materials as compared to the high income households. From the

high percentage of kitchen waste, this suggests that most of the Orang Asli home-cooked their meal. Other than that, the average percentage of plastic or HDPE composition specifies that many of the Orang Asli is likely to use plastic / HDPE made items such as bottles. Next, the low percentage of newspaper, books, and magazines composition tells that the Orang Asli do not read much. This is further supported by the fact that less than 22 percent of the Orang Asli practice recycling and the items recycled excluded papers or newspapers (see page 61). Low percentage of e-waste and hazardous waste composition also shows that the usage of these components is low among the Orang Asli. Finally, the composition of diapers only constituted very small values due to the number of kids below 3 years old is only 4 percent of the total population.

4.2 Current MSW Management Practices and The Impact Towards Environment

Currently, the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor, has three different ways to store their MSW. From the study (Figure 4.2), majority of them i.e. 57.3 percent store their MSW in bin mainly reused plastic bin. However, 34.7 percent open dumped their household waste either at their backyard, front yard or empty space next to their house. Next, 8 percent store their household waste in plastic bags. The findings are contrary with Mohammad and Touraj (2007), whereby their study revealed that 66 percent of the containers are plastic bags, 13 percent are plastic bins, and the rest are used oil drums made of low-grade tin plates in Kurdistan Province in Iran.

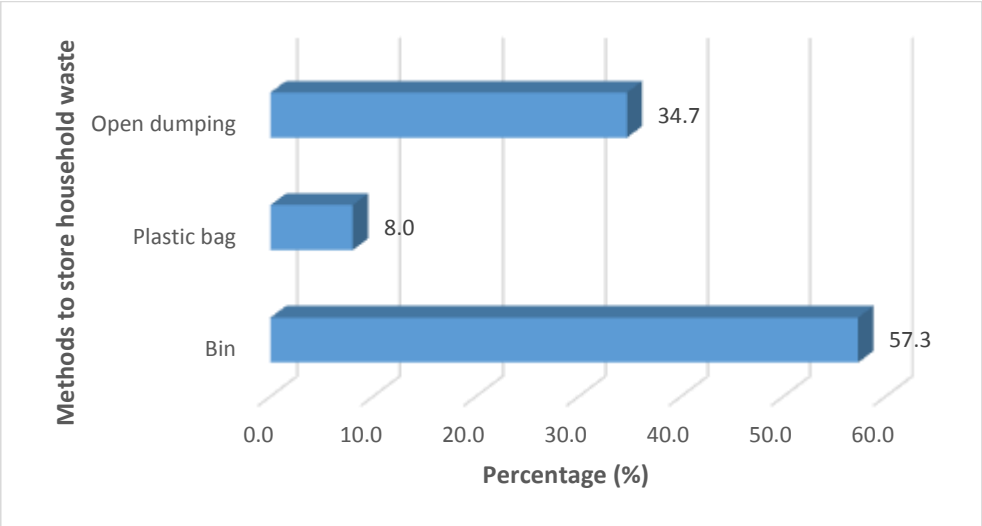

Figure 4.2: Methods to store household waste

Previously, the JAKOA provided nearby disposal pits for the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor. After some times the pits are fully utilized and there is no more new disposal pits to be used. Therefore, the Orang Asli looked for other ways to dispose their MSW. The study reveals that 93.3 percent of the respondents disposed their MSW by burning it in an open area (Figure 4.3). Open burning is strictly prohibited under Section 29A of the Environmental Quality Act 1974 except for certain activities. In addition, under Section 29B of EQA 1974 provided that open burning of land owned by the owner or occupier of premise is forbidden (Environmental Quality Act 1974). For an offence under these sections, a maximum compound of RM 2,000 can be imposed to the offender and if convicted in court, fine of maximum RM 500,000 or five years in jail, or both will be imposed (Environmental Quality Act 1974).

Eventually, 4 percent of the respondents chose to bury the MSW and 2.7 percent send their MSW to communal bin which is located about 20 km away from the village (Figure 4.4). Sending the MSW to the communal bin is the better way to dispose the MSW since the MSW is collected and disposed in environmentally manner by the appointed contractor. However, the activity becomes a threat to the environment and

human health when the communal bin is occupied with MSW and MSW are littered around the bins as a result of less frequent waste collection. Currently, the communal bin is shared by several nearby villages (Figure 4.5).

Figure 4.3: Among the open burning sites in Kampung Kuala Pangsun

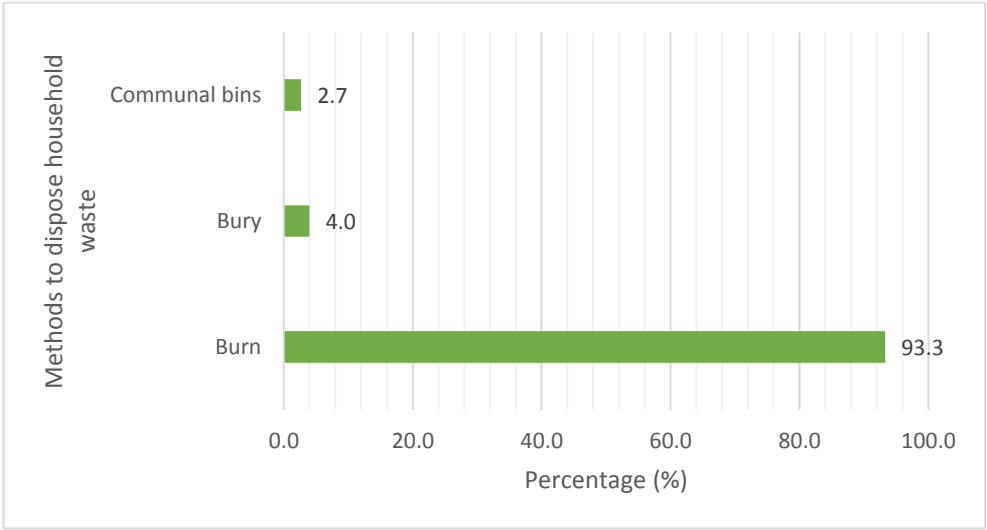

Figure 4.4: Methods to dispose MSW

Figure 4.5: Shared communal bins

In term of recycling activities, only 21.3 percent practice recycling while 78.7 percent do not practice recycling. Those recyclers normally sell their recycling items which are mostly glasses and tin to the middlemen (Figure 4.6). Then, these recyclable items will be sent to the recycling center in Sungai Lui, Hulu Langat, Selangor. The prices per kg recyclable items sold to the middleman are shown as per Table 4.1.

Table 4.1: Price per kg of each recyclable item

Items	Price per kg (RM)
Tin	3.50
Metal	0.80
Plastic	0.40
Glass	0.20

Figure 4.6: Middleman collecting the recyclable items from house-to-house

The study conducted also found out that 100 percent of the respondents thought that the present weather is warmer compare to 10 years ago. This situation may be the effect of global warming caused by human activities such as open burning, industrialization, and deforestation. Other than that, 38.7 percent of the respondents reported that at least one of their family members once experienced skin irritation after making direct contact with the water in the nearby river (Figure 4.7) which may be due to pollution from waste disposal practices. Besides, 93.3 percent claimed that at least one of their family members once suffered from respiratory-related illness such as short of breath, asthma and cough (Figure 4.7). While 38.7 percent reported that the number of vectors such as houseflies and rats has increases and their presence in their area is frequent nowadays (Figure 4.8), in which agrees with Boadi and Kuitunen (2005). Finally, 81.3 percent of the respondents complained that they or their friends encounter reduction in crops production (Figure 4.8). This may be due to global warming, as well as polluted soil and groundwater that affect the growth of the crops.

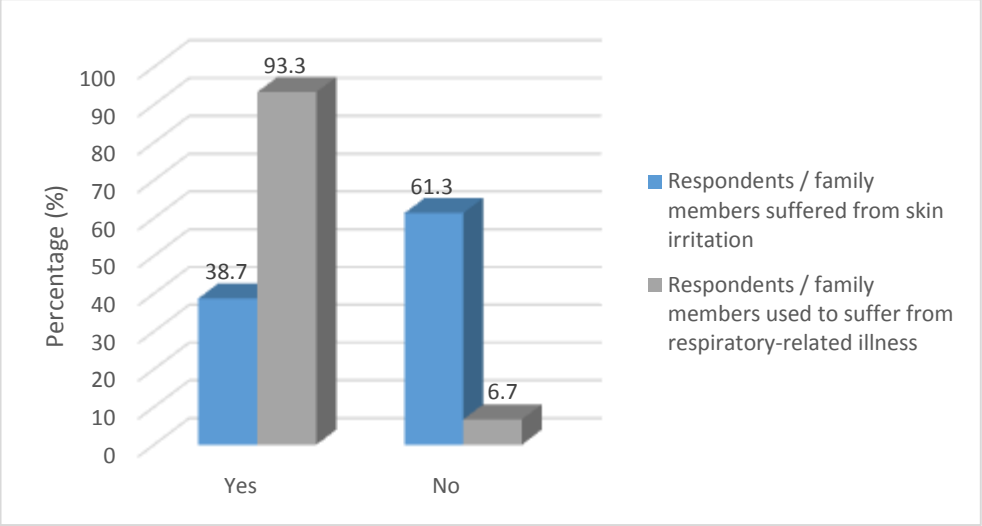

Figure 4.7: Skin irritation and respiratory-related illness experiences

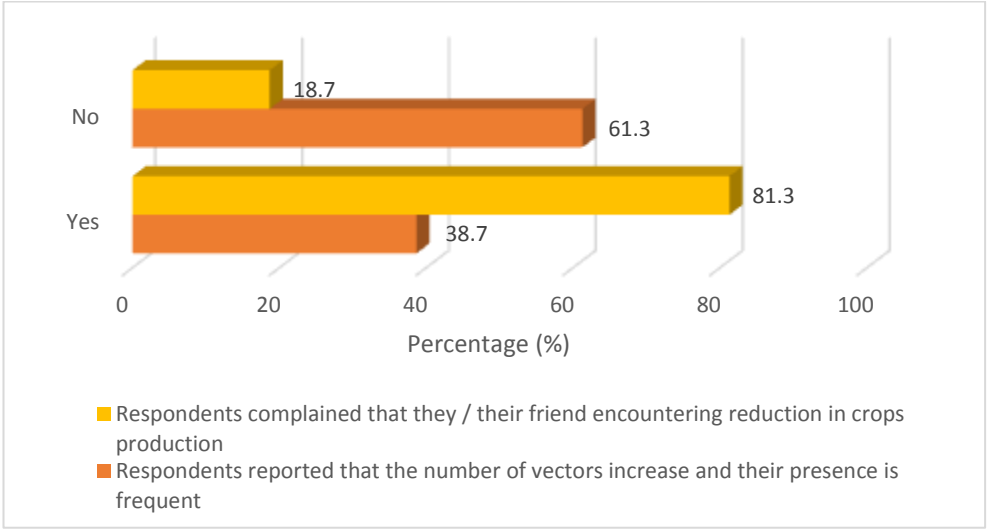

Figure 4.8: Reduction in crops production and increasing number of vectors with frequent presence

4.3 Involvement of MPKj and JAKOA

LAs are responsible to administer within their respective area. However, in term of MSW management, the defined area is restricted to those who pay assessment fee. This area usually included urban and sub-urban areas. However, with the enactment of the SWPCM Act, all household and business solid waste is subjected to the act. Although the SWPCM Act has been enacted in 2007, it is yet fully implemented.

MPKj is the LA responsibles to administer Hulu Langat area. From the interviews conducted with MPKj, it has been found out that, 47 private contractors are appointed to provide MSW management services like house-to-house and fixed station collection to 47 zones in Kajang and Hulu Langat areas. However, it excluded Kampung Kuala Pangsun and its vicinity, as well as, some other rural areas. The frequency of MSW collection varies from three to six times a week depending on the type of houses. The situation causes the MPKj to receive massive complaints and requests from the rural communities for better MSW management services in their vicinity. This issue becomes further highlighted when media is involved. Due to these facts, as well as, social responsibility, MPKj provided few communal bins facilities to some rural areas. Typically, the communal bins are placed in a location which enables neighboring vicinities to share the facility. The MSW in communal bins is collected three times a week.

According to interviews conducted with JAKOA, a department under the KKLBW, JAKOA provides numerous assistances to the Orang Asli including education, houses, businesses, and health assistances. Firstly, the educational assistance included scholarships, transportation and meal allowances, free books and school uniforms, as well as, an incentive for those that performed well in academic. Secondly, JAKOA offers free houses for those without one and identified as eligible recipient and free services for house repair. Thirdly, JAKOA provide free seeds or fertilizers, also capital to start up retail or workshop to any of Orang Asli that seeks to do businesses. Finally, free scheduled checkup and treatment for pregnant women and newborn babies, infant milk, cloth diapers, exemption from medical fee to those warded and free wheelchairs to those needed. In term of MSW management, JAKOA did not provide MSW management services to Orang Asli communities, but will only provide MSW management services to them if there is insistence or serious health issue arise such as

severe outbreak like diarrhea and skin irritation. Due to these reasons, there are three villages in Selangor that receive MSW management services from JAKOA. The MSW collection service provided is thrice a week from the communal bin located in the villages and the MSW are transferred to the respective landfills. However, JAKOA always encourages the Orang Asli to practice recycle or bury their MSW. For future plan, JAKOA thought to offer MSW management services to the Orang Asli communities if the houses are well arranged.

4.4 Suggestions for Better Municipal Solid Waste Management Practices

According to the study, some of the Orang Asli dump their MSW in open area. Hence, they need to be taught to store their MSW in a proper manner like using the bin or plastic bags (supposedly biodegradable plastic bags are encouraged. But due to the cost and most of them is under poverty level, it is advisable to at least use or reuse plastic bags to store the waste). While using plastic bags can be quite costly (either purchasing the garbage bags itself or reuse plastic bags obtained from purchasing other items), using bin is better because it can be acquired with one time purchasing only or without a cost (get it from others who had extra). Nonetheless, the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor, should also be encouraged to practice recycling at source which will not only aid in their income but also preserve the environment. Therefore, they should be taught on easy, low cost and environmental friendly ways to dispose their household waste such as reuse and recycling.

The survey found that 85.3 percent of respondents are not satisfied with their current practice of disposing the household waste. Then, 84.0 percent of the respondents request for environmental friendly ways to dispose their MSW. These indicate that their awareness towards environmental friendly MSW management practices is high. Yet, 14.7 percent was unsure of their satisfaction, and do not know if any improvement is

needed for their current MSW disposal. Other than that, 1.3 percent thought there might be some improvement needed for their current practices (Figure 4.9). Consequently, respondents were asked about their recommendations to improve the current practices of managing MSW. About 70.7 percent of the respondents opted for communal bins to be placed near the village, while 6.7 percent requested for door-to-door waste collection service as well as more disposal pits (Figure 4.10).

Though, some of the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor prefer door-to-door MSW collection service, it is not viable to be implemented due to the unsuitable arrangement of the houses within the area. The houses are scattered without proper paved pathways. Nevertheless, providing communal bins is the best solution considering the arrangement of the houses in the area as well as availability and condition of the pathways. Therefore, more communal bins should be placed in other locations to accommodate the need of rural communities. This will encourage the villagers to dispose their waste in the bin rather than burning, burying or open dumping the MSW.

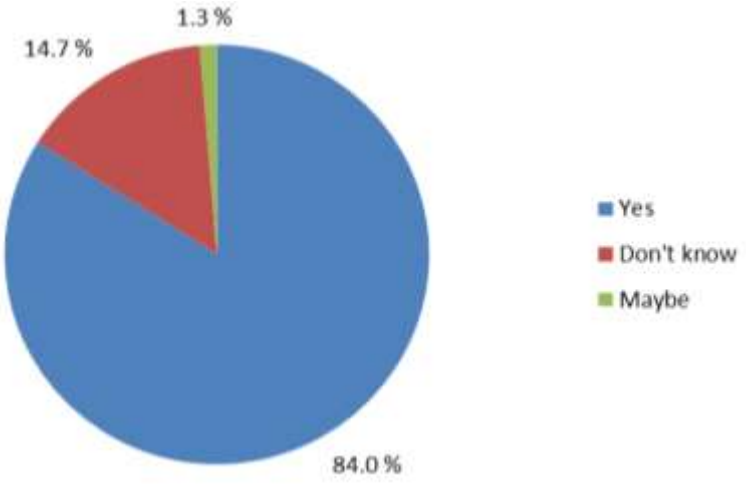

Figure 4.9: Necessity to improve current practices of managing MSW

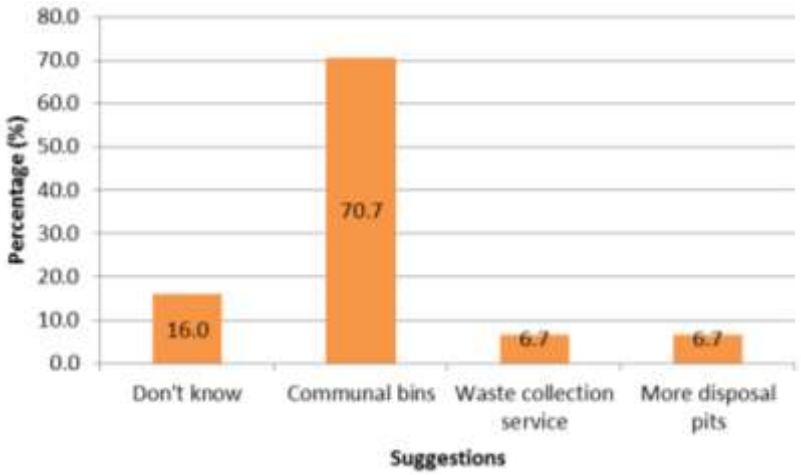

Figure 4.10: Suggestions to improve current practices of disposing MSW

For better and comprehensive waste management plan in the future, study on solid waste management must not concentrate on the urban areas, but must also cover sub-urban and rural areas as the amount, composition, and characteristics of the waste generated might be slightly different, in which will affect the requirements for an effective solid waste management system in certain area. Therefore, more study on solid waste in sub-urban and rural areas need to be conducted in the future.

Also, the SWPCM Act is a good and comprehensive act whereby it grants the Federal Government with executive authority on solid waste management matter thus avoid conflict of responsibility among the relevant government departments; allows privatization of solid waste management services which will boost the performance of appointed contractors to a level set by the Federal Government; and covers all household in all types of areas throughout Malaysia instead concentrating on urban areas only like present days. Hence, the SWPCM Act should not only be gazette, but needs to be implemented soon to preserve our future environment for our future generation.

4.5 Data Collection

Several information were gathered during data collection from each household including demographic information, waste generation, waste composition, waste management practices, recycling practices, as well as suggestions for improvement. The demographic information included occupation, estimated monthly income, academic qualification, gender, and the family size. Furthermore, the impact of their current waste management practices, and involvement of MPKj and JAKOA Malaysia were also identified.

4.6 Demographic Information

Total of 75 houses involved in the study encompassed of 374 people; 206 male and 168 female. Averagely, 5 persons live in a house which consist of 3 men and 2 women. To earn their living, most of the respondents (80 percent) are farmers (Figure 4.11). Typically, the farmers in Kampung Kuala Pangsun, Hulu Langat, Selangor, consume some of their harvested crops themselves. Then, the remaining crops are sold to the middlemen or to the neighborhood villages themselves. Next, 10.7 percent worked either as a technician, security guard, waste collector, or factory production operator. The remaining are retailers (2.7 percent), government employed (2.6 percent), and unemployed (4.0 percent). Normally, the unemployed people sustain their life by depending on the forest products or hunt for animals.

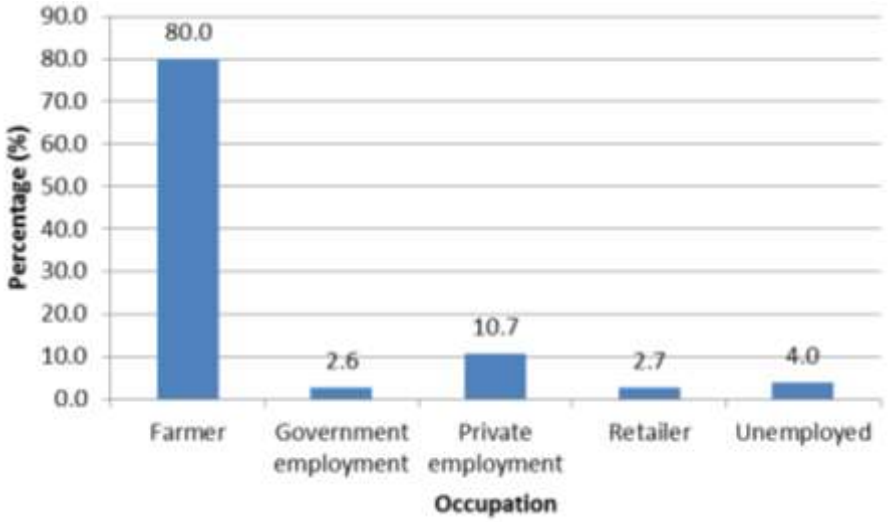

Figure 4.11: Breadwinners' occupation

Many of the respondents earn between RM 100 to RM 900 per month with 30.7 percent earn between RM 301 to RM 600 per month, 29.3 percent earn between RM 100 to RM 300 per month, and 17.3 percent earn between RM 601 to RM 900 per month (Figure 4.12). Approximately, 9 percent earn RM 900 to RM 1,200, 8.0 percent earn between RM 1,201 to RM 1,500, and 1.3 percent earn between RM 1,501 to RM 1,800. Nonetheless, 4.0 percent has no income because they are unemployed and sustain their lives by depending on the forest products or rear animals, and exchanging those to get other basic needs. Based on these results, it shows that majority of the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor, live under poverty, earning less than RM 800 per month.

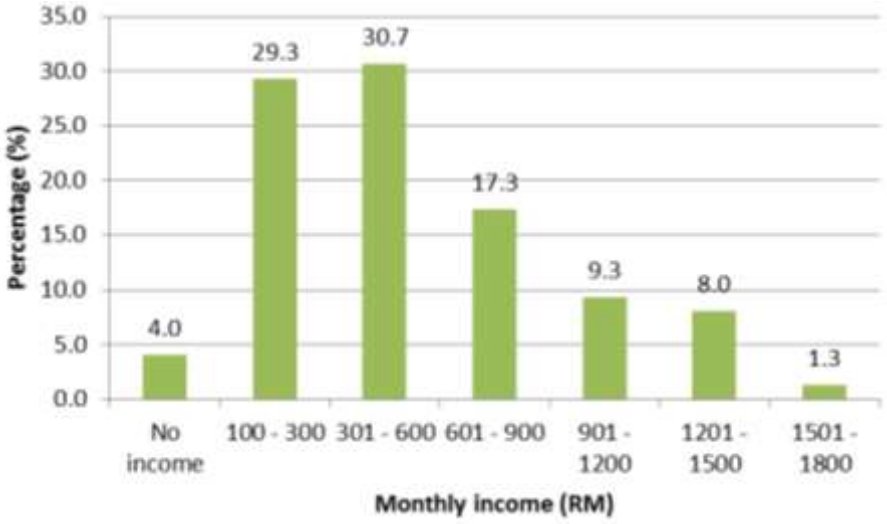

Figure 4.12: Breadwinners' monthly income

It has been identified that the highest education level received by the pbreadwinners are upper secondary school i.e. until form 5. However, most of them only went to primary school i.e. until standard 6 which is represented by about 46.7 percent. Others went to lower secondary school i.e. until form 3 which is represented by 22.7 percent, 20 percent never go to school, and 10.7 percent went to upper secondary school (Figure 4.13). These results indicate that the literacy level among the Orang Asli is low. This explains why many of them are unskilled or semi-skilled workers with low monthly income. Also, throughout the data collection process, it had been found out that many of them do not even know how to read and write. Therefore, the interviews were conducted by the interviewers instead of letting the respondents to fill the survey forms themselves.

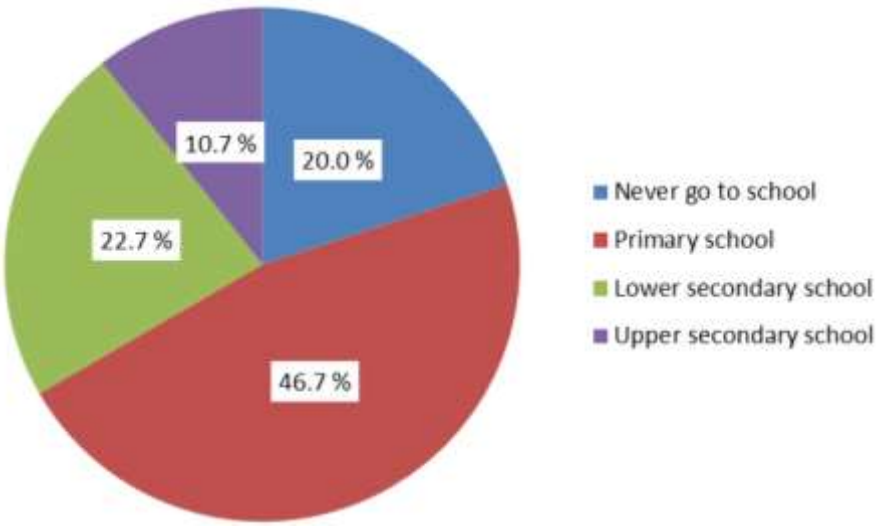

Figure 4.13: Breadwinners' highest level of education

4.7 Correlation Between Monthly Household Income and Waste Generation

Data analysis shows that the average monthly income of Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor is between RM 301 to RM 600 per month, and weekly, each household generates 4.00 kg of household waste. From the analysis of Pearson correlation (Table 4.2), monthly income and amount of household waste generated, has positive correlation. This means that as the monthly income increases, the amount of household waste generated also increases. This finding agrees with Anwar *et al.* (2014), and Mbiba (2014). The regression equation takes the form of:

Amount of household waste generated = 0.278 (monthly income) + 3.367

Table 4.2: Pearson correlation of variables monthly household income and waste generation

		Total fresh weight day 1 to day 7	Monthly income
Pearson Correlation	Total fresh weight day 1 to day 7	1.000	.168
	Monthly income	.168	1.000
Sig. (1-tailed)	Total fresh weight day 1 to day 7	.	.075
	Monthly income	.075	.
N	Total fresh weight day 1 to day 7	75	75
	Monthly income	75	75

4.8 Correlation Between Waste Generation And Population

Additionally, the amount of waste generated has positive correlation with the number of family members (Table 4.3). This means that as the number of family members increases, the amount of waste generated increases. This findings also support studies conducted by Sanaz *et al.* (2009), and Agamuthu and Nagendran (2010), in which the waste generation will increase as the number of people increase. The regression equation takes the form of:

Amount of waste generated = 0.234 (number of family members) + 2.841

Table 4.3: Pearson correlation of variables waste generation and population

		Total fresh weight day 1 to day 7	Number of family members
Pearson Correlation	Total fresh weight day 1 to day 7	1.000	.236
	Number of family members	.236	1.000
Sig. (1-tailed)	Total fresh weight day 1 to day 7	.	.021
	Number of family members	.021	.
N	Total fresh weight day 1 to day 7	75	75
	Number of family members	75	75

4.9 Correlation Between Kitchen Waste Generation And Household Monthly Income

According to Table 4.4, the amount of kitchen waste generated has positive correlation with the monthly income. This means that the amount of kitchen waste generated increases when monthly income increases. This shows that as the families earn more income, they tend to home-cooked their meals, thus generate more kitchen waste. This result is contrasting with study reported by Troschinetz and Mihelcic (2009), where low income family generate more kitchen waste than high income families. The regression equation takes the form of:

Amount of kitchen waste generated = 0.157 (monthly income) + 1.16

Table 4.4: Pearson correlation of variables kitchen waste generation and household monthly income

		Total kitchen waste fresh weight	Monthly income
Pearson Correlation	Total kitchen waste fresh weight	1.000	.181
	Monthly income	.181	1.000
Sig. (1-tailed)	Total kitchen waste fresh weight	.	.060
	Monthly income	.060	.
N	Total kitchen waste fresh weight	75	75
	Monthly income	75	75

CHAPTER 5: CONCLUSIONS

The study found that Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor, generated 300 kg of MSW in seven consecutive days. Therefore, it suggests that each household generates 0.57 kg of waste per day with per capita waste generation rate of 0.12 kg. The study also found that they generates about 38.0 percent of kitchen waste, 15.0 percent of plastic or HDPE, 7.9 percent of box paper, 6.4 percent of unconsumed food, 6.1 percent of plastic bags, 5.6 percent of tin, 5.3 percent of newspaper and 4.0 percent of garden waste. They also produce 2.7 percent of glass, 2.1 percent of diapers, 1.3 percent of mixed paper, 0.6 percent of e-waste, 0.5 percent of polystyrene, 0.3 percent of hazardous waste and 4.0 percent of books, magazines, textiles, rubber, wood, metal, sand, bricks and ceramics.

Throughout the study, it shows majority of Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor, stores their solid waste in bin (57.3 percent), open dumping (34.7 percent) and plastic bags (8.0 percent). The study also reveals that Orang Asli in Kampung Kuala Pangsun disposed their solid waste by burning (93.3 percent), burying the waste (4.0 percent) or send the solid waste to the nearest communal bin (2.7 percent). As for the environmental impacts, the study found that all respondents agreed that the present weather is warmer compared to a decade ago. Approximately 38.7 percent claimed that at least one of their family members had skin irritation at least once after making direct contact with the nearby river, 93.3 percent had suffered from respiratory-related illness like short of breath, asthma and cough at least once, 38.7 percent admitted that the number of vectors like houseflies and rats have increases and around 81.3 complained that either themselves of their friends do encounter reduction in crops production, recently.

MPKj is the LA responsible to administer Hulu Langat vicinity. MSW collection was carried out by appointed private contractors. Even though Kampung Kuala Pangsun

is not given the collection service, MPKj provides communal bin which is collected thrice a week. JAKOA is not responsible to provide MSW management services to the Orang Asli communities. Nevertheless, JAKOA encourages the Orang Asli to recycle or bury the waste. Their long-term plan is to provide MSW management services to the Orang Asli dwellers when the houses are well-arranged.

Thus, it can be proposed that the Orang Asli in Kampung Kuala Pangsun, Hulu Langat, Selangor should be encouraged to store their MSW in bins and practice recycling at source. Approximately 70.7 percent opted for communal bins to be placed near the village, 6.7 percent requested for door-to-door waste collection service, around 6.7 wanted more disposal pits and 16.0 percent had no recommendations. Providing communal bins in several nearby locations is certainly the best solution considering the scattered arrangement of the houses in the area without proper paved pathways.

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APPENDIX A

SURVEY QUESTIONNAIRES

MUNICIPAL SOLID WASTE MANAGEMENT OF INDIGENOUS COMMUNITY IN KAMPUNG KUALA PANGSUN, HULU LANGAT, SELANGOR.

PERSONAL INFORMATION

1. HOUSE NO.: _____
2. OCCUPATION: _____
3. MONTHLY INCOME: _____
4. HIGHEST LEVEL OF EDUCATION: _____
5. FAMILY MEMBERS:

Male	Female

SOLID WASTE STORAGE

1. How do you store household waste?

   _____

SOLID WASTE COLLECTION

1. Is waste collection service available: _____

2. If yes, state
   a. type of lorry:

      _____

   b. contractor:

      _____

3. If no, state waste collection methods:

   _____

SOLID WASTE TRANSPORTATION

4. Will the waste be sent to transfer station / disposal site?

   _____

   If yes, proceed to SOLID WASTE DISPOSAL

5. If no, state where the waste being transported to:

   _____

SOLID WASTE DISPOSAL

6. Do you know the location of that transfer station / disposal site?

   _____

7. If yes, state the location:

   _____

WASTE RECYCLING

8. Is recycling center available in the vicinity?

   _____

9. If yes, state the location:

   _____

10. Do you sell your recyclables?

    _____

11. If yes, to whom did you sell the recyclables?

    _____

12. What are the recyclables being collected?

    _____

13. How much being paid for the recyclables?

Type	Price (RM / unit or weight)

SUGGESTIONS

1. What do you think about solid waste management practice in your village?

   _____

2. Do you think it can be improved? If yes, please specify.

   _____

3. What is your recommendation to further improve the system?

   _____

WASTE MANAGEMENT PRACTICES IMPACT TO ENVIRONMENT

1. Do you think the present weather is warmer than 10 years ago?

   _____

2. Have you or any member of your family suffered from respiratory-related illness?

   _____

3. Have you encountered or any friend of you complained that the crops production decreases?

   _____

4. Have you or any member of your family suffered from skin irritation after making direct contact with the water in the river?

   _____

5. Do you notice there are more houseflies or rats and their presence in your area is frequent nowadays?

   _____

APPENDIX B

RAW DATA AVERAGE WASTE FRESH WEIGHT (kg)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0.33	1	1.3	1.3	1.3
	1.37	2	2.7	2.7	4
	1.565	1	1.3	1.3	5.3
	1.58	1	1.3	1.3	6.7
	1.64	1	1.3	1.3	8
	1.65	1	1.3	1.3	9.3
	1.68	1	1.3	1.3	10.7
	1.755	1	1.3	1.3	12
	1.835	1	1.3	1.3	13.3
	1.88	1	1.3	1.3	14.7
	1.95	1	1.3	1.3	16
	1.98	1	1.3	1.3	17.3
	2.02	1	1.3	1.3	18.7
	2.02	1	1.3	1.3	20
	2.03	1	1.3	1.3	21.3
	2.24	1	1.3	1.3	22.7
	2.29	1	1.3	1.3	24
	2.325	1	1.3	1.3	25.3
	2.34	1	1.3	1.3	26.7
	2.4	1	1.3	1.3	28
	2.45	1	1.3	1.3	29.3
	2.54	1	1.3	1.3	30.7
	2.56	1	1.3	1.3	32
	2.61	1	1.3	1.3	33.3
	2.65	1	1.3	1.3	34.7
	2.73	1	1.3	1.3	36
	2.735	1	1.3	1.3	37.3
	2.755	1	1.3	1.3	38.7
	2.78	1	1.3	1.3	40
	3.07	1	1.3	1.3	41.3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.12	1	1.3	1.3	42.7
	3.13	1	1.3	1.3	44
	3.34	1	1.3	1.3	45.3
	3.41	1	1.3	1.3	46.7
	3.43	1	1.3	1.3	48
	3.49	1	1.3	1.3	49.3
	3.53	1	1.3	1.3	50.7
	3.57	1	1.3	1.3	52
	3.64	1	1.3	1.3	53.3
	3.7	1	1.3	1.3	54.7
	3.72	1	1.3	1.3	56
	3.92	1	1.3	1.3	57.3
	3.94	1	1.3	1.3	58.7
	4.04	1	1.3	1.3	60
	4.14	1	1.3	1.3	61.3
	4.24	1	1.3	1.3	62.7
	4.445	1	1.3	1.3	64
	4.535	1	1.3	1.3	65.3
	4.58	1	1.3	1.3	66.7
	4.59	1	1.3	1.3	68
	4.6	1	1.3	1.3	69.3
	4.67	1	1.3	1.3	70.7
	4.75	1	1.3	1.3	72
	4.87	1	1.3	1.3	73.3
	4.89	1	1.3	1.3	74.7
	4.99	1	1.3	1.3	76
	5.38	1	1.3	1.3	77.3
	5.58	1	1.3	1.3	78.7
	5.645	1	1.3	1.3	80
	5.875	1	1.3	1.3	81.3
	5.96	1	1.3	1.3	82.7
	5.985	1	1.3	1.3	84
	5.99	1	1.3	1.3	85.3
	6.22	1	1.3	1.3	86.7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	6.23	1	1.3	1.3	88
	6.48	1	1.3	1.3	89.3
	6.685	1	1.3	1.3	90.7
	6.89	1	1.3	1.3	92
	7.18	1	1.3	1.3	93.3
	7.9	1	1.3	1.3	94.7
	7.935	1	1.3	1.3	96
	10.78	1	1.3	1.3	97.3
	11.04	1	1.3	1.3	98.7
	11.84	1	1.3	1.3	100
	Total	75	100	100	

APPENDIX C

SUMMARY OF MEANS

	BOCCUPAT	BINCOME	BEDUCAT	HOMESIZE	WSTORE	WDISPOSE
Mean	2.40	2.28	1.24	4.96	1.77	1.09
S.E. Mean	0.17	0.16	0.10	0.27	0.11	0.04

	RECYCLE	SATISFY	IMPROVE	RECOMMEND	WFW	WVOL	WDENS
Mean	1.79	0.85	0.88	1.11	4.00	15.15	10.77
S.E. Mean	0.05	0.04	0.05	0.11	0.26	1.19	0.56

	KWFW	UFFW	MPFW	NPFW	BFW	MFW
Mean	1.519	0.256	0.050	0.213	0.006	0.008
S.E. Mean	0.137	0.076	0.007	0.020	0.003	0.004

	BPFW	HDPEFW	PBFW	POLYSTFW	DIAFW	TTFW	RFW
Mean	0.318	0.600	0.245	0.021	0.083	0.009	0.013
S.E. Mean	0.056	0.042	0.021	0.006	0.024	0.002	0.048

	WOFW	GWFW	GLFW	MTFW	TFW	HWFW	OFW
Mean	0.041	0.162	0.107	0.008	0.226	0.014	0.021
S.E. Mean	0.019	0.041	0.032	0.004	0.037	0.004	0.014