

AN OVERVIEW OF MUNICIPAL SOLID WASTES GENERATION IN MALAYSIA

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Abstract. Increasing population and tremendous urbanisation growth and other factors influence directly the municipal solid waste (MSW) generation in Malaysia. The huge quantity of MSW generation, particularly in Peninsular Malaysia, has increased from 16,200 tonnes per day in 2001 to 19,100 tonnes per day in 2005 or an average of 0.8 kg/capita/day. The amount increases yearly and seems to grow in parallel with the urban areas in many Asian countries which are estimated to produce approximately 8 million tonnes per day. Thus, this paper briefly discusses the scenario of MSW generation in Malaysia. It focuses on the trends of MSW generation, the composition of MSW, the contributing factors as well as the management problems occurring in Malaysia presently. In addition, some updated statistical figures related to the MSW and management aspects are provided to clarify the present situation and the government's future planning. Recent development indicates that the Malaysian government has taken forward to deal with such problems in MSW management across the municipalities through closed dumping sites, upgrading existing conventional landfills to sanitary status, constructing new transfer stations and giving serious priority for an alternative disposal system in the near future. Moreover, the establishing a new national solid waste and public cleansing management corporation and enacted a new specific regulations for solid waste and public cleansing management which approved on September 2007 is also seen as a proactive step towards achieving the sustainability of MSW management as a long term solution.

Keywords: Disposal; Malaysia; management; municipal solid waste (MSW); municipal solid waste generation

Abstrak. Peningkatan jumlah penduduk dan pertumbuhan pesat proses perbandaran dan faktor lain secara langsung mengakibatkan penghasilan sisa pepejal perbandaran. Jumlah kuantiti besar yang dihasilkan terutamanya di Semenanjung Malaysia merekodkan peningkatan daripada 16,200 tan sehari pada tahun 2001 kepada 19,100 tan sehari pada tahun 2005 atau purata per kapita sebanyak 0.8 kg sehari. Jumlah ini kian meningkat dari tahun ke tahun selari dengan penghasilan sisa pepejal di kawasan perbandaran negara-negara Asia lain yang dianggarkan berjumlah 8 juta tan sehari. Justeru, kertas kerja ini membincangkan secara ringkas senario penghasilan sisa pepejal perbandaran di Malaysia. Perbincangan terfokus kepada aliran penghasilan sisa pepejal perbandaran, jenis komposisi, faktor-faktor penyumbang, selain masalah pengurusan sisa pepejal yang sedang dialami oleh Malaysia. Juga dibincangkan, data statistik terkini yang ada hubungkait dengan pengurusan sisa pepejal perbandaran untuk mengetahui keadaan serta rancangan yang sedang dan akan dilaksanakan oleh kerajaan.

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Perkembangan terkini menunjukkan kerajaan Malaysia sedang dan akan membuat tindakan kehadapan untuk menangani masalah pengurusan sisa pepejal perbandaran di seluruh Majlis Perbandaran (termasuk dewan bandaraya) di seluruh negara. Antara langkah yang diambil termasuklah menutup operasi beberapa tapak pembuangan terbuka terpilih, menaikkan taraf beberapa tapak pengambusan sedia ada kepada pengambusan jenis sanitari, membina pusat-pusat pemindahan, serta memberi keutamaan sistem pelupusan alternatif di masa terdekat. Selain itu, penubuhan perbadanan pengurusan sisa pepejal negara serta meluluskan pembentukan undang-undang khusus berkaitan pembersihan dan pengurusan sisa pepejal perbandaran pada November 2007 lalu dilihat sebagai langkah proaktif ke arah mencapai sasaran pengurusan sisa pepejal yang mampan untuk penyelesaian jangka masa panjang.

Kata kunci: Malaysia; pelupusan; pengurusan sisa pepejal; perbandaran; sisa pepejal perbandaran

1.0 INTRODUCTION

The rapid population growth, urbanisation, economic levels and rise in the community living standards will generate a tremendous rate of municipal solid waste (MSW) across the Malaysian municipalities. As a middle-income economy and located in the middle South-east Asia, Malaysia is expected to become a developed country as early as the year 2020 [1]. As spell out in Vision 2020 and the increasing population, the proportion to the rise of solid waste disposal issues related to disposal have become more challenging to dispose of these solid wastes [2]. The tropical climate and disposal practice, as well as inadequate waste management, influence results in increasing environmental problems in Asia region [3]. Moreover, the changes in consumption patterns with alterations in the waste characteristics have resulted in a quantum jump in solid waste generation [4].

The number of current available information on solid waste management in Malaysia is quite limited. For many decades, until the end of 1987, there was no systematic analysis and periodic documentation nationwide from any local authorities to record waste generation rate, which has resulted in inaccurate and outdated databases [5]. Only in May 1987, the first nationwide compilation of waste generation and composition was carried out by the Ministry of Housing and Local Government (MHLG). Since then, the second study was conducted by the Malaysia Industry-Government Group for High Technology (MIGHT) in May 1994, followed by another selected states survey on November in the same year. Nevertheless, the coverage of this survey was limited to the Federal Territory Kuala Lumpur, the states of Selangor, Melaka, Negeri Sembilan and Johor. On the other hand, the first written report on solid waste management by non-government organisations (NGOs) appears in 1978, where the Environmental Protection Society of Malaysia (EPSM), as a local NGO, carried out the survey in five municipalities in Klang Valley [6]. The finding of the survey shows that there were three major inadequacies in solid waste management including improper disposal manner, insufficient coverage of the collection systems, and inefficient collection methods [7].

Related to these issues, a comprehensive study was carried out to investigate the status of waste recycling and its future prospects in Malaysia [5]. The study revealed

that, although a large amount of waste could be recycled, only less than 5% was actually separated and recycled. Plastics, paper and glass are among three types of waste identified as having the greatest potential for recycling. Thus, they conclude that recycling in Malaysia has a long way to go, with major problems and obstacles to be solved, before a successful recycling program can be in place. The purpose of this paper is to share and update the new information and development of MSW generation, particularly in Malaysia, which is seen increasingly in line with the major contributing factors such as population growth, urbanisation, economic growth etc. The further trends and MSW generation contributing factors are discussed in Section 2 and 3 respectively. The present MSW management practices as well as a disposal status in Malaysia are also briefly discussed in Section 4 and 5, respectively. Section 6 focuses on the MSW generation dilemma in Malaysia context, and some concluding remarks are presented in the last section (Section 7).

2.0 TRENDS OF MUNICIPAL SOLID WASTE GENERATION

The trends of MSW generation in Malaysia have been studied since the early 1980s. On average, the MSW generation increased 2% annually [8] and is expected to reach 2.5–3% due to rapid population and economic growth during the Ninth Malaysia Plan (2006–2010). Based on the census data and Malaysia's experience in waste study, Sekarajasekaran [9] projected the residential waste generated in 20 studied municipalities would increase almost 100% from 1980 to 1990 due to growing urbanisation reaching up to 40% of population. This projection is realistic and realises in the present situation where the total MSW generation in Malaysia increased from 5.91 million tonnes in 2001 to 6.97 million tonnes in 2005. Moreover, the average per capita generation rate increased from 0.67 kg/capita/day in 2001 to 0.8 kg/capita/day in 2005 [10] and this amount is expected to increase to double digits in line with the population growth by the year 2020. The MSW generation details in Peninsular Malaysia by states are shown in Table 1. This clearly indicates that the quantity of MSW generation in Malaysia is increasing with time, pointing to a need for a more efficient management system and disposal alternatives of MSW in a future.

The characteristics of MSW components also play important roles to determine the suitability of the disposal systems. According to Visvanathan *et al.* [3], the solid waste composition in most Asian countries is highly biodegradable with high moisture contents such as food waste, paper, plastic/foam, agriculture waste, rubber/leather, wood, metal, glass and textiles. In Malaysia, the average components of MSW are quite similar with the largest categories consisting of food waste (45%), plastic (24%) followed by paper (7%), iron (6%) and lastly 3% for glass and others [10]. Therefore, a continuous effort is required to identify the most suitable alternative for long terms solutions to reduce the burden of existing MSW disposal systems (i.e., open dumping and landfilling).

Table 1 Solid waste generation in Peninsular Malaysia by states ('000 tonnes)

States	1996	1997	1998	1999	2000	2007 ¹	Average growth rate (1998–2000, in %)
Kuala Lumpur	n.a.	n.a.	1,058	1,070	1082	1168	1.14
Selangor	n.a.	n.a.	1,169	1,204	1240	1504	3.04
Pahang	n.a.	n.a.	202	206	210	239	1.98
Kelantan	n.a.	n.a.	123	126	120	110	-1.22
Terengganu	n.a.	n.a.	119	122	125	147	2.52
Negeri Sembilan	245	250	267	278	291	387	4.69
Melaka	192	200	208	216	225	293	4.30
Johor	854	890	927	956	1005	1321	4.49
Perlis	26	27	28	28	29	33	1.79
Kedah	507	538	569	569	631	873	5.49
Pulau Pinang	570	591	611	611	648	785	3.03
Perak	672	696	719	719	763	926	3.06
Total	3066	3192	6,000	6,137	6378	7655	2.86

Notes: n.a : not available

¹ estimated based on the average growth rate (1998 – 2000)

Source: Malaysia Government (2000)

3.0 THE CONTRIBUTING FACTORS

The contributing factors towards the increasing MSW generation in Malaysia are almost similar to other developing countries. Firstly, the tremendous population growth is identified as one of the main contributing factors, based on the ministry of housing and local government (MHLG) annual report in 2002. According to this report, the increasing MSW generation is strongly related with the population growth, with 13,068.97 tonnes per day recorded in 1996 as compared to 16,247.93 tonnes per day in 2001, in line with the increase of population from 15,146,236 inhabitants to 17,136,575 inhabitants in the same period. It means, in the six years period, the total MSW generation increased almost 20% or 3.3% annually [11]. These phenomena clearly indicate that the increasing in MSW generation is significantly related to the population growth in Malaysia. As in other developing countries, Malaysia shows a sharp increase in population from 1970 to 2005. The total population increased from 23.49 million in 2000 to 26.75 million in 2005, an increase of 13.8% in the ten years period. It is estimated that, by year 2010, the population will increase to around 29 million with a corresponding increase of MSW generation in Malaysia. On a regional basis, the total population in the central region was the highest at 8.17 million in 2005 consisting of Melaka, Negeri Sembilan, Selangor and Kuala Lumpur, while Sarawak was the lowest at 2.34 million, as seen in Table 2.

Secondly, the rapid urbanisation process is another main contributing factor to generate more MSW in all cities throughout Malaysia. The urbanisation growth in

Table 2 Population¹ and urbanisation rate by state (2000 – 2010)

State	Population (million)			Urbanisation rate (%)			Average annual growth rate of urban population (%)	
	2000	2005	2010	2000	2005	2010	8MP	9MP
Northern Region								
Kedah	1.67	1.85	2.04	39.1	39.8	40.3	2.4	2.2
Perak	2.09	2.28	2.44	59.1	59.3	59.3	1.6	1.6
Perlis	0.21	0.23	0.25	34.0	35.1	35.9	2.2	2.2
Pulau Pinang	1.33	1.50	1.60	79.7	79.8	80.0	2.0	1.9
Central Region								
Melaka	0.65	0.72	0.79	67.5	70.6	73.4	2.9	2.7
Negeri Sembilan	0.87	0.96	1.03	54.9	56.3	57.4	2.3	2.1
Selangor ²	4.19	4.87	5.31	87.7	88.4	89.1	2.7	2.4
W.P. KL	1.42	1.62	1.70	100.0	100.0	100.0	1.9	1.5
Southern Region								
Johor	2.76	3.17	3.46	64.8	66.5	67.7	2.9	2.6
Eastern Region								
Kelantan	1.36	1.51	1.67	33.5	33.4	33.3	2.0	2.1
Pahang	1.30	1.45	1.57	42.0	43.5	44.6	2.7	2.5
Terengganu	0.90	1.02	1.12	49.4	49.8	50.3	2.6	2.6
Sabah								
W.P. Labuan	0.08	0.09	0.09	76.3	77.6	78.6	2.2	1.8
Sarawak								
	2.07	2.34	2.56	48.1	49.5	50.6	2.8	2.4
Malaysia	23.49	26.75	28.96	62.0	63.0	63.8	2.5	2.3

Notes: ¹Population data refer to mid-year population; ²Includes Wilayah Persekutuan Putrajaya;

W.P. KL ~ Wilayah Persekutuan Kuala Lumpur; 8MP ~ Eighth Malaysia Plan; 9MP ~ Ninth Malaysia Plan

Source: Malaysia Government (2006)

Malaysia was stated to be the most rapid in Southeast Asia in 1980 [12]. Generally, the trend of urbanisation can be linked directly to several federal government policies [6]. For example, in the Ninth Malaysia Plan (2006–2010), the government plans to expand the urban area development based on a hierarchy growth conurbation approach which includes national, regional, intermediate and urban centres [10]. Moreover, the extension of five new development corridors across Malaysia, such as Iskandar Development Region (IDR) in south Johor, Northern Corridor Economic Region (NCER) encompassing Penang, Kedah, south of Perlis and north of Perak, East Coast Economic Region (ECER) covering north of Mersing in Johor, Pahang, Terengganu and Kelantan.

The other two development corridors are Sabah Development Corridor (SDC) and Sarawak Corridor of Renewable Energy (SCORE). Thus, these policies will have a direct impact to the expansion of urban boundaries, migration of the young population from the rural areas and increasing opportunities available in the urban areas as well as on the MSW generation increased.

Thirdly, the urban population showed a significant increase from 8.8 million or 28.7% in 1970 [13] to 16.85 million or 63% in 2005. In 2005, the rate of urbanisation in Pulau Pinang, Wilayah Persekutuan Labuan, Selangor and Wilayah Persekutuan Kuala Lumpur, Melaka and Johor was higher than the national urbanisation rate (2.5%). Moreover, the trends of population growth in selected town in Peninsular Malaysia also demonstrate the significant increase from 1980 to 2005. For example, the total population in Kajang, recorded as only 29,301 in 1980, increased to 99,914 inhabitants in 1991, which means an increase of 70,613 inhabitants or a growth of more than 24% annually. Thus, the mean monthly income of urban households increased from RM3103 in 1999 to RM3956 in 2004 or an increase of 27.5% during that period [10]. This resulted in an increase of MSW generation in the urban areas. Table 3 demonstrates the sharp increase for mean of urban households' income from RM1,541 in 1985 to RM3,151 in 2005 or an average 4.7 % annually in 20 years period.

Table 3 Mean monthly household income (RM) of Peninsular Malaysia (1985 – 2005)

	1985	1990	Year 1995	2000	2005 ¹
Urban households	1,541	1,617	2,596	2,984	3151
Rural households	824	951	1,300	1,495	1579
Mean income of all households	1,095	1,167	2,007	2,482	2621

Notes: ¹Based on the Eight Malaysia Plan (8MP) achievement report
US\$1 = RM3.50 (approx.)

Sources: Malaysia Government (1986, 1991, 1996, 2001)

Fourthly, the age structure of population in Malaysia is relatively young, the category 0 – 14 years increased to 32.6% from 8 million in 2000 to 8.72 million in 2005. It means the labour forces age group 15–64 constitutes only 63.1% of the total population [10]. Thus, Malaysia has somewhat of a high dependence ratio proportion. It is highly demanding for the government to provide schools, hospitals, housing and others services. This implies that the government will face more challenges to provide funds for sustainable development and environmental improvement in the near future.

Fifthly, rapid economic growth is another main contributing factor of the increasing MSW generation. For the last two decades, Malaysia has experienced a rapid economic growth since gaining independence from the United Kingdom in 1957 and it grew almost three times higher than the world's average annual economic growth rate at

Table 4 Gross Domestic Product (GDP) from 1970 to 2006 (in 1980 prices)

Year	GDP (RM million)	Per capita GDP (in RM) 1980	Average annual growth rate between period
1970	25,233	2,341	6.3%
1980	44,702	3,221	5.7%
1990	120,316	5,815	8.9%
2000	176,635	7,593	8.3%
2006 ^(e)	240,223	10,327	6.0%

Note: ^(e) estimated, in 2000 prices

Sources: Economic Planning Unit (2006),

Department of Statistics (1973, 1982, 1986, 1991, 2000, and 2006)

2.5% per annum [6]. Despite a financial crisis in 1997 – 1998, the economic development before 1997 was the most impressive since 1986. The Gross Domestic Product (GDP) of the country has increased from RM57,093 millions in 1985 to RM79,103 in 1990 [14]. The total per capita and total GDP of Malaysia from 1970 to 2006 is shown in Table 4. It can be seen that the GDP has significantly increased from RM25,233 million in 1970 to RM240,223 million in 2006, or on average, the annual growth recorded maintained a range of 6.3% to 8.5% in the studied period.

As an impact of the rapid economic growth in Malaysia, the production structure has also seen a significant change moving from the agriculture sectors before 1970 to industrial and service sectors as the engine of growth. Thus, these changes of production structure will also directly influence the composition of the solid waste disposal. For example, in 1970, the highest composition of the solid waste generated was agricultural and services waste (including food waste etc.). However, recently, the trends of solid waste generated completely changed to manufacturing and services base due to the changing structure of production. Table 5 shows the significant shifts of production structures from agriculture and mining sector, which recorded 38.6% in 1970 and only 14.5% in 2006. However, the manufacturing and services recorded a significant increase from 57.4% in 1970 to 89.8% in 2006.

Table 5 The structure of production (1970 – 2006)

Sector	(% of GDP)				
	1970	1980	1990	2000	2006
Agriculture	38.6 ¹	21.0	16.3	8.9	7.9
Mining		12.1	9.4	7.3	6.6
Manufacturing	13.9	17.2	24.6	31.9	31.7
Construction	4.0	2.7	3.5	3.3	2.6
Services	43.5	43.1	46.8	53.9	58.1

Note: ¹ Combined percentage for agriculture and mining

Source: Economic Planning Unit (2006)

Lastly, the multi-racial society with more than 32 ethnic groups, including the bumiputeras in Sabah and Sarawak may have also contributed to waste increase. In 2005, for instance, the ethnic composition in the Malaysian population was bumiputera which comprised of Malay (majority in Peninsular Malaysia), Iban and Dayak (in Sarawak), Kadazan, Bajau, and Dusun (in Sabah) etc. (65.9%), followed by Chinese (25.3%), Indian (7.5%) and others (1.3%). The different races have different cultures, customs and different holidays. Due to these differences of customs, for certain period of the year the MSW generated will sharply increase because they celebrate their festivities. For example, Malay people celebrate 'Hari Raya Puasa' in the month of Syawal (tenth month of Muslim calendar) and the Chinese celebrate 'Chinese New Year' every year based on the Chinese calendar, and the Indian race celebrate 'Deepavali.'

4.0 MUNICIPAL SOLID WASTE MANAGEMENT

As the economic activity and population increases, the management of solid waste is becoming a serious problem in all municipalities. Public health, air pollution, odour disturbance, hazardous gas emissions are among the common phenomena occurring in urban areas. In general, MSW disposal requires an adequate environmental control from waste collection to disposal and finally regular monitoring of disposal sites [15]. The local authority in most of the municipalities in Malaysia is responsible for the collection service of solid waste, even though some municipalities or city hall (for example Kuala Lumpur City Hall) has outsourced to private companies. The monitoring of the overall MSW management however, is still under their responsibility.

The situation of MSW management in Malaysia is similar to other Asian countries. Therefore, it is noteworthy to mention that the recommendations and conclusions from the World Bank report are very significant in the local context as well. Some of the key conclusions [16] are:

- (1) The municipal government needs help from other levels of government, businesses and the general community due to solid waste collection and disposal problems being beyond their magnitude to control.
- (2) Urban residents generate two to three times more solid wastes than their fellow rural citizens.
- (3) Municipalities should change the waste disposal, and possibly collection, based on generation rates.
- (4) The waste components requiring priority attention are organic and paper.
- (5) The daily waste generation rate in urban areas is about 760,000 tonnes and is expected to sharply increase to 1.8 million tonnes per day by the year 2025.

- (6) The urban areas in Asia spend about US\$25 billion (RM87.25 billion) on solid waste management per year and this figure will increase to at least US\$50 billion (RM175 billion) in 2025 (*note: US\$1 = RM3.5 (approx.)*)

To manage the solid waste in an efficient manner, four functional element interrelationships should be practiced well before the final disposal decision. According to [17], the first function element is the material generated at the source. Materials that are no longer considered as having value are discarded as waste, and the quantity and the characteristic of that waste depends on the source. The second function element is waste handling, separation and storage at site. Wastes are separation before placing into the store containers. Paper, plastic, cardboard, ferrous metals, aluminum cans are some of these components. This action is very important before moving to the next point (collection). In collection, solid waste is picked up and placed into empty containers with separate parts for recyclable materials. Then, the collection vehicles collect the waste around the disposal centres manually before disposing into the disposal sites. Figure 1 shows the detailed steps involved from material generated at the source until the final functional element for disposal purposes.

Malaysia should learn from developed countries' experience in handling efficiently the MSW management and disposal policy. For example, the policy on waste management in the European Union (EU) countries has targeted the 'rational and sustainable use of resources', and achieved through a hierarchy of management options [18] as shown in Figure 2. The hierarchy clearly shows that, first, it focuses on prevention efforts to generate unnecessary waste which are related to the human habits,

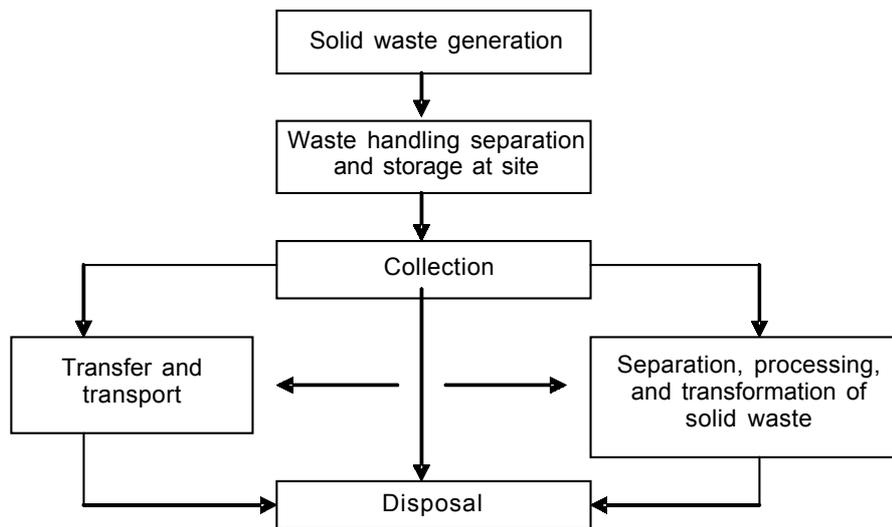


Figure 1 The basic solid waste management system [17]

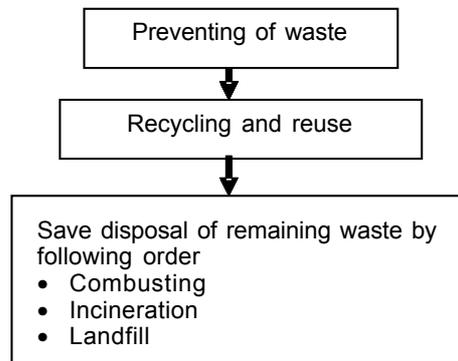


Figure 2 The hierarchy of management options

environmental awareness and responsibility. Second, if the first hierarchy cannot be avoided, the next priority is to recycle or reuse the refuse waste in other materials. Finally, if both the previous measures cannot be avoided then the waste can be disposed in a proper manner by the following order; (i) combusting, (ii) incineration, and (iii) landfilling. Thus, it is clear that the EU policy emphasises landfills as the final option for waste disposal to minimise the adverse impact on the environment.

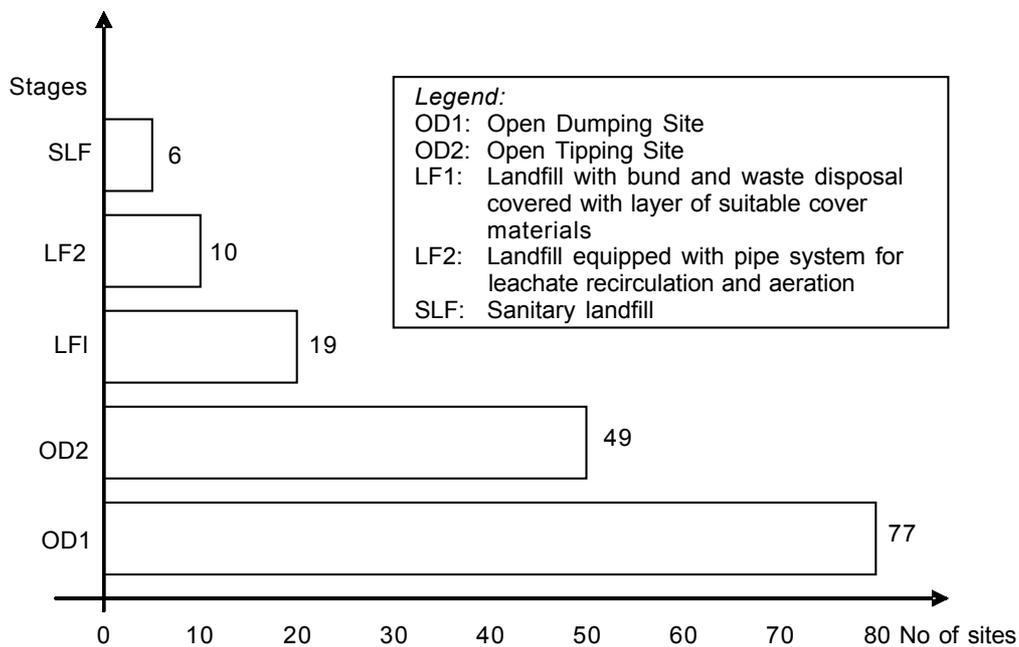
However, recent development indicates that the Malaysia government gives priority to MSW management and related sanitary efforts. In the Ninth Malaysia Plan, for instance, the National Strategic Plan will be implemented with emphasis on upgrading the unsanitary landfills as well as the construction of new sanitary landfills and transfer stations with integrated material-recovery facilities. The new legislation to streamline solid waste management was enacted on September 2007, specifically to facilitate the implementation of the strategies and to measure properly [19]. Moreover, the awareness campaigns and related activities will be increasingly organised to educate the public on the benefits of practicing sustainable consumption. Besides that, the establishing of the solid waste and public cleansing management corporation [20] becomes a platform to implement and administer solid waste policy, planning and management in a holistic manner.

5.0 STATUS OF MUNICIPAL SOLID WASTE DISPOSAL IN MALAYSIA

For many decades, all municipalities in Malaysia have practiced the open dumping and landfilling for disposal of the MSW. Landfills still cover 60 to 90% of the served areas, and are projected to cover more than 75% in the near future, with 80 % of the waste disposal sites having less than two years of remaining operating life [21]. Thus the urgency for municipalities to secure new landfills is priority before the existing ones exhausted. Moreover, the technical evaluation study in 1992 also found that landfills would remain the major waste disposal system for the nation in the near future.

Landfilling is done almost solely through this method and open dumping is being practiced and takes place at about 50% of total landfills [22]. The landfills sites can be categorised into five types according to the landfill stages such as, (i) open dumping sites, (ii) open tipping site, (iii) landfill with bund and waste disposal covered with layer of suitable cover materials, (iv) landfill equipped with pipe system for leachate recirculation and aeration, and (v) sanitary landfill [23]. As seen in Figure 3, there are 161 landfills available across Malaysia and only six landfills or 3.7% are in the sanitary landfills category, while 77 landfills still practice open dumping and have an adverse impact on the environment and public health. With regards to this problem, the government has plan to upgrade some of the existing landfill sites to sanitary landfills, build ten new sanitary landfills and 18 transfer stations during the Ninth Malaysia Plan [24]. These efforts are seen as further steps taken by the government in reaching the sustainable solid waste management in Malaysia for the short and middle term solution.

In the Seventh Malaysia Plan (1996–2000) on the other hand, the government purchased seven mini-incinerators with a capacity of 5 to 20/tonnes/day to operate in the resort Islands in Labuan, Tioman, Pangkor and Langkawi with a cost estimated at RM17 million [25]. Due to scarcity of land and high MSW generation rate, especially in the central region of Peninsular Malaysia, the government in the future plans to



Source: MHLG (2001)

Figure 3 Number of landfills in Malaysia according to landfill stages

install three incinerator plants of large capacity in Kuala Lumpur, Selangor and Pahang [10].

Composting method is another option for MSW disposal, however, the government presently has not given it priority and it is still under thorough study for possible implementation in the future. Another potential method to handle the MSW generation is recycling activities. Recent studies revealed that, less than 5% of the total (almost 10000 tonne/day) is actually separated and recycled, although a large amount of Malaysian waste has potential to be recycled [5]. In response to these critical phenomena, the government has take further initiative to relaunch the recycling campaign on 2nd December 2000 with a targeted 22% of waste recycled by year 2020.

6.0 MUNICIPAL SOLID WASTE DILEMMA

The annual quantity of solid wastes generated in Malaysian cities has increased from 2.5 million tonnes in 1991 to 5.9 million tonnes in 2005, with an annual growth rate of 2.0%, and it is expected to increase to 7.0 million tonnes by year 2010 (Table 6). The national average generation rate and the amount of MSW generated is skewed towards fast-developing and urbanised regions or cities, such as cities in Klang Valley, Kuala Lumpur, Johor Bahru, Penang and Kuching. The amount of solid waste generated in Kuala Lumpur city and local authorities in Selangor, for instance, constitutes one-third of the total amount of solid waste generated in Malaysia [14]. Table 7 shows the detail of per-capita waste generation per day in all Peninsular Malaysia states except Kedah and Perlis. As we can see, Kuala Lumpur, Johor and Selangor are the top three ranked in MSW generation, while Melaka, Negeri Sembilan and Penang lies in the next three ranks, which recorded between 0.96 to 1.2 kg/capita/day of MSW generation.

Table 6 Estimated solid waste generation in local authorities in Malaysia

Year	Population in Local Authorities (Million) (increase at 3 percent annually)	Waste Generation Rate (Kg/cap/day) (increase at 2 percent per capita per year)	Total Amount of Solid Waste Generated in Local Authorities (million tones)
1991	13.727	0.7	2.5
1995	15.450	0.8	3.0
1996	15.913	0.8	3.2
1997	16.391	0.8	3.4
1998	16.882	0.8	3.5
1999	17.389	0.8	3.7
2000	17.911	0.9	3.9
2005 ^e	20.598	1.0	5.9 ¹
2010 ^e	23.284	1.2	7.0

Note: ^eestimated based on 3 per cent population annual growth and 2 per cent waste generation growth.

Sources: Department of Environment (1999)

¹Malaysian Government (2006)

Table 7 Per-capita waste generation rate per day for each state in Peninsular Malaysia

State	Kg/cap/day
Kuala Lumpur	1.57
Selangor	1.26
Pahang	0.92
Terengganu	0.86
Kelantan	0.5
Johor	1.35
Melaka	1.20
Negeri Sembilan	1.20
Penang	0.96

Source: Nasir (2002)

The generation of huge quantities of MSW and consequential environmental degradation in Malaysia has manifested from rapid population growth and urbanisation for many decades. Consequently, all local authorities identified facing acute problems in the collection and disposal of MSW and these mainly related to shortage of adequate funds, manpower problems, lack of disposal sites, absence of good management systems and lack of expertise [26]. Unfortunately, the present situation of MSW management has hardly improved after more than two decades. It is clear that MSW management involves a number of issues and trade-offs, and many factors should be considered in planning and decision making [27]. These factors include land use, labour needs, air and water pollution, recycling rates, financial costs, energy usage, and equity in the number and demographics of people affected by a policy. Since the legislation was newly enacted, thus the efficiency of such implementation cannot be measured instantly at least for the recent years. As a result, there is a hiccup in establishing an integrated MSW management plan nationwide in the near future period.

7.0 CONCLUSIONS

As solid waste is generated everywhere, addressing the environmental safe management of solid waste is not limited to Malaysia. The MSW disposal management strategies should be investigated and handled carefully without sacrificing the stakeholder's interest and local requirements as well as fulfilling an international environmental standard. In spite of variations in the management from countries to countries, the most important decision must be in the 'environmental safe management framework.' Thus it can minimise the adverse impact (if not totally avoid) for continuation of safely living and comfortable atmosphere. In reality, the MSW generation cannot be avoided completely as long as humans exist and this issue will always arise simply because societies will continue to generate trash due to increasing populations and the growing

demand of modern society [28]. Therefore, all parties, including federal, state, and local authorities, industry as well as citizens, should make substantial efforts through source reduction before loading into disposal sites.

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