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Enhanced the Municipal Solid Waste Management in Kuala Lumpur by Implementing Technologies from European Countries: Strategies and Action Plans

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ABSTRACT

This paper has discusses theseveral action plan to improve municipal solid waste management (MSW) in Kuala Lumpur with the implementation of integrated MSW management from European countries. Several data of MSW management in Kuala Lumpur such as key legislation, population growth, solid waste generation, disposal and collection has been review and study for guidelines and evaluation of the best selection on MSW management for Kuala Lumpur. The main goal of this paper is to develop an effective MSW management, which can diminish the weaknest of current MSW management in Kuala Lumpur. Based on the data gather, a combination of several MSW management and technologies from Europeancountries such as PAYT (Pay as You Throw) program, incinerator, Refused Derived Fuel (RDF) and Dual system has been found as the best selection for immediate and long term strategies for implementation on MSW managementin Kuala Lumpur.

1. Introduction

Currently, most of the countries around the world were facing serious issues in developing an effective solid waste management. Most of the developing countries like Malaysia have to deal with a deficiency of appropriate policies and inefficient management and operation, which can interrupt the improvement, and sustainability of municipal solid waste management. Moreover, the rapid population growth and urbanisation occur in Malaysia may also contributed on generation of excessive solid

waste. Municipal Solid Waste (MSW) management practices are different for every country depending on types and volume of waste, population growth, and socio –economics of the countries (Harvey, Sohrab and Reed 2002) . According to Rekaewicz (2002), low incomes countries in Asia have produced great amount of total waste (158,000,000 tonnes per annum in 1999 to 480,000,000 tonnes per annum in 2025) , which far more than in high income countries (85,000,000 tonnes per annum in 1999 to 86,000,000 tonnes per annum in year

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2025). This happens due to population growth in low income countries (projected to triple from their current population in the next 25 years) which contribute to an enormous increment on total solid waste generation. While in high-income countries, the improvement and strengthening of integrated solid waste management affects a stable and decreasing trend of total solid waste generation. Therefore, adoption of waste hierarchy policy and integrated solid waste management (ISWM) can minimise and reduce the solid waste generation especially in Kuala Lumpur. In the following, an attempt are made to discover appropriate strategies and action plan that can be implemented from European countries such as United Kingdom and Germany to reduce the burden of landfill, and improve the MSW management in Kuala Lumpur.

2. Background and population growth in Kuala Lumpur.

Kuala Lumpur is the main capital city for Malaysia and situated on the west coast of peninsular Malaysia with the surface area of 243.65 km². Kuala Lumpur has divided into ten regions, which is , Kepong ,Segambut, Wangsa Maju , Setiawangsa, Titiwangsa, Bukit Bintang, Lembah Pantai, Seputih, Bandar Tun Razak , and Cheras. Kuala Lumpur City Hall is

the local government in Kuala Lumpur under the Federal Territories Ministry of Malaysia. The task of Kuala Lumpur City Hall is to monitoring and maintenance of public health and sanitation, waste removal management, town planning, environmental protection and building control, social and economic policy, and infrastructure of the city. In January 1997, a solid waste management for Kuala Lumpur was take over by concessions together with other four other states in the central region of Malaysia.

Kuala Lumpur is the predominant urban, with an urban agglomeration of 7.2 million and 1,809,699 million populations in 2007 (World Gazetteer 2008). Kuala Lumpur has diversity culture, which includes Malays, Chinese, Indians, Eurasians, other native from East Malaysia and Peninsular Malaysia. Table 1 shows the distribution of population and average population growth in Kuala Lumpur from year 1980 to year 2010. The increasing of populations' numbers from 1.3 million in years 2000 to 1.6 million in 2010 lead to an increment in the generation rate of solid waste per household . This was showed from previous studies; where the average amount of MSW generated in Kuala Lumpur has increased from 0.5-0.8 kg/person/day to 1.7 kg/person/day.

Table 1: Distribution of Population (Number and Percentage) and Average Population Growth Rate in Kuala Lumpur, 1980 -2010

State	1980		1991		2000		2010		Average annual population growth rate (%)		
	Population	%	Population	%	Population	%	Population	%	1980-1991	1991-2000	2000-2010
Malaysia	13,136,109	100	17,563,420	100	22,198,276	100	27,565,821	100	2.64	2.6	2.17
W.P Kuala Lumpur	919,610	7	1,145,342	6.5	1,305,792	5.6	1,627,172	5.9	2	1.46	2.2

(Source from: Department of Statistics Malaysia 2011)

3. Municipal solid waste generation and composition in Kuala Lumpur.

The main compositions of MSW in Kuala Lumpur were founded are food, paper, and plastic which most of 80% of the waste by weight. The data for waste composition in Kuala Lumpur were based from data gathered from

Alam Flora and previous research project. Municipal solid waste in Kuala Lumpur is produced from varies sources such as high, medium and low-income residential households, institutional, commercial, and other sources. A recent data on MSW composition in Kuala Lumpur cannot be obtain due to lack of available data provided by the municipality and

only previous pilot plant done in 2003 is available. The average composition of MSW generated by various sources in Kuala Lumpur are summarised in Table 2. This table shows residential areas has contribute most of the MSW in Kuala Lumpur, up to 60% of food /organic wastes. Low income residents in the main contributor for food waste because they

tend to cook and eat in their houses compared to high income residential likely to eat in a restaurant due to a busy lifestyle. The organic compounds cover up to 85 -90 % of the MSW in Kuala Lumpur and another 10% is inorganic compounds.

Table 2: Average Municipal Solid Waste (MSW) composition generated in Kuala Lumpur

Composition	Sources				
	Residential high income (%)	Residential Medium income (%)	Residential low income (%)	Commercial (%)	Institutional (%)
Food/organic	30.84	38.42	54.04	41.48	22.36
Mix paper	9.75	7.22	6.37	8.92	11.27
News print	6.05	7.76	3.72	7.13	4.31
High grade paper	-	1.02	-	0.35	-
Corrugated paper	1.37	1.75	1.53	2.19	1.12
Plastic (rigid)	3.85	3.57	1.90	3.56	3.56
Plastic (film)	21.62	14.75	8.91	12.79	11.82
Plastic (foam)	0.74	1.72	0.85	0.83	4.12
Pampers	6.49	7.58	5.83	3.80	1.69
Textile	1.43	3.55	5.47	1.91	4.65
Rubber/leather	0.48	1.78	1.46	0.80	2.07
Wood	5.83	1.39	0.86	0.96	9.84
Yard	6.12	1.12	2.03	5.75	0.87
Glass (clear)	1.58	2.07	1.21	2.90	0.28
Glass (coloured)	1.17	2.02	0.09	1.82	0.24
Ferrous	1.93	3.05	2.25	2.47	3.75
Non-ferrous	0.17	0.00	0.18	0.55	1.55
Aluminium	0.34	0.08	0.39	0.25	0.04
Batteries/hazards	0.22	0.18	-	0.29	0.06
Fine	-	0.71	2.66	0.00	0.39
Other organic	0.02	0.00	-	1.26	1.00
Other inorganic	-	0.27	0.25	-	8.05
Others	-	-	-	-	6.97
Total	100	100	100	100	100

(Source from : Kathirvale, et al. 2003)

Kathirvale et.al (2003) has reported, the calorific value for MSW in Kuala Lumpur is about 2200 kcal/kg, whereas it is low in comparison to other places in Malaysia, due to higher organic content/wet waste. Table 3 from the previous pilot project shows the various data on the characteristics of Kuala Lumpur MSW. The weight of moisture content for MSW is 55.01 per cent, this contributed on complexity for solid waste treatment, especially for incineration due to high energy required.

In year 1970, Kuala Lumpur has generated 98.8 tonnes per day of MSW and it is increased to 3,478 tonnes per day in the year 2005 (K, et al. 2002). MSW generation in Kuala Lumpur

from year 1970 to 2005 is shown in Table 4. The increased of solid waste generated is corresponding to the population and rapid economic growth in Kuala Lumpur. Alam Flora Company has reported, domestic waste collection for year 2008 is 677,930 tonnes per year and about 25,614 tonnes of the waste is illegal dumping generated by household areas and commercial areas.

Table 3: The characteristics of MSW Kuala Lumpur

Proximate analysis (wet)	Weight %
Moisture content	55.01
Volatile matter content	31.36
Fixed carbon content	4.37
Ash content	9.26
Heavy metal (dry)	ppm
Chlorine	8.84
Cadmium	0.99
Mercury	0.27
Lead	26.27
Chromium	14.41
Other parameter	
Bulk density (kg/m ³)	240
Net calorific value (kcal/kg)	2180

(Source from: Kathirvale, et al. 2003)

Table 4: Total MSW generated in Kuala Lumpur from year 1970 to 2005.

Year	Population in Kuala Lumpur^a	MSW generated (tonne/day)^b
1970	451 801	98.8
1980	919 610	310.5
1990	1,145 075	586.8
2000	1,297 526	3,070
2005	1,458 790	3,478

Source: ^a World Gazette and ^b(K, et al. 2002)

4. Current MSW management in Kuala Lumpur

The management of municipal solid waste in Kuala Lumpur was handled by Kuala Lumpur City Hall and it has been privatized to Alam Flora Company and other concessionaires in January 1997. The privatisation of solid waste management is applied to control and manage the waste collection and disposal to proper and legal sanitary landfill. The concessionaire also responsible to supply communal bins for public use, manage waste collection along with schedule, used the cost effective and efficient solid waste management system and promote educating the public for proper handling and waste storage. It has been reported that before solid waste management was privatized, most of MSW was disposed to open a landfill and create a lot of environmental pollution especially to groundwater cause by the absence of ground cover and improper landfill design.

4.1.0 Waste collection

A collection rate in Kuala Lumpur is 80 percent and using labor intensive and motorized floats for collection and transport. Municipal solid waste collection in residential areas is a door-to-door collection whereas households need to place their rubbish in plastic bags and put it in garbage bin in front of their kerbsides for collection. Usually the collection time for solid waste in residential areas is twice or thrice a week for terrace, bungalow and semi-D houses. While for commercial and institutional areas, MSW was collected from containers and communal bins everyday and it was paid directly to private solid waste contractor. Compare to residences areas, resident need to pay for collection services through annual house assessment. Local authorities set up the tariff rate for MSW management after consulting the private service providers. Usually, hauling and compaction trucks are using for daily collection and transportation.

Currently about 95 percent of MSW is transported to transfer station located in Taman Beringin before is dumped into Bukit Tagar Landfill in Hulu Selangor. Meanwhile another 5 percent of MSW is recovery either through recycling as reported by the Ministry of Housing and Local Government. However, according to the Draft KL City Plan 2020, 40% of total waste generated must be recycled and target solid waste generation must be reduced to 0.60 kg/d in the year 2020.

Each trailer carried 20 tonnes of compacted MSW from transit station and makes 80 trips a day. As mentioned in Solid Waste and Public Cleansing Management Act 2007, there is no specific provision for disposal hazardous waste generated by households and any contractors handled MSW need to be licensed, controlled, scheduled and dispose by approval facilities. Incinerator facilities had been planned to be built in Kampong Bohol, Kuala Lumpur or Broga in Semenyih, Selangor but the protests from nearby residents make the project imminent till now.

4.1.1 Recycling activities in Kuala Lumpur

The Malaysian government has announced on November 11 every year as National Recycling Day started in 2000. However, the practices of recycling activities among the community especially in Kuala Lumpur is not very successful due to lack of management and public awareness. Malaysia didn't have a special act regarding to recycling activities like in Germany, whereas they have 'Dual System' for every waste generated. Even though there are voluntary waste recycling and safe disposal programs was implemented but the busy lifetime, lack of public awareness, and poor legislation, contribute to the high amount of potential recycled waste being dumped into dustbin. From the 30% of potential garbage can be recyclable, only three to five percent of MSW is recycling and other were dumped to landfills, in drains or abounded properties. As overall recycling method and management in Malaysia is not well-organised and recycling bins is only provided in several places and not in every houses as applied in UK and Germany.

The task for recycling MSW has taken by scavengers, municipal collection workers, middleman, traders and manufacturers. Scavenging has played the main role in collecting vendible things from garbage bins or landfill sites and sales to sub agent /middleman for traders and manufactures purposes. Lack of health and safety among scavengers and municipal collection workers contribute to health problems and hazards. The high amount of recycled items (such as glass (1352 tons/day) , paper (2097 tons/day) and plastics (315 tons/day)) offered by sub agents and middleman effect on massive present of scavengers (Siwar , 2008). Roughly, in Malaysia, scavenging activities provide an income for scavengers around MYR 900 to MYR 1500 per month.

5. Current Problem Of Municipal Solid Waste in Kuala Lumpur

Municipal solid waste management in Kuala Lumpur has posed a lot of problems regarding management, government policy, public awareness and environmental pollution, which effect on human health. The rapid pace of development in industrialization has contributed to this problem and the deed of improving the quality of the environment is the main emphasis

in order to reduce pollution. Until now, the Malaysian Government has received many criticisms and reports regarding to this problem. There is several factors contribute to the problem in MSW management in Kuala Lumpur, as follows:

- There is less involvement from public to improve a quality of MSW treatment and disposal infrastructure.
- Delay on amendment of appropriate legislation effect on delay of federalization and privatization of MSW services
- There is no clear information and implementation of MSW legislation to the concessionaire and communities.
- There is no appropriate location for site treatment plants and disposal sites due to limited spaces.
- Less public attention on MSW activities and environmental effect.

6. Malaysian Solid Wastes Legislation

Nowadays, in Malaysia, solid waste management become as the most extremely issue plays over around the country besides others. This critical situation was contributed to the implementation of National policy by government, which mainly focused to the establishment of comprehensive, integrated, cost-effective, sustainable, and socially acceptable of solid waste management. Meanwhile, that policy also has stated that the priority is given to waste reduction through the 3R program, intermediate treatment and final disposal in order to improve the solid waste management system (Yahaya, 2007)

In Malaysia, there is no Federal and state legislation deal specifically with all aspects of Municipal Solid Waste. Before July 2007, only four relevant act directives deal and concerns with solid waste, namely Local Government Act (1976), Street, Drainage and Building Act (1974), Town and Country Planning Act (196) and Environmental Quality Act (1974). Started from July 2007, Federal Government has developed Solid Waste and Public Cleansing Management Act to rule all the issues regarding to the management of solid waste and public cleansing all over the peninsular Malaysia. It was developed to administer and impose the solid waste and public cleansing laws and meantime other three earlier laws were

restructuring to accommodate these deviations authority.

Further down on Solid Waste and Public Cleansing Management Act 2007, all annual property taxes paying by house owners to their local authorities for collection and disposal by local governments was reassigned to the new Solid Waste Management Corporation to pay for the service operator and their contractors. The Federal Government also agreed to revise and give a funding capital investment to improve transfer stations, landfills, and incinerators. The Act is inclusive all collection and disposal of solid waste from all areas including commercial area, public sites, construction sites, households, industrial zones, and institution. However, the Act did not have a specific requirement for disposal hazardous waste generated by households and other non-industrial sources. During development of this Act, Malaysian Government had realized that solid waste

management cannot be handled alone. Therefore, it has been privatized in order to increase the productivity in solid waste management. There are three concessionaires were hired and each operating in one of the three regions that cover peninsular which controller by Solid Waste and Public Cleansing Management Corporation. The main role of Solid Waste and Public Cleaning Management Act 2007 is to ensure all the basic system is in place and work efficiently rather than set up a provisions for 'pays' funding or requirement of mandatory waste separation at source. Under new legislation started from 2008, all solid waste lifecycle need to be licensed and every stages or point of solid waste initiating included its travel path, mode of transport, collecting and transporting agency, and place of disposal will be controlled and schedule. Figure 1(a) and 1(b) show the comparison between solid waste management system to 2007 and from 2008.

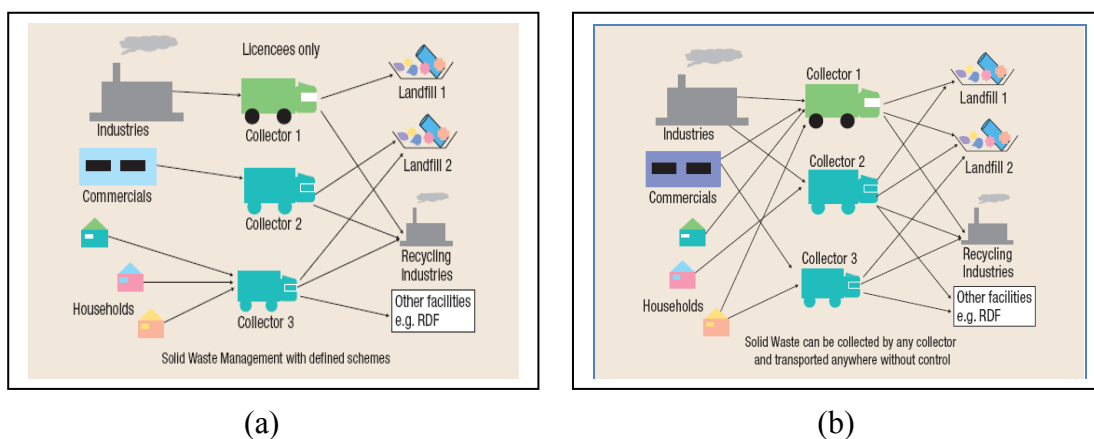


Figure 1: (a) Solid waste management framework to 2008. (b) Solid waste management framework to 2007. (Source from :United Nations Development Programme, 2008)

7. Strategies and action plan to improve MSW management in Kuala Lumpur.

7.1.1 Improved Waste Storage, Collection, Transportation and Disposal System

A good and effective solid waste management system must complete several criteria such as a well-managed storage, collection, transportation, and disposal system. It needs to be improve and well monitoring to ensure it can achieve a sustainable MSW management.

a. Storage System

The several actions can be done to provide a good storage system for MSW, as follows:

1. Determine the types and quantity of solid waste generated by the resident/customer (done by concessionaires). Future waste generation can be estimated by multiplying several factors such as the amount of waste generate , population growth, and the numbers of years of the landfills will be in operation.
2. Determine the need of the resident or customer on MSW management and

give immediate action on the report / complaint done by the resident/customer.

3. Provide more recycling bins nearest the waste container to convenience resident/customer for sorting their waste into the right bins and reduced amount of waste dumping to the landfill.
4. A stringent enforcement from local authorities to citizen of prohibition of illegal dumping.
5. Regular monitoring from local authorities to residential areas to verify any lack of utility or services provided from the contractor.
6. The concessionaire / contractor must always monitor a report or data of the population growth and waste generated to ensure it can provide an efficient service and adequate container to the areas.
7. Revised the legislation on types of waste can be disposed and cannot be disposed on the regular trash bin to prevent from contamination of hazardous waste into landfill sites.

b. Collection and Transportation System

Hot climate and high humidity in Malaysia also cause a lot of problems to MSW due the high composition of organic waste content. Irregular collection time and uncollected waste during festival season also cause odor and existing of flies and insect in the waste. These not only harm to human health and create an unpleasant environment but also contribute to blockage and flash flood. As mentioned, MSW collection in Kuala Lumpur is collected twice or thrice a week in residential areas and every day in commercial and industrial areas. However, the time collection is not mentioned and always changed. Sometimes it is done during the night or afternoon and worse it's not collected. Consequently, the best time for waste collection is early morning like 5.00 a.m. to 7.00 a.m. or maybe at night because it can prevent congestion because people started to working and come back from working at the peak time. The concessionaires must organize the collection schedule especially during the festival season to prevent from uncollected waste. The truck/lorry

maintenance must be done regularly to ensure it can work properly. While to prevent illegal dumping from poverty areas, a discussion within local authorities and resident regarding fees or may be government can subsidize half of the fees in order to reduce the burden from this community. Therefore the waste collection can be done and reduce the problem of illegal dumping.

There is a lot of planning can be prepared to provide an efficient waste collection and transportation system in Kuala Lumpur, including:

1. Customize the types of lorry/truck can be used according to the areas. Example: Only lorry compactor is used to collect waste from residential areas in order to prevent or reduce odour and leachate problems.
2. Encourage and educated communities segregate and recycling their waste. It is can help to solve an excessive waste collection for landfill disposal.
3. Provide different coloured of plastic bag (same as implement in Hamburg, Germany) to communities/customer for sorting the waste and it can easiness the user to segregate and promote recycling.
4. Organized the suitable time for waste collection depending on residents or customer needed and inform resident or customers about the schedule. Therefore, residents or customers can be more alert and prepare for waste collection time. This can be done by providing a web or template to inform any changes or improvement done by contractors such as SRH company applied in Hamburg, Germany.
5. The government gives more funding or loan to concessionaires or contractor to improve the transport system for waste collection.

c. Disposal System

In Kuala Lumpur, the only method used for solid waste disposal is landfilling. Recently, a landfill system for Kuala Lumpur was improved by implementation of state-of-the-art-technology facilities with proper management in new Bukit Tagar landfill. However, due to the rapid growth of

migration and population in Kuala Lumpur and active economic development can cause more MSW produce especially packaging waste and organic waste. Therefore, Bukit Tagar landfill cannot take the duty alone without other options for treatment and disposal MSW in Kuala Lumpur. Local authority and government need to think other options than landfilling in order to manage MSW in Kuala Lumpur due to scarcity of land and to reduce cost for maintenance and transportation the waste. Composting, incineration, recycling and RDF (Refused Drive Fuel) can be used to help with reduction of MSW in Kuala Lumpur and reduce the burden of landfill. However, political issues always affect on the development of new technologies. Lack of education and exposure about the benefit of new technologies to community and NGO's reflect on implicated of some parties to provoke people. As a result, no development is done like happens on construction of incineration in Kampung Bohol, Kuala Lumpur and Broga, Semenyih. In view of that, government need to be more alert on this problem and give more exposure to people about the benefit and impact of each technology in order to help on reduction of waste and protect environment. Other than that, the construction and implementation of other technologies can help on prevention of illegal dumping. Most of the developed countries like Denmark, Netherlands, Germany, France, and Austria have banned landfilling as one of disposal methods for MSW. This is because landfill not only contaminates soil and groundwater but also promote on greenhouse gases and environmental pollution. Implementation of separation from the source (e.g. Austria and Germany are the best examples) is the best method to reduce biodegradable waste sent to landfill.

7.1.2 Recycling Option

Several steps and strategies can be done to improve recycling activities in Kuala Lumpur, including:

STEP 1: Revised Solid Waste legislation by adding some act regarding recycling activities such as 'Dual System' and

packing ordinances done in Hamburg, Germany. By adopting this ordinance, the producer will take responsibility to take back the packages and reduce the amount of the waste with the Eco friendly recovery. Local authorities can categories every waste generates into several categories and label them depending on it's potential. As the example in Hamburg, Germany wastes are categories into ABC waste and types of disposal method.

STEP 2: Enforcement from local authorities regarding the types of waste will be collected and must be recycled. The execution of PAYT (Pay as You Throw) can help the success of recycled activities because users or households will recycle much more items to avoid from paying the tariffs for every wastes generated for collection. In Taipei's , PAYT has reduced the volume of waste to 35.08% and increase recycling activities to 2.6 fold from 1999 (Wikipedia ,2009). It has also helped the government and local authorities to cover the cost of solid waste disposal and increase the performance of MSW management.

STEP 3: Educated and encourages people about the advantages and how to recycle. It can be done starting from children in kinder garden to old people. Cleary describes to them about the types of wastes can be recycled by giving them templates and campaign in the media. In the United Kingdom, a template about recycling battery and electrical items is distributed together with a recycled bag every month.

STEP 4: Sorting from generations points by resident and stakeholders. Implement curbside collection for waste separated by resident. This can help on reduction of waste need to be transfer to landfill and reduce the amount of illegal scavengers.

STEP 5: Provide different colors of bucket to every house of the customer / resident for recycling purposes and collect it every week. Such as in United Kingdom's, two types of bucket (Green for paper or magazines and purples for glasses, plastic and tin) are provided in every house in the UK. While in Hamburg, Germany several colour of container are provided depending

on, it types of potential recycling waste. For other potential recycling such as cartridges and clothes, a different plastic bag is supplied every month for every house.

STEP 6: Provide a several recycling centre in each areas and inform a location and time of duty to the communities and effective way to do it is through web site and templates.

For this moment, recycling activities in Kuala Lumpur is done through collection by scavengers, municipal collection workers, intermediary, traders, and manufactures. This method not only require long period but also unsuccessful among the communities in Kuala

Lumpur. By implementation of source separation, it can help to achieve targeted reduction on biodegradable municipal solid waste dumped into landfill and reduce tendency of health problem among scavengers during collection on landfill. The opening of more MRF (Materials recovery facilities) also can assist on further separation and consolidation of recyclable material using high technologies facilities. MRF also can recovery material that can be used for composting or Refused Derived fuel to generate power. Figure 2 shows a recycling process can be done for this option in order to make it realised and cooperation from local authority and concessionaires will make it much more easily.

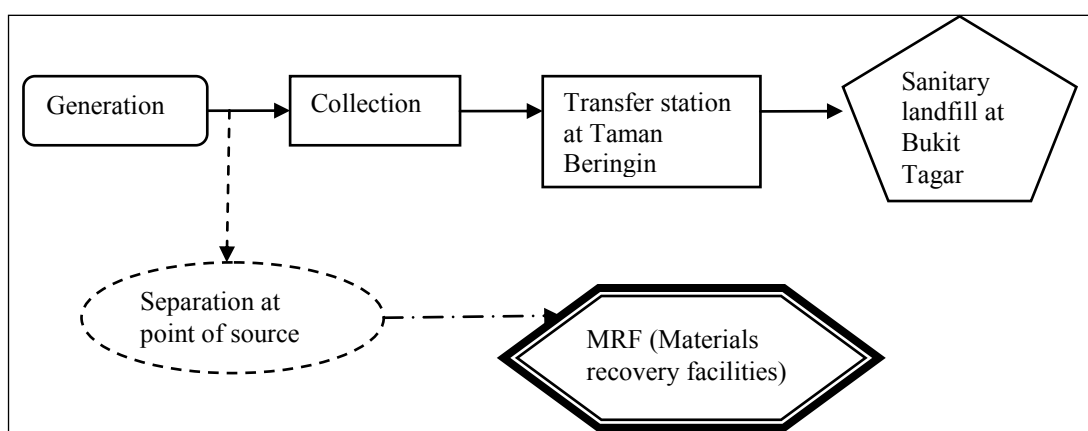


Figure 2: Recycling option for Kuala Lumpur

7.1.3 Composting Option

In Kuala Lumpur, composting is not familiar option chosen for MSW management even it is the easier option to apply and produce a good compost, soil conditioners, and fertilizers for landscaping and gardening activities. This option can be done in small scales such as at backyard and neighbourhood or large-scale centralized facilities. This method not only can reduce the amount of biodegradable waste especially Kuala Lumpur has produced high amount on organic content (approximately 45% from the total MSW) but also promote on separation of waste at point of source and low cost for operation. On the other hand, this option has been successfully practiced in Germany, Austria, and other countries.

Several strategies are required making it successful, which is:

1. Banned the disposal of biodegradable and organic waste into landfill. This was

implemented in Germany and the application of PAYT and Dual system can assist in the reduction of waste generation and encourage separation at point source.

2. Gather cooperation from households, food outlets (such as food stalls and restaurants), markets, schools, and hotels to separate at point source.
3. Do an educational campaign to show the benefit of composting and how doing it to citizens. Supervise and educate staff about composting technologies in order to produce quality feedstock.
4. Build more composting plant and for cost effective built it near the transfer station to reduce transportation costs.
5. Survey the market for compost and promote it or do a collaboration with potential companies to market it.

Nevertheless, some detailed considerations need to be specified before it can be implemented in

Kuala Lumpur like research on facilities areas, types and quality of inputs stream, management cost (including collection, transportation and handling costs) and also market development. All these detailed are important because it can

affect on the effectiveness and functions of composting technologies in Kuala Lumpur. Figure 3 shows the composting option suggested for Kuala Lumpur.

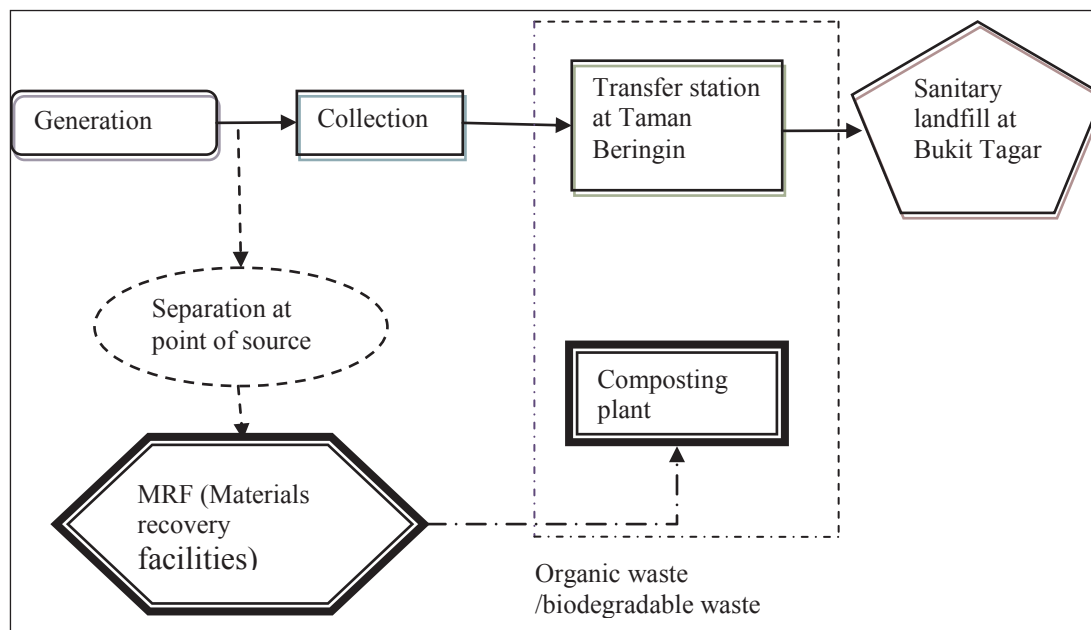


Figure 3: Composting option in Kuala Lumpur

7.1.4 Incineration Option

Incineration is the most expensive and high maintenance option for MSW management. Conversely, it can solve problem due to scarce land areas in Kuala Lumpur and provide energy recovery for electricity. However, the incineration project is not a new thing for Kuala Lumpur because in 2006, this project had been most controversy issues and received a lot of protest from resident and NGO's (Non Government Organisation) until it had been called off by government. If this project is successfully, it will cost RM 1.5 billion (Malaysian ringgit) and received about 1,500 tonnes waste per day which is can solve and reduce the waste transfer to landfill. The biggest affect of the cancellation of incineration project in Kuala Lumpur is because government did not involve and consult resident before it has been planned and most of the resident and NGO's are not clearly understand on the purpose of incineration to waste management and still believed it is dangerous and harmful to human health due to emissions production. In United Kingdom, Environmental Agency (EA) and Scottish Environment Protection Agency

(SEPA) had regulated MSW incinerators under integrated pollution control (IPC) regime and limit on substances released to environmental and control the operation of incinerator. The application of some standards to incinerator also can reduce the pollution produce.

Incinerator technology has several benefits compared to landfill such as reduced the 85 to 95 % volume of combustible solid waste, provide energy recovery for electricity and district heating, gas emissions production are controlled, bottom ash can be reused as aggregate in construction and no long term liabilities. In spite of that, several issues regarding the incinerator should consider such as high costs and maintenance for operating, required skilled staff for operation, public perception on health effects and need long term waste disposal contracts.

If all this issue can be solved than implementation of incineration with energy recovery or known as 'energy from waste' (EfW) or 'waste to energy' (WtE) can reduce the production of waste, reuse, recycling and recovery the waste generated and pursue the

waste hierarchy policy. Therefore, this option can be prioritized event it can cause a lot of money and required high maintenance.

7.1.4 Refuse-Derived Fuel (RDF) Option

Refused Derived Fuel (RDF) is also known as solid recovered fuel/ specified recovered fuel (SRF) is the process involve separation of non combustibles such as dirt, glass, metals and wet organics waste from MSW to produce fuel value of the waste. The residual products produced from this process can be either in form of palletised or other form to ease storage and transportation of the product. The products can be sold for recursive recycling process, manufacturing uses, sources of fuel for coal power plants, cement kiln industry and fed into plasma arc gasification and pyrolysis plants depending on the process of treatment. In order to provide effective RDF plant in Kuala Lumpur, several improvements need to be considering such as:

1. Application of waste separation at source to improve the operation of RDF.
2. An effective recycling activity to prevent or reduce the entrance of non-combustibles and hazardous waste such as battery to RDF plant and prevent explosion from happens during process.
3. Commercial consideration for RDF marketing to final users. A refused from final users will impacts on failure of RDF as an MSW disposal strategy.

In Malaysia, RDF is still unknown technology and did not have a commercial entity to Malaysian market for RDF file .An effort from government and local authorities is needed to support and introduce this technology to communities in Malaysia especially in Kuala Lumpur. This option is reliable for long-term actions due to limited areas for landfilling and production of energy recovery for future use.

8. Conclusion

There are many other MSW strategies can be develop to achieve an excellent MSW management in Kuala Lumpur, but a detail investigation must be carry out to prove it. As overall, this study has accomplished the objective and aim of this research. For the first step to prepare MSW management in Kuala Lumpur as good as Germany and European countries, immediate action plant must implement as soon as possible and pilot project for selected options should be perform. As mentioned, MSW disposal in Kuala Lumpur is only depending on Bukit Tagar landfill, which is not enough to accommodate MSW in Kuala Lumpur in future. Therefore, several action planning has suggested for immediate strategies and Refuse Derived Fuels (RDF) together with recycling methods is recommended for long-term improvement. Additionally, Integrated Solid Waste Management approach can be implementing to provide efficient MSWmanagement and pursue the objective of this study.

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