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Municipal Solid Waste Management in Malaysia: Current Practices, Challenges and Prospect

Mohd Dinie Muhaimin Samsudin[a], Mashitah Mat Don[a*]

[a]*School of Chemical Engineering, Engineering Campus, Universiti Sains Malaysia, 14300 Nibong Tebal, Penang*

*Corresponding author: chmashitah@eng.usm.my

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Graphical abstract

Year	Kuala Lumpur Population	Solid Waste Generated (tons/day)
1998	1 446 803	2257
2000	1 787 000	3070
2005	2 150 000	3478

Abstract

Over the past decade, generation of municipal solid wastes (MSW) in Malaysia has increased more than 91%. However, MSW management in Malaysia can be considered relatively poor and disorganised. The most preferred of MSW disposal method in Malaysia is through landfilling due to several factors. This method is not sustainable and brings a lot of problems. This paper reviews the characteristics of Malaysian MSW, reports the current practices of MSW management, and provides some suggestions to improve MSW management system in Malaysia.

Keywords: Municipal solid wastes (MSW); MSW management; waste to energy; renewable energy

Abstrak

Beberapa dekad yang lepas, penghasilan sisa pepejal awam di Malaysia telah meningkat lebih dari 91%. Bagaimanapun, pengurusan sisa pepejal awam di Malaysia boleh dianggap buruk dan tidak teratur secara umumnya. Langkah bagi pelupusan sisa pepejal awam yang paling mendapat pilihan adalah melalui tapak pelupusan sampah disebabkan beberapa faktor. Kertas ini menyemak ciri-ciri sisa pepejal di Malaysia, melaporkan praktik semasa dalam pengurusan sisa pepejal, dan memberi beberapa cadangan bagi memperbaiki sistem pengurusan sisa pepejal awam di Malaysia.

Kata kunci: Sisa pepejal awam; pengurusan sisa pepejal awam; sisa ke tenaga; tenaga boleh diperbaharui

1.0 INTRODUCTION

Municipal solid waste management (MSW) becomes a great challenge in development plans throughout the world, especially in rapidly growing cities. Malaysia is one of the most successful countries in transition. Steady economic growth and low unemployment rates driven by stable political conditions and plenty of resources making Malaysia on a par as developed country [1]. Malaysia is experiencing rapid industrialisation and urbanisation giving the adverse effects on the environment from the increasing of waste generated [2]. Similar to many other countries, rapid urbanisation and industrialisation also have changed the characteristics of Malaysian solid waste generated [3]. Besides, waste generation rates also increase due to the demand of Malaysian for quality of life increases.

The main purpose of waste management is to reduce the amount of waste being produced, and as consequence reducing the disposal costs, the impact on the environment [4], and the impact on human health [5]. The typical solid waste management system practiced in developing country brings many problems [3]: (i) low collection coverage and irregular collection services; (ii) crude open dumping and burning without air and water pollution control; and (iii) the breeding of vermin and flies.

This paper attempts to review the situation of MSW management in Malaysia. With this aim, this paper seeks to: (i) identify generation, composition, sources, and types of MSW in Malaysia, (ii) the current practices of MSW management in Malaysia, as well as studies problems and challenges that arise, and (iii) identify the future prospects and potentials for development of sustainable MSW management system in Malaysia.

2.0 MALAYSIAN MSW GENERATION AND CHARACTERISTICS

At present, poor solid waste management become the prime environmental problem in Malaysia [6]. In all aspect of solid waste management system, the fundamental aspect that needs to be considered is the characteristics of solid wastes generated [3]. In characterizing solid waste stream, solid waste should be described by generation rates, composition, sources, and types of waste produced [7]. These information is necessary in order

to monitor and control waste management systems as well as to make decisions regarding regulatory, financial, and institutional actions.

Over the past 10 years, generation of Malaysia MSW has increased more than 91% [8]. In 2001, estimated 5.475 million tons of solid waste generated which is about 0.81 kg/capita/day [9] while in main cities, the figure escalated to 1.7 kg/capita/day [10]. The highest average generation rate per capita of MSW was reported in Penang at 1.1 kg/capita/day [11]. A report found that about 7.34 million tons of solid wastes were generated in Penang on 2006, enough to fill up 42 buildings [6].

The main waste generator is the urban population which is constitutes more than 65% of the total population [8]. In 1980, Malaysia population was 13,136,109, increasing to 17,563,420 in 1991, 22,198,276 in 2000, and 27,565,821 in 2010 [12]. In the Capital City of Malaysia, Kuala Lumpur, waste generation rate is growing every year due to uncontrollable consumption as the population increases, attitude towards spending and high living standard [6]. MSW generation rate in Kuala Lumpur for 1998-2005 and relationship between population and generation rate of MSW is shown Table 1. It is undoubtedly shows that MSW generation rate is proportional to the number of population.

Table 1 MSW generated in Kuala Lumpur for 1998-2005 [6]

Year	Kuala Lumpur Population	Solid Waste Generated (tons/day)
1998	1 446 803	2257
2000	1 787 000	3070
2005	2 150 000	3478

Foods, papers and plastics found to be the major components of Malaysia MSW where it covers 80% of overall weight. These characteristics reflect the nature and lifestyle of Malaysian. As economy and urbanization of a country growing, waste composition changes. Significant increase in paper and plastic composition is the most obvious change [7]. The composition of waste (percentage of wet weight) in Malaysia for 1975-2005 is tabulated in Table 2.

Table 2 The composition of waste (percentage of wet weight) in Malaysia for 1975-2005 [6]

Waste Composition	1975	1980	1985	1990	1995	2000	2005
Organic	63.7	54.4	48.3	48.4	45.7	43.2	44.8
Paper	7.0	8.0	23.6	8.9	9.0	23.7	16.0
Plastic	2.5	0.4	9.4	3.0	3.9	11.2	15.0
Glass	2.5	0.4	4.0	3.0	3.9	3.2	3.0
Metal	6.4	2.2	5.9	4.6	5.1	4.2	3.3
Textiles	1.3	2.2	NA	NA	2.1	1.5	2.8
Wood	6.5	1.8	NA	NA	NA	0.7	6.7
Others	0.9	0.3	8.8	32.1	4.3	12.3	8.4

Waste composition also influenced by other several external factors including geographical location, the standard of living, energy sources and weather [7,9]. The correlation of waste generation rate and Malaysian lifestyle was reported by Yusof *et al*. [13] as follows:

$$W = 1.120 - 0.125(DO) + 0.191(FS)$$

where

W : total daily residential waste (kg/household/day)

DO : frequency of dining out

FS : family size

The sources of MSW in Malaysia vary for each local authority area depending on city size and economic standards. In central and southern regions of Malaysia, 36.73% of wastes are household waste, 28.34% industrial and construction wastes, and 34.93% of waste comes from other sources [2]. The percentage of wastes generated by various sectors in Kuala Lumpur in 2003 is shown in Table 3.

Table 3 Waste generated by various sectors in Kuala Lumpur in 2003 [10]

Sectors	Waste Generation (ton/day)	Percentage (%)
Residential	647.1	33.6
Industry	253.4	13.2
Commercial	244.1	12.7
Office	68.9	3.6
Market	67.8	3.5
Hospital	17.5	0.9
Wood Waste – Road	143.9	7.5
Wood Waste – Park	23.7	1.2
Wood Waste – Fallen Tree	71.5	3.7
Others	386.2	20.1
Total	**1924.0**	**100.0**

3.0 PROBLEMS AND CHALLENGES

3.1 Public Awareness, Environmental Education, and Technical Skills

The way humans respond and co-operate on waste management issues is influenced by their education [5], therefore, the public's education is an essential element of the success of any waste management program [14]. In Malaysia, environmental awareness among the public generally is still not adequate. In 1988, The Government of Malaysia had introduced the Action Plan for a Beautiful and Clean (ABC) Malaysia, followed by a recycling campaign in consecutive years. However, the campaigns do not lead to a positive result due to minimal responses from the public [8]. In 2001, a recycle campaign has been launched in Penang State with the aim to encourage Penang residents to recycle at least 1% of their daily waste generated. However, the campaign with the motto of "Kembalikan Sinar kepada Pulau Mutiara" (Restore the Shine to the Pearl of the Orient) had not made a positive impact on Penang's waste management problem. The recycle bins had been misused where about 40-60% of the contents were found to be non-recycle items [11]. Generally, Malaysian still have very low awareness on the importance of involvement in recycling programs.

On the other hand, professionalism in Malaysia solid waste industry is relatively weak and poorly represented. Skills and knowledge among practitioner in solid waste management at all levels still need to be improved. Malaysia is still not capable to planning, designing, constructing and managing of solid waste management facilities and services due to insufficient number of personnel and technical capabilities. As the result, the lack of solid waste planning and financial investment in recent years has led to inadequate and poorly operated facilities [15].

3.2 Current Solid Waste Management

Many cities in Southeast Asia unable to practice good waste management due to shortcoming of several matter including institutional, financial, technical, regulatory, knowledge, and public participation [9]. Despite residential waste represents only about 30% of overall MSW, solid waste planners tend to give more attention on this type of waste [7]. A good MSW management should cover waste generated from other sources such as commercial, industrial, institutional, and municipal services as well.

The main challenges in MSW management in developing country are [16]: (i) disposal via traditional landfilling is preferable (mainly due to financial, social, and technical factors); (ii) landfill tipping fees is relatively low; (iii) technical challenge; and (iv) difficulties with leachate recirculation and gas attraction in landfills. In Malaysia, the preferred method practiced for the disposal of MSW is through landfill [3,17] and most of the sites are open dumping areas [3]. Open dumping landfill is preferable due to it is the cheapest cost and most common method to treat solid waste with high percentage of organic components [9]. Open dumping gives a lot of severe impacts on environment such as [9]: (i) surface and groundwater contamination through leachate, (ii) soil contamination through direct waste contact or leachate, (iii) air pollution through burning of wastes, (iv) spreading of diseases by different vectors like birds, insects and rodents, (v) odour in landfills, and (vi) uncontrolled release of methane by anaerobic decomposition of waste. Practicing landfill for disposal greatly exposed river water to the risk of contamination from leachate unless proper leachate management is carried out. To date, very limited data on the impact of leachate from controlled and uncontrolled landfills on river in Malaysia is accessible [17].

Besides, waste collection almost covers all communities in urban areas, but only about 66% of the populations in rural areas of Malaysia are covered [1]. As consequences, in rural areas, wastes being dumped on the streets and drains. This situation brings serious environmental and social threats like flooding, breeding of insects and rodent vectors and the spread of diseases [18]. Table 4 shows the percentage of waste treatment method applied in Malaysia.

Table 4 Waste treatment methods practiced in Malaysia [8]

Treatment Methods	Percentage (%)		
	2002	2006	Target 2020
Recycling	5.0	5.5	22.0
Composting	0.0	1.0	8.0
Incineration	0.0	0.0	16.8
Inert landfill	0.0	3.2	9.1
Sanitary landfill	5.0	30.9	44.1
Other disposal sites	90.0	59.4	0.0
Total	**100.0**	**100.0**	**100.0**

Currently, 176 landfills are in operation, while 114 have been closed [19]. The number of solid waste disposal sites in all state in Malaysia is tabulated in Table 5. As urban areas expand, new appropriate landfill sites are becoming more difficult to be located because communities are not willing to accept operation of new landfill site near their residence [9].

Table 5 Number of solid waste disposal sites in Malaysia [19]

States	Landfills In Operation	Landfills Have Been Closed
Johor	15	21
Kedah	10	5
Kelantan	13	4
Melaka	2	5
Negeri Sembilan	8	10
Pahang	19	13
Perak	18	11
Perlis	1	1
Pulau Pinang	2	1
Sabah	21	1
Sarawak	49	12
Selangor	8	12
Terengganu	9	11
Federal Territories	1	7
Total	**176**	**114**
	290	

■4.0 FUTURE PROSPECT AND POTENTIAL ON MSW MANAGEMENT IN MALAYSIA

When designing a waste management system, Malaysian's need must be recognised. Their needs may be vary for different housing types and different areas [20]. Generally, sustainable waste management is influenced by six factors [5,21]: (i) public health; (ii) environmental protection; (iii) resource value of waste; (iv) closing the loop; (v) institutional and responsibility issues; and (vi) public awareness. The Selangor State Government became a pioneer in preparing the first sustainable development strategy at the sub-national level in 2000 [22].

Typically, the conventional waste management approach, waste generation, collection and disposal systems are planned separately whereas the three operations are very closely inter-linked and can influence each other. Duly, a balance between the subsystem of manufacturing, transport system, land use patterns, urban growth and development, and public health should be considered when planning these operations [23].

In order to achieve genuine progress towards sustainability, it is necessary to propose and develop targets of a sustainable environment [24]. The targets can be an impetus for MSW management and improvement provided that they are achievable, reasonable and desirable [24,25]. Otherwise, they can give negative effects and jeopardise the waste management. Therefore, the targets proposed should have clear vision and objectives, devoid of any political agenda or interference [24]. However, from time to time, environmental knowledge and waste management changing, therefore, the targets as well as standards need to be modified accordingly [24].

4.1 Improve Public Behaviour, Awareness, and Education

In minimizing MSW, understanding public behaviour is critical. Lack of knowledge among the society and social norms often the significant obstacles that negatively affect solid waste practices [26]. The public's willingness to cooperate and participate in waste management relies on their awareness and attitude [18]. Socio-economic status and housing characteristics of the population not only affect the MSW characteristics, but also their behaviour on solid waste management [20]. Age, ethnicity, education and knowledge, attitude, skills, aspirations, and ability to change behaviour are the factors influencing Malaysian environmental behavior [11,20]. A study found that the Malaysian teenage girls are more likely to display stronger concern on environmental issues than boys and Chinese

teenagers were found to have better environmental awareness compared to Malay and Indians. However, in general, the overall level of knowledge of Malaysian teenagers is low, especially those studying in the arts stream compared to those studying in the sciences stream [27].

Improving Malaysian awareness should be given the highest priority. Environmental attitudes, behaviors and participation are highly influenced by knowledge. Thus, there is a possibility to increase public consumption behavior if public environmental awareness is improved [27]. The most effective method of educating public differs according to location, types of waste management system in use, and socio-economic factors [14]. Therefore, any education and awareness campaign planned should take these factors into account for maximum effectiveness. The decision of public education approach and methods should be tailored to the target persons to ensure its effectiveness [27]. Policies should be formulated to focus on promoting knowledge, education, and skills on environmental friendly waste management.

4.2 Waste Prevention and Minimisation

The best preference for waste management is by preventing and minimising the waste from generated. The main barrier in waste prevention is the confusion of public that waste prevention and minimisation is equivalent to recycling [28]. There are two principles in minimising wastes: firstly reducing the quantity of waste generated, and secondly adopting effective system to manage unavoidable waste [4]. The benefits of waste reduction activities are preventing the waste generation and reducing cost for waste management including cost for waste recycling, transportation, and disposal [29]. Since this the only way to reduce the growth of waste amount, waste prevention should have the highest priority in waste strategy [30].

4.3 Waste Recycling and Composting

The lowest hierarchy in product recovery is recycling [31]. Implementation of recycle campaign is a way to reduce waste disposal problem. Recycling is cheaper and more environmentally friendly alternative than seeking new landfill site, and capable to extend the lifespan of the existing landfill. Besides, the program is more economical by substituting raw materials with used materials, conserves energy, and creates jobs [11,20].

To ensure the successful of recycling, people must know how to recycle and be motivated to recycle. The procedures also must be convenient, inexpensive, and with less barriers [20]. It is estimated that, about 65% of the municipal disposed at landfill daily is recyclable materials [11]. Table 6 shows the recyclable components of Kuala Lumpur MSW. Waste recycling targeted to reach 22% of the waste generated in Kuala Lumpur by 2020. Besides recycling activity, the recycling industry in Malaysia still need to be enhanced since the Malaysian's attitude towards recycling shows positive sign but only few recycling industry is available [6].

Table 6 Recyclable components of Kuala Lumpur MSW in 2009 [6]

Recyclable Solid Waste Components	Mass (kg/capital/year)	Percentage (%)	Recycling rate (tons/year)
Mix paper	35.59	16.50	14235.00
Mix plastic	61.87	15.30	24747.00
Textile	7.12	1.30	2847.00
Rubber and leather	3.29	0.60	1314.00
Wood	2.19	0.40	876.00
Yard	25.73	4.70	10293.00
Fine	3.83	0.70	1533.00
Glass	6.57	1.20	2628.00
Ferrous	13.14	2.40	5256.00
Aluminium	0.55	0.10	219.00

One of the primary barriers to improve waste management for householders were related to the accessibility of recycling and waste management facilities. Studies found that, householders more willing to undertake recycling if they felt it was workable [32]. In 2009, there are 15 recycling centres in Kuala Lumpur, 22 in Selangor operated, and 56 in Pahang operated by Alam Flora Sdn. Bhd [19]. From ecological point of view, composting is an outstanding method of recycling biodegradable waste into compost [18] and regarded as the most suitable and utilisable method of biowaste recycling [33].

4.4 Energy Recovery from MSW

Energy is a basic need of people. In 2005, the main sources of energy supply (fuel mix) in Malaysia were crude oil and petroleum products (46.8%), natural gas (41.3%), coal and coke (9.1%), and hydro (2.8%) [34]. As the Malaysia economy grows steadily, the demand for the energy to empower the economic development is expected to increase. The energy demand was increase from 1243.7 PJ in 2000 to 2217.9 PJ in 2010 [61]. Even, Malaysia energy supply is relatively high than other developing countries [35]. In line with industrialisation and urbanisation growth, the efficient supply of energy at economically acceptable cost and sufficient quantity will be vital concern in the improvement effort in the energy sector [36].

Petroleum and natural gas is the major contributor to Malaysia's economy since the collapse of the tin market in early 1980s. In 2004, Malaysia was ranked 24th in terms of world oil reserves and the 13th for natural gas where 56% of the oil reserves exist in Peninsular Malaysia. As 1st January 2007, oil and gas reserve in Malaysia as reported by Petronas amounted to 20.18 billion barrels equivalent. At the current production rates, it is estimated that Malaysia will be able to produce oil up to 18 years and gas for 35 years. The reserve will deplete around 2030 if no new fields were found and as consequences, affecting the energy sectors [34].

Besides depleting oil and gas reserves, Malaysia also need to face the increasing of oil price. In recent years, World prices of crude oil and oil products in general have increased in volatility. Raising the oil price and limited supplies of fossil fuel together with increase concerns about global warming have created a growing demand for renewable energy sources [37]. Sustainable development becomes an important term nowadays in waste management, energy generation and rural development plans [38].

Realizing the fact that a country's economic development and progress of society rely on stable energy supplies, other energy sources should be investigated. Energy recovery from

MSW through incineration and production of renewable energy from MSW should be seriously considered.

4.4.1 Incineration

Cabinet committee formed by the Government of Malaysia had suggested incineration as an alternative to landfill for MSW treatment [39]. Incineration has been proven as an effective approach in reducing volume of MSW and also provides usable energy [40]. This technology has been used increasingly over the last 50 years in highly industrialized countries and potentially reduced the volume of waste to be landfilled approximately 75% of waste by weight and 90% by volume [41]. Currently, incineration in Malaysia mainly used to dispose clinical and hazardous waste where 100% of the wastes are incinerated [1].

There are potentials to built waste to energy plants (WtE) in Malaysia since the average calorific value of Malaysian MSW is about 2200 kcal/kg [10] while the average calorific value waste suggested for a successful operating of WtE plant suggested by The World Bank [41] must not less than 7 MJ/kg (1672 kcal/kg). However, Malaysian MSW contains high moisture content. This characteristic brings a challenge to find an incineration technology that is capable to handling MSW with high moisture content at a low operating cost [39]. Various data on the characteristics of Kuala Lumpur MSW possibly useful in the study of implementing energy recovery by incineration is shown in Table 7.

Table 7 Various data on the characteristics of Kuala Lumpur MSW [10]

Proximate analysis (wet)	**Weight %**
Moisture content	55.01
Volatile matter content	31.36
Fixed carbon content	4.37
Ash content	9.26
Elemental analysis (dry)	**Weight %**
Carbon content	46.11
Hydrogen content	6.86
Nitrogen content	1.26
Oxygen content	28.12
Sulphur content	0.23
Heavy metal (dry)	**ppm**
Chlorine	8.840
Cadmium	0.99
Mercury	0.27
Lead	26.27
Chromium	14.41
Other paramaters	
Bulk density (kg/m^3)	240
Net calorific value (kcal/kg)	2180

Incineration would be a considerable choice because the system does give high returns while the energy consumed to treat the MSW is relatively lower [10]. However, the most important issue in ensuring the successful outcome of a waste incineration projects is depending on accurate estimation of the future waste quantities and characteristics. In-depth knowledge of the waste collection area's demographic and commercial/industrial structure is required in estimating the future amount and composition of solid waste [41].

4.4.2 Production of Renewable Energy from MSW

Since Malaysian MSW contains high volume of organic matters and it is highly biodegradable, Malaysia should consider converting MSW to bio-energy. Bio-energy has several advantages not only to solve MSW generation problem and fulfil energy demand in forms of liquid and gaseous fuels, electricity and heat, but it also carbon neutral and acts as a carbon sinks as well as helps to fix and improve barren or degraded lands, improves biodiversity, soil fertility and water retention [42]. By bioconverting MSW to bio-energy, Malaysia will reduce the volume of MSW in landfill and also diversify energy sources. Malaysian MSW contains high composition of organic substances [43] potentially to be converted into biogas with the help of technologies such as anaerobic digestion. Production of bio-hydrogen, and bio-ethanol from MSW also should be considered.

4.5 Improve on Landfill System

In average, the Malaysian government spent RM0.06 for every kilogram of waste [44]. In order to provide the necessary resources to sustain good landfill practices, tipping fees may be revised, moreover, for many businesses, sending their wastes to landfill sites still the cheapest option [4]. Table 8 compares tipping fees charged in several developing country landfills. Higher fees should be charge on industries for waste disposal to increase motivation on waste minimisation [45].

Table 8 Tipping fees in several developing country landfills [46]

Country	**Tipping Fees (US$/tonne)**
Argentina	5-18
Chile	5-17
Brazil	5-18
Malaysia	1.2
Mexico	4-17
South Africa	12
Peru	5
Colombia	11
Philippines	9.7
Indonesia	1.3
China	2.5
Hong Kong	10

As a result of practicing landfill method in Malaysia, leachate could affect the quality of river water. The impact of leachate on river water could be determined by monitoring the river water chemistry and thus, the risk of contamination can also be assessed [17]. Department of Environment (DOE) regularly monitors water and air quality. 116 major rivers in Malaysia monitored regularly from 892 monitoring stations while, there are 229 sampling stations in coastal and estuarine for the assessment of marine quality [2].

To reduce environmental impacts affected by open dumping activities, open dumping landfills in Malaysia should be upgraded to engineered landfills and sanitary landfills; a landfill that incorporates a full set of measures to control gas, collect and treat leachate, apply soil cover on waste daily, and implement plans closure and aftercare after the landfill closed [46]. For a period of 2004-2020, 22 sanitary landfills are required to manage Malaysian MSW [15]. Open dumping landfill lack of some important features such as no leachate management system, geo-membrane liner system at the bottom of the landfill, clay-lined layer, a gaseous migration system, perimeter control, etc [9].

This traditional landfill brings a lot of problems such as even a landfill is closed, leachate will still be generated, and landfill gas will continue to be produced. Landfill gas contains

approximately 50% methane. Methane will contribute 2-4% of the total global GHG when released to atmosphere [46].

4.6 Role of Non-Government

Waste management cannot be handled by government alone [18]. Therefore, both government and non-government organisations (NGOs) should work in synergy to formulating and spreading educational and user-friendly strategies in order to sensitize public environmental consciousness, convey environmental knowledge and inspire the public on the importance of environmentally friendly values [27].

Privates should collaborate through Public Private Partnership (PPP) with government in developing comprehensive waste management programs. The most important factor in the success of private sector participation is the capability of municipal administrator to write and enforce an effective contract. Not only large companies or multinational companies, but the local private sector, microenterprise, or even community-based organisation can also contribute much on the solid waste services [18]. Community-based waste management could be an alternative approach when municipal authorities incapable to manage waste generated properly especially in unserviced areas. This system relies on the community to manage waste including the collection, transportation, and diversion of waste [47].

4.7 Integrated Approach

A collective effort from all involved parties is essential in the successful implementation of waste management measures [26]. A successful waste management is inclusive, fully integrated with economic and social practices, and incorporate with all sectors of society [20]. In planning the MSW management, a system with the least technically complex and most-effective solution should be preferred. In order to achieve the target, an integrated approach may be considered [7]. Integrated thinking for materials and energy recovery are the keys to waste management systems that can shift the waste sector from being the source of environmental problem to becoming the environmental problem solver [48].

5.0 CONCLUSIONS

Malaysia experienced rapid industrialisation and urbanisation over the last few decades. This situation has increased the generation and changes the characteristics of MSW. The fundamental aspect that needs to be considered in designing a sustainable MSW management system is the availability of information on the characteristics of waste generated. However, such data on the Malaysian MSW is limited. The most preferred method of waste treatment in Malaysia is by landfilling and most of the sites are open dumping areas. This method brings adverse impacts on the environment.

Proper training needs to be conducted for operators to operate equipments and sufficient funds must be allocated for MSW management since often modern landfill in Asia are remain idle due to lack of trained operator and insufficient funds for operation. Besides, landfills' effect on environment should be monitored and supervised regularly. To ensure a sustainable development of Malaysia towards achieving vision 2020 as a developed country, environmental awareness and education should not be neglected. Continuous campaign and programmes must be planned.

MSW prevention, minimisation, and recycling should be put at the top hierarchy in MSW management. Only if these approaches not practicable, then integrating of materials and energy recovery should be considered. Landfilling supposedly to be considered as the last option.

The demand for energy in Malaysia is increasing in line with steady economic growth. Currently, Malaysia highly depended on petroleum and coal as their energy sources which bring negative effect on the environment. Thus, production of renewable energy from MSW would be a good choice to be considered since Malaysian MSW contains high moisture.

In order to develop a comprehensive waste management program, all sectors should work in synergy to improve public environmental awareness, and knowledge. A collective effort from all parties is the key of successful waste management implementation. A successful waste management is inclusive, fully integrated with economic and social practices, and incorporate with all sectors of society.

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