

## IMPROVING MSW LANDFILLING SYSTEM OF DEVELOPING COUNTRIES: AN ASSESSMENT

### IN KEDAH, MALAYSIA

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#### ABSTRACT

*This article is about finding key structural and institutional adjustments that, if undertaken, would allow for realisation of continuous improvements to any municipal solid waste (MSW) landfilling system. Our analysis of the MSW landfilling systems of the developed nations had shown that every modern MSW landfilling system is comprised at least four major components that are interconnected. These four components are rules and regulations, environmental protection measures consisting of procedures, engineering, and technology, organisation and personnel arrangement, and revenues and costs. With the objective of finding what changes are necessary so as to cause improvement to the Kedah's landfilling system, data on all four components were collected. The data gathering methods that were employed included a self-administered questionnaire, field observations, and structured interviews. Our assessment of the landfilling system of Kedah yielded the following results: the majority of landfill facilities in Kedah consisted of crude open dumping operations and the contributory factors to this situation include; facility operations were not overseen by higher level of governmental bodies; badly or improperly site, design, and construction criteria; facility management by either untrained or unskilled managers; and lack funds. The structural and institutional adjustments that we think should be undertaken include development of clearer laws and re-assignment of oversight responsibilities, adoption of appropriate landfilling practices and technology, creation of landfill worker training programmes, and the development of new financing devices to pay for higher costs associated with safer landfilling technology and management. Not until all of these four adjustments have been simultaneously*

*considered, any attempts to cause improvements to the Kedah's MSW landfilling systems will only just be a temporary solution.*

**Keywords:** *Structural and institutional adjustments; landfills; municipal solid waste disposal.*

## ABSTRAK

*Artikel ini bertujuan untuk mengenal pasti pelarasan struktur dan institusi yang menyumbang ke arah pembaikan sistem pelupusan sisa pepejal yang berterusan. Berdasarkan sistem pelupusan negara-negara maju, didapati sesebuah sistem yang moden mengandungi sekurang-kurangnya empat komponen penting yang saling berhubung iaitu peraturan dan undang-undang, prosedur, kejuruteraan dan teknologi, penyusunan organisasi dan personel, dan hasil dan kos. Berlandaskan objektif untuk mengenal pasti perubahan dan pembaikan yang diperlukan oleh sistem pelupusan sisa pepejal di Kedah, semua maklumat berkaitan dengan keempat-empat komponen ini telah dikumpul menggunakan kaedah soal selidik, pemerhatian dan temuramah berstruktur. Keputusan yang didapati daripada penilaian yang dibuat menunjukkan kebanyakan sistem pelupusan di negeri Kedah masih mengamalkan pembuangan secara terbuka. Ini disebabkan oleh beberapa faktor termasuklah kurang pengawalan daripada pihak atasan, pemilihan tapak, reka bentuk dan kriteria pembinaan yang tidak sesuai, pengurusan tapak oleh pekerja yang tidak atau kurang mahir, dan kekurangan dana. Oleh itu, pelarasan dan perubahan yang perlu dibuat termasuklah pembentukan undang-undang dan agihan kuasa pengawasan yang lebih jelas, amalan pelupusan dan teknologi yang lebih sesuai, program-program latihan kepada pengurus dan pekerja tapak pelupusan dan pembentukan satu mekanisme penjana hasil yang baru. Elemen-elemen ini adalah faktor penting yang menyumbang ke arah pengurusan sisa pepejal yang lebih baik dan berkekalan.*

## BACKGROUND TO THE STUDY

Preliminary inquiries into municipal solid waste (MSW) disposal situations of cities in the developing countries exposes that available literature on this subject matter are particularly similar in at least two aspects. The first and most noteworthy resemblance is nearly every author had portrayed solid waste disposal facilities of these places were poorly managed and consequently were posing a threat to the environment. The second notable similarity is in connection with the recommendations by these authors. Nearly every study concluded that the owners or operators of poorly managed landfills need to replace their present methods of waste disposal operations with sanitary landfilling operations.

Further scrutiny of available literature on this subject matter also highlighted at least two more additional key facts. The first is regarding the problem concerning poorly managed landfills in developing countries, which is an old issue that also has long been recognised by the authorities. The second key fact is, despite the fact that authorities are aware of this issue, the situation has not changed very much. In other words, there is very little progress or improvement of the very poor state situations. One possible reason for this lack of progress is perhaps the intent of most authors is to draw attention to the solid waste disposal issue. Subsequently, the nature of data is of little utility for authorities to draw up a thorough strategy to address these issues. However, the main purpose of this paper is to furnish those categories of information that are pertinent and hopefully assist planners in not only appreciating the issues, but also to draw up a specific strategic plan to address these issues.

Another possible reason for the very slight progress, if any, in the solid waste disposal situations being achieved is connected to the fact that nearly all authors had neither approached nor offered solutions to the issue they studied holistically. For that reason, most authors were only able to recommend the safer sanitary landfilling methods and fall short in outlining what needs to be undertaken towards achieving the preferred conditions. This study was largely prompted by the following thesis. The widespread use of the unsafe method of MSW disposal by cities in developing countries and the slow progress achieved by these cities were two obvious indicators that the present MSW landfilling system of these places is not working properly. Thus, if one wishes to see a continuous improvement in the country's MSW landfilling system, the landfilling system of these places must be reexamined and adjustments be made to it.

The major objectives of this paper are listed below. It should be noted that these objectives are inter-connected, and they are;

- (1) to add information on solid waste landfilling operations of selected cities of a developing country that would be relevant for drawing up a strategic action plan, and
- (2) to propose an approach to improve the solid waste management systems.

## **LITERATURE REVIEW**

For the most part, the majority of existing work on solid waste management systems of cities in the developing countries highlights

the fact that the majority of MSW disposal facilities or landfills are being poorly managed (Rushbrook & Pugh, 1999). Terms used by these authors to describe the MSW landfill facilities of developing countries include crude open tipping, open dumping operations, and crude dumps.

While information on landfills in Malaysia is still relatively scarce, there is evidence that the issues of improper management of landfills of this country have long been acknowledged by authorities. The Environmental Protection Society of Malaysia study was perhaps the first to report the issue of improper disposal of MSW (EPSM, 1979). Following this, the Ministry of Housing and Local Governments reported much more comprehensive but more or less similar findings (MOHLG, 1988). Subsequent studies (Law, 1992; Lokman & Osman, 1992; Nasir, 1995; Jusoh, 2002) all reported almost similar findings that the majority of municipalities in Malaysia were improperly disposing their MSW.

Needless to say, nearly all authors of the reviewed articles had suggested that municipalities in Malaysia should replace their unsafe method of MSW disposal with the sanitary landfilling method. This is because the risks associated with an open dumping method of MSW and poorly managed landfills can significantly be reduced and controlled if local governments practised sanitary landfilling technology and operating procedures. Details regarding benefits and technical details of sanitary landfilling are well described in many engineering textbooks such as Tchobanoglous and O'Leary (1994), Baghi (1994), and McBean, Rovers, and Farquhar (1995).

Further review of available literature also pointed out that various levels of government in Malaysia have been attempting to improve the MSW landfilling situation for a very long time, perhaps as early as 1988 (MOHLG, 1988). Several municipalities in Malaysia had attempted to employ the sanitary landfilling method but such attempts were hampered primarily due to lack of funds (Ismail, personal communication, June 2002). Abdul Hamid (personal communication, July 2002) stated almost the same thing but he also noted that many landfilling improvement projects were short-lived and the primary reason was the municipalities were short of funds to sustain decent disposal operations.

Assuming that the authorities in Malaysia were aware of this issue some 30 years ago and that an alternative method of disposing MSW had been suggested, why then have the municipalities not made any

progress with only finance being the only issue? In other words, other than the lack of money issue, what are the major obstacles preventing municipalities in Malaysia to adopt the sanitary landfilling method of disposing their MSW?

In an attempt to discover and to understand the inter-relationships of the key components of every MSW landfilling system, it was discovered that the unsafe open dumping methods of disposing MSW was also once a major issue in the United States of America. From the work of Melosi (1982), O'Leary, Walsh, and Ham (1988), and Baghi (1994), the transformation of the US MSW landfilling system had undergone at least four distinct institutional and structural adjustments. The four adjustments were change in rules and regulations, landfill requirements requiring facilities be properly sited and designed by professional engineers and subsequently constructed by a competent team of workers, landfill requirements that requires landfills be managed by a team of competent workers or operators, and creation of new mechanisms or devices to raise funds.

It appears that the above four adjustments were sequentially undertaken and both the public as well as environmental movement groups were crucial in getting the authorities to act. The adjustments were sequential largely because most municipalities have many difficulties that included lack of funds, and lack of experienced or trained personnel, as well as knowledge on sanitary landfilling technology.

## **RESEARCH METHODS**

As this article has two objectives that are inter-connected, the first key step of this study was to determine the kinds of data that needed to be collected. From the preceding section, it was determined that there were at least four key components of the every landfilling system. Once this was undertaken, a series of discussions was held with environmental experts so as to further ascertain the inter-relationships of the four key elements of a landfilling system. A total of 10 academicians and key federal governmental officers were interviewed. For the most part, all concurred that the above four were important elements and had assisted in a greater understanding of the relationships of the four elements, which was crucial so that the quest for detailed information would be more useful in drawing up a strategic action plan. This kind of work parallels greatly with the majority of work undertaken by World Bank researchers.

The above two preliminary steps were then followed by a 12 months of field study trips to 11 municipalities in Kedah. Since the major task was first to get a complete depiction that would also let us make assessments of the current situations and conditions of the MSW landfilling system in Kedah, it was decided that a number of data gathering methods must be employed that would at least generate a set of data that would enable cross-validation of the information collected. Thus, the required information on the MSW landfilling system of all 11 municipalities of Kedah was accomplished by using both survey and non-survey data collection methods. During field work investigation, the survey method consisted of the following two instruments – self-administered questionnaire and face-to-face structured interviews. The questionnaire was mainly to gather quantitative facts of the municipalities while the interviews were conducted with key municipal officers who we thought could provide information that was needed. A list of topics for discussion was prepared ahead of the face-to-face structured interview. Our non-survey method consisted of field observations and document analysis of accounting reports, maps, annual municipal reports, etc. At most municipalities, a minimum of three municipal personnel were interviewed so as to gather the needed information.

At each municipality, a minimum of three days was spent to complete the data gathering activities. Most of our landfill site visits began early in the morning (about 8.30 am) and would end around 5.30 pm. The majority of interviews with landfill site managers or supervisors were conducted during landfill site visits. All researchers had travelled in cars to collect all of the data required and a total of 7,000 kilometers were achieved.

## KEY FINDINGS

The key findings of the study, that is, the conditions and situations, as well as landfilling practices of the 11 municipalities of Kedah in 2004, is provided below under the following subsections. Part (a) provides some selected features of the landfill facilities that we visited and inspected. Part (b) and Part (c) describe the siting and acquisition processes, and the hydrogeological and physical conditions of the 11 facilities, respectively. The rules and regulations pertaining to landfilling practices of Kedah are illustrated in Part (d) while the descriptions on construction; infrastructure and pollution prevention technologies available at each landfill are in Part (e). Part (f) and Part (g) explain landfill operating arrangement and management, and

operational practices and procedures of each landfill, respectively. The present way of raising funds to pay for SWM purposes is described in Part (h).

#### **a. Selected Landfill Features**

*Amount of waste received per day:* The daily amount of solid waste received in tonnages of the 11 facilities varies greatly, ranging between 15 and 300 tons per day. The computed average and median daily tonnages were 109.727 and 80 tons, respectively. For the most part, more than half of the studied landfills may be considered as small-scale landfill facilities, receiving less than 50 tons per day.

*Landfill size:* The landfill size in hectares of the studied landfill areas vary, ranging between less than 1 and 57.3 hectares. The computed average and median landfill size was 14.3 and 7.3 hectares, respectively. For the most part, the majority of the facilities were relatively small in size.

*Land ownership:* The previous landowners of all 11 landfills before each was developed into a landfill were the Kedah state governments, with the exception of one landfill that is still privately owned.

*Distance to main waste generation areas:* The one-way distances of each landfill to their respective main waste generation areas vary between 1.5 km and 16 km. All were found to be located within a 20 km radius from a major town.

*Landfill age and closure date:* Using year 2004 as the base year, the average and median landfill age for the 11 landfills were 16 and 16 years old, respectively. With the exception of one newly-established landfill facility, the remaining 10 landfills may be regarded as old landfills. Most municipalities revealed that they plan to use their current landfill site for at least 10 years or more.

#### **b. Site and Acquisition Process**

From the MSW directors, it was discovered that the site and acquisition process of the studied landfill facilities were very similar regarding two aspects. Firstly, it seemed that all municipalities had purposely chosen those land parcels that are owned by the Kedah state government because these state-owned lands can be obtained at no cost to these municipalities.

Secondly, in addition to the purposeful selection or targeting of state-owned properties, it appears that most selected those land parcels that can be regarded as marginal land, such as old tin mine pits, old quarries, ravines, swamplands, or marshlands.

### **c. Hydrogeological and Physical Conditions**

For the most part, the three most important hydro-geological features and conditions of any operating landfills that are of great concern were the distances of wastes with respect to the nearest groundwater bodies and surface water, and the surface drainage conditions of the completed portion of the landfills. In most situations, these three features or conditions are good indicators of the extent of water pollution that has already occurred or the potential of it happening, all of which are caused by leachate.

From the observations, it was learned that (i) wastes of 10 out of the 11 landfills visited were found to be either already contacting or near (i.e. less than 1 meter) a ground water source, (ii) of the 11 landfills, leachate and/or wastes of 10 landfills has already entered or is in contact with the nearby surface water bodies, and (iii) the surface drainage at the already completed portions of at least nine out of the 11 landfills were either draining into the site or were seen to have accumulation of water at most parts of the landfill.

### **d. Rules and Regulations**

At least three important statements about the current rules and regulations that pertain to landfill management in Malaysia and/or Kedah was obtained from the municipal personnel. Firstly, at present, neither the federal nor the Kedah state governments have yet to enact rules and regulations specifically for landfilling facilities and operations. Nevertheless, five out of the 11 SWM directors noted that they were aware of guidebooks containing recommended practices for landfills published by the Department of the Environment (DOE), MOSTE.

Secondly, all solid waste managers stated that they do not need to have permits or licenses or authorisation from any governmental agency in order to establish, construct, and operate their respective landfills. Nevertheless, the majority of the municipal directors stated that they began their landfilling operations after obtaining some sort of understanding or sanction from the District Land Office, (which acts on behalf of the state government).



Finally, all solid waste managers we interviewed disclosed that at the present time, their operations were not regularly monitored by any governmental agency. Nevertheless, conversations held with several landfill municipal workers of certain landfill sites revealed that they do get occasional visits from their immediate superiors and officials from the DOE, in particular during or after experiencing accidental fires at the landfill.

**e. Landfill Construction, Available Infrastructure, and Pollution Prevention Technology**

*Available on-site facilities:* Table 1 shows the types of on-site facilities currently available at the studied landfills at the time each was visited. From Table 1, at least one fact became obvious, that is, the majority of the studied landfill sites were lacking in many on-site landfill infrastructures considered basic at landfill facilities, such as a weighbridge, site office, clean water, etc. Of those sites that were observed to have some landfill infrastructures, it was observed that with the exception of one landfill, erection of these existing on-site facilities at all other landfill sites were mostly recently undertaken (sometime in 2002 or 2003) after each landfill owner or municipality had received a grant from the federal government.

**Table 1**  
Available Onsite Facilities at Studied Landfills as of March 2004

Facility	No of landfills*		Comments
	Without	With	
Weighing scale	8	3	One was broken at the time it was visited
Site office	7	4	
Garage for landfill equipment	9	2	
Communication system	8	3	Wireless communication or telephone network
Electricity	7	4	
Perimeter fence	8	3	Nine facilities have some control over accessibility via landfill entrance gates
Restroom	7	4	
Clean water	7	4	

\* Total number of landfills studied was 11.

From the MSW directors and operators of all 11 landfills regarding the issue of how each landfill was developed, the following three additional facts were learned. Firstly, the manner each municipality erected the main facilities now available at each respective landfill was a gradual process, i.e. constructed over time and many were not installed before the first load of wastes arrived. Secondly, installation of such infrastructures was very much contingent on availability of funds. Thirdly, while independent contractors were engaged to construct the majority of the landfill infrastructures, there was, however, one instance in which municipal workers were utilised to erect the majority of facilities now found at this particular landfill.

**Table 2**  
Available Pollution Prevention Measures at Studied Landfills, as of  
March 2004

<b>Pollution Prevention Devices</b>	<b>No of landfills*</b>		<b>Comments</b>
	<b>Without</b>	<b>With</b>	
Leachate collection system (LCS)	8	3	The LCS & LTPS is functional at only 1 landfill
Leachate treatment pond & system (LTPS)	8	3	
Landfill gas venting system (LGVS)	9	2	LGVS is functional at only 1 landfill
Stormwater diversion system	9	2	Available at only some portions of landfill

\* Total number of landfills studied was 11.

*Landfill design and technology:* Table 2 shows the various types of pollution prevention measures currently available at the studied landfills. From Table 2, it became clear that three out of every four landfills lacked the landfill pollution prevention systems that are considered vital, such as leachate collection (LCS) and treatment systems (LCTS), landfill gase venting system (LGVS), and stormwater diversion system (SDS). From discussions with landfill operators of sites that had pollution prevention systems, we also learned that the majority were uncertain whether the LCS, LTPS, and LGVP of their respective landfill facility are properly functioning. In addition, most were unable to disclose to us specific details regarding the landfill design, concepts, etc. Nevertheless, we did observe that the semi-

aerobic sanitary landfilling technology was predominantly being described at those landfills that had installed pollution prevention measures.

#### **f. Landfill Working Arrangement and Management**

Table 3 shows the existing operating and management arrangements currently being carried out at the studied landfills. From solid waste managers of the 11 municipalities, it was uncovered that although all municipalities have assigned one of their departments to administer and operate the management of solid waste responsibilities, only four have arrangement for a special unit to be fully responsible for the planning and daily operation of their respective landfill facilities. At these four landfills, several municipal employees work on a full-time basis. Other details pertaining to landfill management include:

- At four landfills, municipal workers that were stationed at the landfill site handled most of the routine daily administration work that included record keeping and inventory management. Six landfills, at the time each was visited, were unmanned. One municipality contracts out the entire of its landfill administration and operations to one main contractor while retaining supervisory function. With the exception of one municipality, the remaining 10 municipalities have always engaged its own contractors to carry out most of the needed construction work such as construction of on-site road systems, garages, etc.
- Two municipalities had hired a single contractor to undertake most of its waste disposal operations that include spreading, compacting, landfill traffic management, and application of soil cover. In addition, eight operators stated that they own the landfill equipment and carried out landfill equipment maintenance work. Three municipalities had to hire a separate contractor to supply them with the daily cover soil.

Regarding the issue of the number and the technical ability levels of the workers who were currently working at each of the 11 landfills that were studied, except for six landfills that were totally unmanned at the time each was visited, the crew size of landfill workers at the remaining five varied from two to six. Most of these landfill crew workers were also untrained workers. The majority of them revealed that they had never been given any formal training prior to or after working at their respective landfill sites. They also revealed that the know-how and knowledge that they currently possess about landfilling operations were acquired from two main channels, which are from learning-by-doing the tasks and from their fellow workers or superiors.

**Table 3**  
Landfill Management Arrangement at the Studied Landfills as of  
March 2004

Type of landfill activities	Undertaken by			Examples of work
	Municipal contractor	Municipal workers	Others	
Daily administration site	1**	4	6***	Record keeping, of inventory management.
Construction work	10	1		Construction of roads, berms, etc.
Waste disposal operations	2	9		Spreading, compacting, landfill traffic management, soil cover operations, etc.
Equipment provision maintenance	3	8		Bulldozers, and excavators, open-top trucks, including repair works, oil change, etc.
Purchase of cover soil	3	8		In cases where cover soil is unavailable onsite.

\* Total number of landfills studied was 11.

\*\*With supervision of municipal workers at site office.

\*\*\* Landfill was unmanned at the time it was visited

### **g. Landfill Operational Practices and Procedures**

Table 4 shows the basic operational procedures currently being carried out at the studied landfills. From the operators of the 11 landfills, we found that:

- five were able to at least appropriately limit their work or active area relative to the daily amount of waste each received, respectively.
- three landfills were able to compact their waste appropriately.
- three landfills practised proper application both periodic and intermediate, of final cover materials.
- nine landfill operators informed that regular inspection of incoming waste was not undertaken.

- nine landfill operators noted that they practised regular control of blowing litter.
- A total of 10 landfill operators declared that they no longer burnt their wastes, although several admitted the occurrence of sporadic accidental fire outbreaks.

**Table 4**  
Site Operational Procedures Practised at the Studied Landfills as of  
March 2004

Operational procedures	No of landfills*		Criteria used
	Appropriate	Inappropriate	
Confinement of wastes	5	6	Based on size of active area relative to daily amount of wastes received
Spreading and compaction of wastes	3	8	Based on how wastes were spread out and later compacted by landfill equipment
Application of periodic soil cover	3	8	Based on frequency, type of cover & thickness of cover application
Application of intermediate or final cover	3	8	
	Practised	Not practised	Comments
Inspection of incoming wastes	2	9	To inspect for unauthorised wastes such as hazardous materials
Control of blowing litter	9	2	
Burning of wastes	1	10	

\* Total number of landfills studied was 11.

#### **h. Costs and Revenue of Solid Waste Management Services**

Pertaining to the issue of revenues and costs for solid waste management purposes, we learnt from all 11 solid waste managers

that the provision of solid waste services has been traditionally considered as part of municipality's responsibility to provide public cleansing services. Thus, it came as no surprise that none had yet to set up an account specifically for solid waste management purposes. Such a separate account, if properly kept, would enable one to measure the efficiency of the solid waste management system.

While all solid waste managers had great difficulties in providing us with actual figures of landfill revenues and costs since no separate accounts were prepared for landfill operations solely, nevertheless, they were able to provide their best *guesstimates*. While taking note of this limitation, the following were learned.

- Furnishing of public cleansing services, one of which is SWM services (collection and disposal services of wastes) took up between 25 and 45% of their annual municipal budget.
- All funds to pay for public cleansing services were raised primarily through property taxes (most municipal officers termed such funds as annual assessment fee).
- Provision of solid waste management services is still widely regarded as public goods. As such, SWM services are therefore provided at no charge at all in the 11 municipalities. Nevertheless, three of the 11 municipalities are now charging certain users with tipping fees for disposing wastes at their landfill.
- At three facilities, the tipping fees were based on sizes of truck and not based on weight or volume of waste disposed. The remaining eight municipalities have yet to charge any tipping fees.
- While most managers noted that lack of funds was one of the major reasons for the present state of conditions and situations of the landfills, they also agreed that their municipality has very limited ability to find new source of funds to pay for solid waste management improvement purposes.
- Eight solid waste managers revealed that new landfill equipment and improvements now found at their landfill were funded mainly through federal grants, amounting between RM200,000 and RM250,000, and these were given on one-off or as needed basis.
- While each municipality determined its tipping fee structure, the rates were arbitrarily set and were based on convenience such as RM per truck basis. At one municipality, however, the tipping fee was purposefully set high so as to discourage inflow of illegal wastes. The disparity of a tipping fee structure can cause problems such as the uncontrolled flow wastes to landfill that charge lower tipping fees.

## CONCLUSION AND RECOMMENDATIONS

This article is mainly about finding the necessary structural and institutional adjustments that, if undertaken, would improve the possibility of continuous improvements to the MSW landfilling systems of the developing countries. Analysis of available evidence has established that landfills of these countries are poorly managed. During the examination of reports and documents that are available with regard to the SWM landfilling system of the developed countries, particularly the US, this paper uncovered that their MSW landfilling system consisted of at least four components. The four were rules and regulations, environmental protection measures consisting of procedures, engineering, and technology, organisational and personnel management, and revenues and costs.

So as to understand and to make an assessment of the present conditions of the Malaysian MSW landfilling system, information on all key components were collected for the state of Kedah. A number of data collection instruments were utilised that included both survey and non-survey methods. The use of a variety of data gathering instruments could help in the cross-validation of information collection and would allow us to gain maximum understanding of the present situation and conditions that pertains to Kedah's MSW landfilling system.

The assessment of the present situations and conditions yielded one main conclusion, that is, the majority of landfill facilities and its operation resembled much of those of open dumping operations. Other specific findings include the fact that many landfill facilities in Kedah (i) lack the oversight responsibilities due to perhaps unclear assignment of oversight duties, (2) have many landfills that were improperly sited and also badly designed and constructed, (3) have many landfills that were being managed by either unqualified or unskilled managers, and (4) lack of funds seem to be the most often quoted barriers that prevent municipalities in Kedah from carrying out improvement projects.

Given the present situation, it is recommended that the following structural and institutional changes to the Kedah's MSW landfilling system be made. Firstly, the enactment of clearer laws pertaining to SWM duties that allows the reassignment of responsibilities should be implemented. This would allow municipalities to have some governmental agency so that they would have to be accountable. Secondly, the establishment of training programmes related to MSW landfilling technology and operation, where they would help in

creating a pool of competent municipal landfill workers to design, construct, as well as operate landfill facilities. Thirdly, development of new financing devices to pay for the higher costs associated with the safer landfilling technology and management should be considered. Without doubt, the increase in the inflow of funds into MSW programmes would allow managers to become more confident in introducing structural and institutional adjustments.

Finally, unless the relevant authorities responsible for SWM of this country are willing to make all of the necessary structural and institutional changes that have been mentioned, any improvements that have been or will be achieved could only be temporary and would not promote continuous long-term improvements to the MSW landfilling system.

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