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Public Perception on the Current Solid Waste Management System in Malaysia: A Comparative Study of Matang Landfill and Bukit Tagar Sanitary Landfill (BTSL)

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Abstract: The key issue highlighted in this study focuses on public perception of the current solid waste management system, particularly landfill, which has been one of the most preferred methods for solid waste disposal in Malaysia. Two different types of landfill have been thoroughly investigated via case study, namely the Matang Landfill, which is an open dump site and the Bukit Tagar Sanitary Landfill (BTSL) which is a full sanitary landfill. The key methodology adapted for data collection is mainly through a questionnaire with public respondents/ community residing near the selected landfill sites as well as on-site field investigation for observation purposes. The questionnaire is consisted of solid waste management, landfill operation and management and groundwater contamination risk. In regards to solid waste management, approximately 60% of the respondents involved refused to comply with the suggestion of waste separation at home between household hazardous waste (HHW) and municipal solid waste (MSW) while 50% of respondents are willing to pay extra cost for improving solid waste management services. On landfill operation and management issue, approximately 70%- 80% of the respondents are unwilling to have landfill sites near their residence as they see vector disease as the main problem that would be caused by land filling activities. Even though they have a limited knowledge on groundwater contamination, almost 80% of the respondents involved in this study agreed that poor landfill management, especially handling hazardous chemical materials, could lead to groundwater contamination. Although they refused to comply with the suggestion of waste separation, approximately 85% of the respondents agreed that waste separation between household hazardous waste (HHW) and municipal solid waste (MSW) would minimise potential groundwater contamination risk at landfill sites.

Key words: Sanitary Landfill · Landfill · Solid Waste Management · Groundwater Contamination

INTRODUCTION

Waste can be described as material that has been used or has otherwise served its intended purpose and, for whatever reason, can or will no longer be used for its intended purpose. Waste generated by the full extent of human activities range from relatively innocuous substances such as food and paper waste to toxic substances such as paint, batteries, asbestos, healthcare waste, sewage sludge derived from wastewater treatment and as an extreme example, high-level (radioactive) waste in the form of spent nuclear fuel rods. The generation of waste has become more complex as civilizations progress. Solid waste is a by-product of human activities which tends to increase with rapid urbanization, improved living standards and changing consumption patterns. Numerous classifications of solid wastes have been proposed [1]. The increase in population and urbanization are also largely responsible for the increase in solid waste. In today's modern world, wastes vary from food waste, paper, plastics, glass, metals, hazardous chemicals, sludge from wastewater treatment plants, etc. The diversity of these refuse are increasingly becoming more complicated along with the modernization [2].

Household waste, municipal waste (MSW), commercial and non-hazardous industrial waste, hazardous (toxic) industrial waste, construction waste as well as health care waste represent a simple classification of waste into broad categories according to its origin and risk to human and environmental health [3, 4]. Municipal

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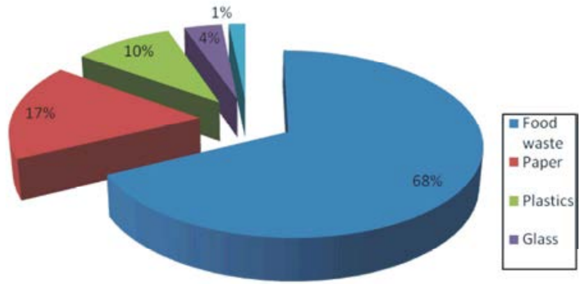

Fig. 1: Distribution of Waste Composition in Malaysia [5]

Table 1: Categories of Landfill Site in Malaysia [10]

Level	Type of Landfill
Level 0	Open Dumping
Level I	Controlled Tipping
Level II	Sanitary landfill with bund and daily cover
Level III	Sanitary landfill with leachate recirculation system
Level IV	Sanitary landfill with leachate treatment facilities

solid wastes are usually described as any scrap material or other unwanted surplus substance or rejected products rising from the application of any process; any substance required to be disposed of as being broken, worn out, contaminated or otherwise spoiled. Jokela (2002) [5] defined MSW as household waste plus other waste of a similar composition collected by (or on behalf of) the local authority. Figure 1 portrays findings generated by the Ministry of Housing and Local Government or locally known as *Kementerian Perumahan dan Kerajaan Tempatan.* It can be seen that approximately two-thirds of MSW in Malaysia comes from food waste [6]. Food wastes are usually biodegradable and thus suitable to be disposed of either at landfills or used as compost. Figure 1 also indicates that another 32 percent of MSW in Malaysia are recyclable materials such as paper, plastics, glass and metals. As MSW usually ends up in landfills, recyclable items that are non-biodegradable will result in slow stabilization rate at landfills.

The selection of disposal method is usually made based on the easiest way of doing so [7]. In the early years, the common disposal method used for SWM was by digging pits near either temporary or permanent dwellings before burying the refuse. Although there are many means of solid waste disposal, such as reducing, reusing, recycling, composting and incineration, landfilling is by far the most preferable method adapted by the public as well as industries. There are a number of landfill types, including municipal landfill and sanitary landfill. Municipal landfill is defined as a designated place to bury wastes and cover them up with soil [8]. Sanitary landfill can be defined as follows: an engineered method of disposing of solid waste on land in a manner that protects the environment, by spreading the waste in thin layers, compacting it to the smallest practical volume and covering it with compacted soil by the end of each working day, or if necessary, more frequently [9, 13]. Most of the wastes being disposed of at landfills come from homes, which are mostly organic wastes. Organic wastes such as food and kitchen wastes; paper, glass, plastics, metals, bulky items such as furniture and electronic wastes (e-waste) such as old television, computer's CPU and batteries are all dumped at landfills [5]. Due to the wide diversity of wastes disposed at landfills, all sorts of elements, compound and contaminants are expected to be found there [10].

The statistics show that in Malaysia, about 60% of generated waste are disposed of at landfills. Presently, the number of available landfills is limited and more than half of existing landfills have nearly reached the maximum capacity to receive any MSW disposal. The categories of landfill site classified by the Ministry of Housing and Local Government or locally known as *Kementerian Perumahan dan Kerajaan Tempatan* for Malaysia practice is shown in Table 1 [11]. There are about 292 landfill sites in Malaysia of which only 183 of them are currently operating [6]. Most of these sites are open dumpsites and the capacity has been exceeded. The operation of these sites has been extended due to the absence of appropriate and cost-effective alternatives to treat the waste [12]. Out of 183, 12 of the sites are classified as level III and level IV sanitary landfills while the remaining sites are categorised as open dumpsite and semi-sanitary landfills. Sanitary landfill at level II is categorised as semi-sanitary landfill where leachate or other liquid waste is not under control. Usually sanitary landfills at level III and level IV require a thorough treatment for controlled leachate and other liquid waste besides solid waste disposal.

Landfills are another major source of contamination since they are where garbage is taken to be buried. Landfills are supposed to have a protective bottom layer to prevent contaminants from getting into the water. However, if there is no layer or it is cracked, contaminants from the landfill (car battery acid, paint, household cleaners, etc.) can make their way down into the groundwater [13]. Landfills contaminate groundwater when rain water leaks into aquifers below the landfill. Many early landfills did not have liners to trap rainwater that percolates through the landfill and some newer landfills have liners that leak. The percolating water leaches toxic chemicals from batteries, broken fluorescent bulbs, electronic equipment, discarded household chemicals, paints and solvents. Although landfills now prohibit toxic waste and they are carefully regulated to prevent leakage to groundwater, many older sites are unlined and leak [14].

The environmental pollution, leachate problems, disturbing odour and opposition by the surrounding community are some challenges faced by the government before considering opening any additional landfill site. Moreover, the poor site design, inadequate compaction, lack of leachate collection and treatment system and shortage of landfill covering are also other common problems experienced in most developing countries, including Malaysia [15]. Some of the common environmental hazards from landfill operations are air pollution, water pollution and vector diseases. Poor management of the daily operational activities of a particular sanitary landfill would lead to environmental hazards that cause significant consequences to humans. Groundwater can be badly affected from poor landfill operation. Since groundwater is one of the sources for water supply, especially in agricultural and industrial sectors, this risk should not be neglected and thus this research is meant to explore the prospective risks of groundwater contamination associated with landfill activities [16]. Groundwater is recharged from and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps and can form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal and industrial use by constructing and operating extraction wells. Groundwater contamination occurs when man-made products such as gasoline, oil, road salts and chemicals get into the groundwater and cause it to become unsafe and unfit for human use. Some of the major sources of these products, called contaminants, are storage tanks, septic systems, hazardous waste sites, landfills and the widespread use of road salts, fertilizers, pesticides and other chemicals.

Since the most common disposal method for solid waste in Malaysia is landfill while groundwater contamination is the most likely risk to occur as a result of waste degradation on site, therefore the key aim of this study is to determine the perception of the public, especially in terms of their satisfaction on issues related to solid waste management, landfill operation and groundwater contamination in Malaysia. The significance of outcomes generated from this study would be important for local authority to justify whether the current operators are managing the landfills involved properly in terms of efficiency, daily solid waste management as well as the awareness of landfill operators in regards to significance and impact of groundwater contamination.

Methodology: The surrounding area of two landfill sites have been chosen for this study, namely Matang Landfill in Taiping, which is in the state of Perak and Bukit Tagar Sanitary Landfill (BTSL) in Hulu Selangor, which is in the state of Selangor. Both states are situated in the Peninsular of Malaysia. The selection of these landfill sites is made based on their differences in category classification where Matang Landfill is an open dump site landfill classified as Level I while the BTSL is a full sanitary landfill at Level IV. Perception of the surrounding community/ public has been determined through focus group's questionnaire where the target respondents were divided into three main groups: youngsters aged between 18 to 21 (Group A), working adults between 23 to 63 years old including pensioners (Group B) and others such as house wives, etc (Group C). The age group chosen are within the bracket of the working age group (15-64 years old), as stated in the Population Distribution and Basic Demographic Characteristic Report 2010, which made up of 67.3 percent of the total population in Malaysia [17]. 450 respondents involved at both landfill sites completed the questionnaire. 200 respondents were from Group A, 150 respondents were from Group B and 100 respondents were from Group C. In terms of race, 50%are Malay while the rest are Chinese (30%) and Indian (20%).

The questionnaire involved in this study is divided into three major sections; solid waste management (Section 1), landfill operation and management (Section 2) and groundwater contamination risk (Section 3). The first section is concerned about solid waste management issues, in order to acquire public opinion about the effectiveness of current practice as well as general understanding on different types of wastes and ways of handling them by the operators in their respective areas. The second section focuses on landfill matters where the opinions of the surrounding community/public are determined. The final section of the questionnaire looks into key issues related to groundwater contamination. The awareness of the surrounding community/public on the significance and impact of groundwater contamination is identified as well as community/publicviews on current on-going landfill activities, which may lead to groundwater contamination. Results generated from this questionnaire survey could be useful for local authority to determine the efficiency of current daily solid waste

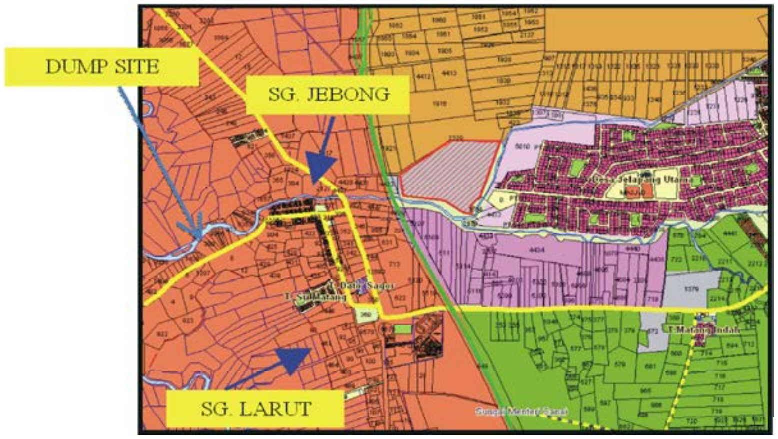

Fig. 2: Location of the MatangLandfill in Taiping, Perak

Fig. 3: Actual Condition of Matang Landfill in Taiping, Perak

management practice as well as the awareness of public and landfill operators on the significance and impact of groundwater contamination.

Study area and Site Investigation

Matang Landfill: This landfill site, which covers a total area of 50.29 acres, is located at Lot 1706 in Mukim Jebong in the District of Larut and Matang. By longitude, this site is situated at 100° 41'E and latitude 4° 49' 30" N, 8 km west of Taiping town in the state of Perak in Peninsular Malaysia.The current landfill site is located at Lot 1706 in Mukim Jebong of District of Larut and Matang, plus the adjacent areas within a 3-km radius. By longitude, this site is situated at 100° 41'E and latitude 4° 49' 30" N, 8 km west of Taiping town. The nearest river is Sungai Larut, which is about 50 m from the dump site. Geologically, the area was previously atin ore mining area. The geological formation at this site is of the quaternary period consisting of mainly recent alluvium and may contain other alluvial ore minerals [18]. Naturally, the soil consists of yellow grey silty sand with traces of gravel over a layer of dark grey sandy silty clay with average permeability of 2.55×10^{-6} m/s. Fig. 2 shows the actual location of the Matang Landfill site.

In terms of topography, this landfill site is comprised of flat and low lying land, with heights varying between 1.8 to 3.3 metres above sea level. The site was originally covered by weeds and grass. In the area between north and northwest of the North-South highway, the land is cultivated with oil palm. The south of Sungai Larut left bank is occupied by traditional Malay kampong houses and cultivated with coconut trees, oil palm and fruit orchards. The meteorological condition of the Taiping town is relatively wet and dry throughout the year due to the effect of the Northeast and Southwest monsoons throughout the year. The average volume of rainfall is about 4000 mm per year for Taiping town and its surrounding area [19]. The wind condition is generally manipulated by the northeast and southwest monsoon regimes with an average of 13.8 km/s. The average temperature is 26.8°C, with the mean lowest temperature at 26.1°C and the mean highest temperature at 35.6°C. The relative humidity of the area is between 78.3% and 84.8%. The natural drainage around the Matang landfill area has no distinct pattern with minimal surface run-off to adjacent rivers [20]. Figure 3 outlines the actual condition of the Matang Landfill on site.

Table 2: Summary of site observation results at the Matang Landfill

Site observation results
• First impression: poor sight; not enough soil cover; improper compaction
• The wastes dumped can be seen clearly and the waste complexity is visible
• Poor drainage at the site leads to leachate pooling around the site after rain (although there is a leachate collection system)
• Leachate easily escapes into the nearby surface water bodies and undoubtedly is absorbed into the ground and eventually reaches the groundwater reservoir underneath the dump site area
• There were several scavengers seen who took recyclables to sell
• There are two common practices at the Matang landfill that are bothersome: first, no soil cover during rainy days; second, excavation of the final soil cover on the next day in order to add the incoming wastes and cover them back at the end of the day.
• As a result,tt will loosen the compacted wastes and thus allow leachate to form should it rain. Additionally,it will attract birds, rodents and insects to breed.

Generally, this landfill appears to have complete facilities and necessary points that allow it to be classified as sanitary landfill level IV. However, the owner cum operator of Matang Landfill, the Majlis Perbandaran Taiping (MPT), which is a local council, has classified it as landfill level I or also known as an open dump site. The leachate collection ponds are available and uses biological treatment. Sump pits are constructed for leachate collection purpose and the site uses HDPE pipes for leachate collection. There are three ponds in total. The leachate treatment process is conducted by RA Bio Resources Sdn. Bhd. and produces effluent of Standard B quality of Environmental Quality (Industrial Effluents) Regulation 2009 [21]. It utilizes anaerobic treatment process by using microbes and crystal carbon is placed in the pond to absorb dissolved solids resulted from the anaerobic process. In terms of storm-water drainage system, several concrete drains of approximately 1.8 m in size have been constructed around the dump site. There are also banks being constructed to control surface run-off to flow into the right flow path. This surface run-off will flow into the collection pond/wetland before draining out to the nearby river. As for the final cover, it is placed on top of and around the first two phases of landfill cells to cover the wastes from exposure to the environment, control odour and prevent rainwater from infiltrating into the wastes. In terms of landfill operation, the wastes accepted here are municipal waste and commercial waste, with 250 to 300 tons of waste per day being received from around Taiping town area.

Since Matang Landfill is classified as open dumpsite level I, it is asthetically unappealing and has a poor drainage system that may lead to leachate problems. Also, there is no soil cover at the site, which may lead to leachate formation. Table 2 summarises the overview of the actual Matang Landfill from observation done on site for this case study.

Bukit Tagar Sanitary Landfill (BTSL): The Bukit Tagar Sanitary Landfill (BTSL)is situated on parts of Lots 25, 36 and 37 of Ladang Sungai Tinggi in Hulu Selangor district at the longitude of 101°28'60.00"E and latitude of 3°31'60.00"N. The waste dumping area is approximately 700 acres and the site is located in the middle of oil palm plantations. There are approximately 6 estate settlements near the landfill area. The nearest one is the Lady Mary quarters that is 1.5 km from the landfill site while the biggest settlement is Ladang Sungai Tengi, which is approximately 3 to 6 km to the south of the landfill site. This landfill site is situated within two steam valley systems surrounded by high ridges on all sides except for areas to the west and northwest. It is drained by two small streams, which flow north-westerly and converge to drain westwards. The two stream valleys are separated by low hills which act as a natural divide between the two valleys. The BTSL site is characterized by undulating to hilly terrain with elevations ranging between 20 and 210 m above mean sea level [22].

This landfill site was previously agricultural land which has been cultivated with oil palm and rubber plants. The landfill site is situated within the catchment area of Sungai Tengi and is adjacent to the North Selangor Peat Swamp Forest (NSPSF). The peat swamp forest occupies some 750 km^2 of the north-western part of Selangor and extends just west of the landfill site to the coast some 40 km away. Drainage from the site is towards the west to the NSPSF and ultimately into Sungai Tengi. The catchment area is approximately 3.26 km^2, comprising an area of 1.36 km^2 in the northern valley and 1.88 km^2 in the southern valley [23]. Seasonal variations exist of relatively wet and dry periods due to the effect of the Northeast and Southwest monsoons.The average rainfallis 2403 mm per year in the Hulu Selangor area. The wind condition around the dump site area is manipulated by the northeast and southwest monsoon regimes with an average speed of 1.5 m/s. The average temperature is 27.5°C, with the mean lowest being23.3°C and the mean highest being 32.8°C. The relative humidity recorded is 78% to 89%. Figure 4 indicates the dump site area of the BTSL.

Generally, the BTSL site is characterized by widespread thin layer Quaternary deposits overlaying predominantly low grade metamorphic bedrock.

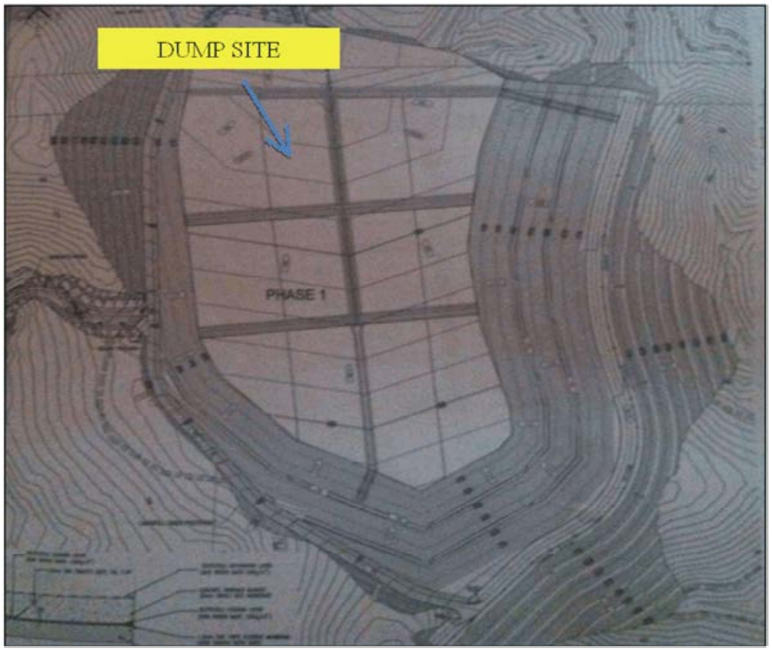

Fig. 4: The Bukit Tagar Sanitary Landfill (BTSL) in Hulu Selangor

Fig. 5: High Density Polyethylene (HDPE) cover used at BTSL

Geologically, the area is covered by a thin layer of young alluvium deposit, mostly in the stream channels, underlain by a bedrock of meta-sandstone and shale/slate/phyllite. The alluvium is generally formed by recent deposits from soil erosion of the surrounding areas. The bedrock that characterizes most of the area and intense weathering has resulted in thick soil profile over the terrain. Geological structures within the bedrock are mainly foliation and folds, in the north-northwest trend and in parallel to the regional structures. The on-site soils generally comprise 4 to 12 m thick veneer of loose to medium dense yellowish brown sandy silt and clayey silt, overlaying dense to very dense light grey clayey silt and sandy silt. The permeability of the natural soils is lower than 1 x 10^{-7} m/s or better. Groundwater conditions in the area are essentially associated with and influenced by fracture systems in the bedrock. The permeability of the bedrock carried out during soil investigation prior to landfill development [22] is in the order of 10^{-8} m/s to 10^{-7} m/s.

The BTSL, which has been classified as a level IV sanitary landfill under the categories of landfill site in Malaysia guideline (KPKT, 2010), is designed by the T&T Konsult Sdn. Bhd. where the turn key contractor is KUB-Berjaya Sdn. Bhd. This is a joint-venture project between the Malaysian Government andKUB-Berjaya Sdn. Bhd. under a long-term 30-year concession contract. This landfill site covers an area of 1,700 acres and operates as a fully-controlled dump site with all the necessary monitoring and control being exercised according to the technical guidelines published by KPKT. Figure 5 portrays the surface view of the BTSL on-site. High density polyethylene (HDPE) liners are plainly visible around the site, thus indicating that these liners

Fig. 6: Leachate treatment system at BTSL

Table 3: Summary of site observation results at the Bukit Tagar Sanitary Landfil

Site observation results
• Operation starts with wastes being brought in to the waste tipping area, where the wastes will be dumped by the waste vehicles before the spreading and compaction takes place.
• The excavators, spreader and compaction equipment are placed at the waste dumping cell.
• The tipping area is large enough to cater for multiple waste vehicles to unload and move in and out of the site.
• The spreading and compaction tasks are conducted immediately upon receiving wastes.
• Soil excavation is done the earliest to form a stockpile for final soil cover usage; landfilling method is trench method, thus excavation is the key to this approach.
• High density polyethylene (HDPE) liners are plainly visible around the site, thus indicating that these liners are used at almost every layer of the daily wastes as a prevention of leachate from migrating to the groundwater.
• HDPE liners will be used instead of soil as the final cover of the waste during rainy days to avoid leachate formation and run-offs due to rainfall, which are feared to pollute stormwater as well as groundwater source.
• The outlook of the waste cell is immaculate, organized and well-run.
• Methane (CH_4) flaring zone is created as one of the ways to manage the CH_4 gas produced, other than sending them to the energy grid.
• From the total production of 4,000 m^3/hour of CH_4 gas of the three waste cells, 50 percent of the gas is flared at 800 to 900°C.
• Leachate is monitored and managed using SCADA system, which is a fully automated system; inclusive of one raw leachate collection pond, following four aeration lagoons that apply SBR (Sludge Batch Reactor) system.
• Treated leachate is sent to a holding pond, then to a dissolve air floatation (DAF) treatment system and finally to reed beds as well as sprinkled to oil palm and rubber plantations nearby.
• There are no scavengers, birds, or scattered wastes that can be observed here.

are used at almost every layer of the daily wastes to prevent leachate from migrating to the groundwater aquifer underneath the dump site. The purpose of HDPE liners being used instead of soil as the final cover of the waste during rainy days is to avoid leachate formation and surface run-offs due to rainfall, which are feared to pollute stormwater as well as groundwater sources. The outlook of the waste cell can be best described as immaculate, organized and well-run.

The leachate collection and treatment system design in BTSL can be regarded as a secluded yet modern and well-controlled system. The leachate treatment section is located away from the dump site cell/phase area and houses a central control room (CCR) for SCADA system monitoring by the engineers and technicians in charge. The treatment system adopted is biological treatment by using SBR lagoons, which usean aeration method. There are four lagoons to cater for daily use and in addition to that, the best policy of this system is that it adopts the zero discharge policy, in which the treated leachate is used to water the surrounding oil palm and rubber trees. As mentioned previously, the leachate treatment system is driven by automated system called SCADA. This system is thus considered state-of-the-art in the nation and even in other developing countries.

In terms of leachate treatment system applied at the BTSL, the sophisticated SCADA control system ensures operator intervention requirements are minimized. The treatment process includes extensive reed beds polishing and land irrigation of treated leachate to achieve zero discharge of treated leachate from the site. The storage ponds, aeration ponds and the treatment plants have comprehensive secondary containment and monitoring system. It uses SBR (sludge batch reactor) lagoons to treat the raw leachate from the dump site. HDPE pipes are used for leachate collection. The effluent quality produced is of Standard B. BSTL adapted zero discharge policy in which the treated leachate is sent to reed beds as well as sprinkled to oil palm and rubber plantations nearby, rather than being sent to the nearby surface water bodies. Figure 6 provides an overview of the leachate treatment system used on-site at the BTSL. Table 3 summarises the overview of the actual Bukit Tagar Sanitary Landfill (BTSL) from observation done on site for this case study.

RESULTS AND DISCUSSION

The first section of the questionnaire involved the perceptions of community/public residing within the surrounding area of the selected landfill sites on solid waste management (SWM). Common questions on issues like the type of waste and the approximate quantity of waste that they produced daily as well as their general knowledge on household hazardous waste (HHW) were asked to all public respondents involved. There are three vital issues that were looked into on SWM in the first questionnaire section, namely HHW, waste separation and willingness of the public residing in the area to pay for an improved SWM. HHW is a very much neglected type of waste since most people would classify it as non-hazardous municipal solid waste as it usually comes from homes or residential areas. However, this type of waste, for example mosquito spray cans, batteries and detergents, contains harmful chemicals that can pollute the surrounding environment and thus cause health hazards to the neighbouring residents. The respondents were also asked to specify the disposal method they used in managing HHW materials plus their recycling and waste separation practices at home. It is necessary to identify the public's level of understandingon these issues as they are responsible for creating all sorts of waste, which is ultimately disposed of at landfill sites.

Figure 7 indicates the response received from public respondents involved in the questionnaire in regards to the HHW disposal method. Out of two disposal options suggested, more than 50% of respondents from all three categories preferred to sell HHW to appropriate collectorsresponsible for managing and disposing off HHW properly, rather than throwing away hazardous waste recklessly as normal garbage. This result shows that the level of awareness of the surrounding community/public on HHW is increasing and hence heading towards a positive development. By exercising good practice as a result of great awareness on the importance of HHW at home, the waste disposal process on-site at landfills can expect less complicated waste composition and volume received as well as reducing the potential impact of hazardous compounds infiltration to the groundwater source.

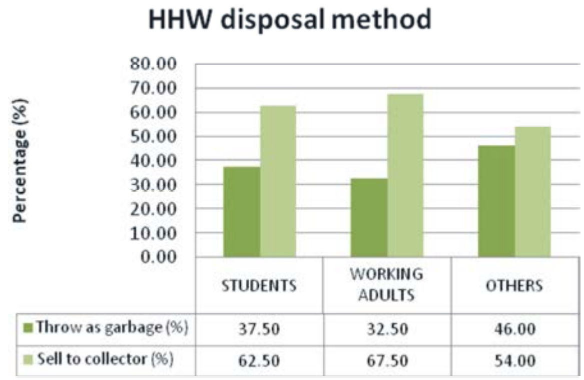

Fig. 7: Public response on Household Hazardous Waste (HHW) disposal method

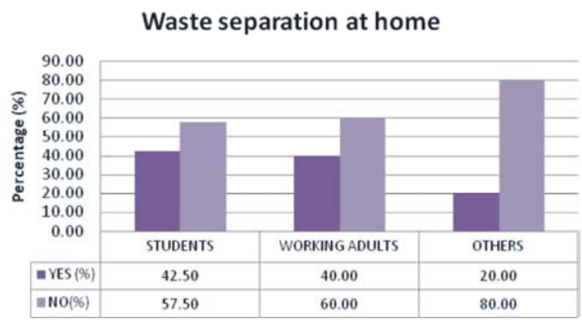

Fig. 8: Public response on waste separation at home

In regards to waste separation issue at home as shown in Figure 8, surprisingly respondents from 'other' category comprised of housewives, etc, who spend most of their time dealing with all sort of household waste, recorded the highest number of 'no' responses (80%). This figure indicated that recyclable wastes such as plastic containers, glass bottles, used papers and aluminium cans are mixed together with other organic kitchen waste and disposed of as normal municipal waste. This waste separation is a very important practice at home in order to ensure that waste volume and also waste complexity received at landfill can be reduced significantly. If only organic wastes are sent to the landfills, chances of faster decomposition of wastes will

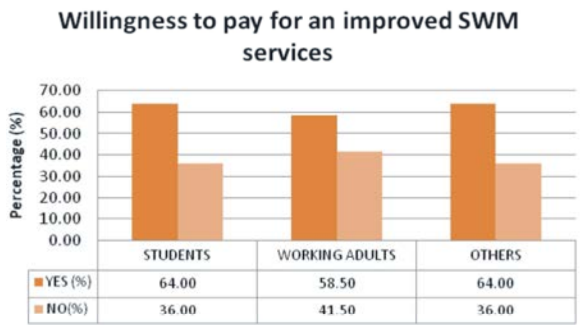

Fig. 9: Public response on willingness to pay for an improved SWM

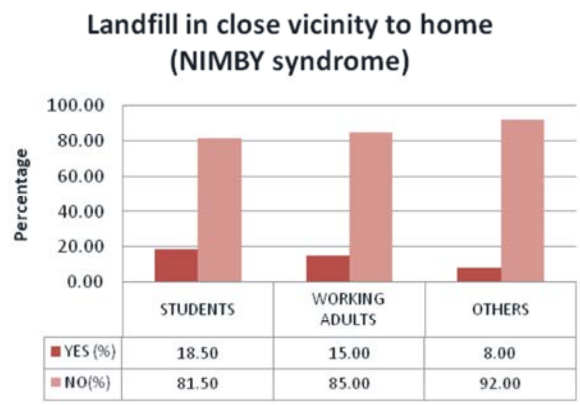

Fig. 10: Public response on having a landfill near home

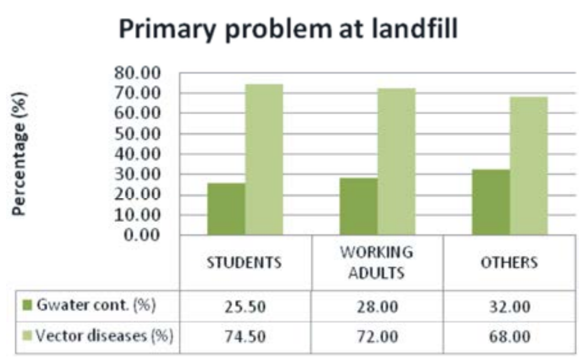

Fig. 11: Public response on primary problem at landfill

exceptionally increase and thus reduce the total waste volume, which will subsequently enhance the lifespan of a specific landfill.

Figure 9 shows the survey results achieved in regards to pay-as-you-throw (PAYT) issue. Most of the public respondents involved seem unwilling to pay extra money for additional or so-called 'improved' SWM services. Even the working adult category also refused to pay for an improved SWM service, which is supposedly more efficient in terms of waste collection method that divides organic waste, recyclables and HHW than what the surrounding community/public have been experiencing currently. Unless there are being thoroughly explained and understood, the decision of the surrounding community/public for not paying extra money for an improved SWM will remain unanimous.

The second section of the questionnaire involves the perceptions of community/public residing within the surrounding area in regards to landfill operation and management. Most of the questions evolved around the satisfaction level of the community/public with the nearest or known landfill to them being managed, their knowledge on landfill types, "Not in My Backyard "(NIMBY) issues as well as common problems associated to landfill operation/ management. Many countries are facing continuous challenges on the NIMBY syndrome [24-27]. Nobody wants to have a dumping site anywhere near his or her house. The prospects of bad odours wafting to their houses, attacks of flies, mosquitoes and rodents, which may dictate vector diseases like cholera, dengue and hepatitis, in addition to a horrible sight that is visually distracting to look upon, are among common reasons given by the public in regards to having dump sites nearby. A survey distributed to the community/public residing near landfill sites involved in this study, as shown in Figure 10, indicates that almost all of the respondents involved have a complete rejection of having a dump site in their neighbourhood. Usually there are always ways to solve this 'NIMBY' problem for the local council before making any decision on building a landfill near a particular residential area. Apart from considering views from local residents, the NIMBY syndrome can be minimised via efficient landfill management at dump sites in Malaysia. Consequently, positive outcomes from an effectively managed landfill will increase public's confidence and thus the idea of having a landfill nearby their residence will not be an issue anymore.

In terms of problems caused by nearby landfill sites, the survey conducted has shown that groundwater contamination and vector diseases are the two common ones. Typically dump sites are the regular ground for vector insects such as flies and mosquitoes to breed. Dump sites are also associated with the pollutions of surface water such as rivers and lakes, groundwater and air as a result of the decomposition of waste received at the landfill site. Figure 11 indicates that the main concern for almost 70% - 75% of the respondents is on the vector disease while the remaining evolved around groundwater contamination. This signifies the familiarity of respondents on the impact and implication that can be caused by vector disease in contrast to groundwater

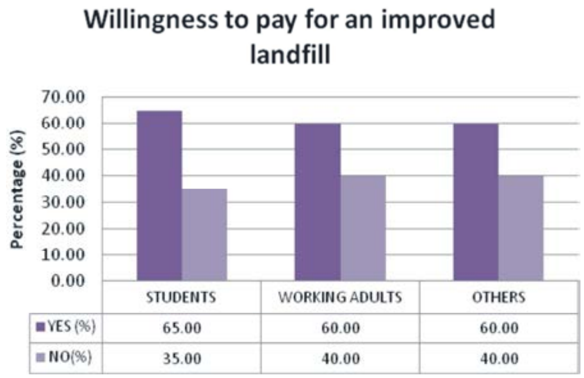

Fig. 12: Public response on willingness to pay for an improved landfill

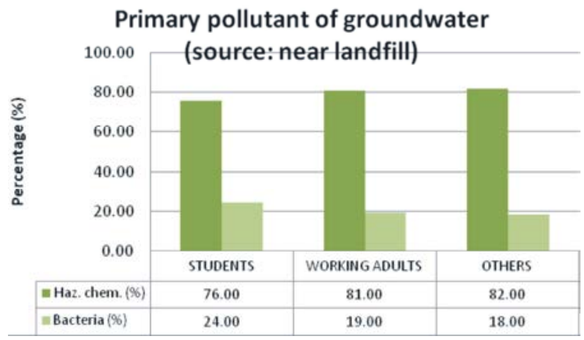

Fig. 13: Public response on primary source of groundwater pollution near landfill

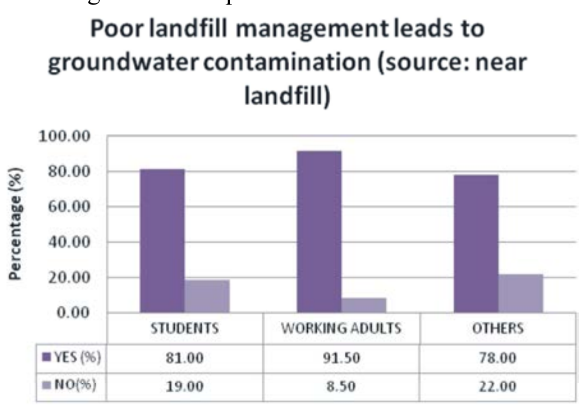

Fig. 14: Public response on poor landfill management

contamination. The community/public residing near the landfill sites of this study have also indicated their willingness to pay extra money to improve the current landfill,for instance, the Matang Landfill from an open dump site onto full sanitary landfill like the Bukit Tagar Sanitary Landfill (BTSL) where solid wastes are properly treated. Figure 12 shows that almost 60% of respondents from all categories involved in the survey stated their willingness to pay, if necessary, for landfill improvement.

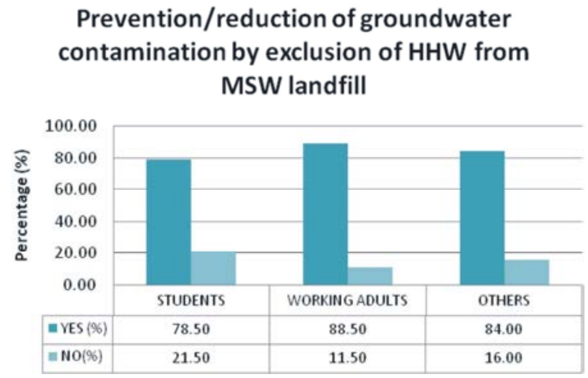

Fig. 15: Public response on the prevention of groundwater contamination

The final section of the questionnaire focuses on technical issues related to groundwater contamination where the complexity level of the question is low, which can be easily understood and answered by all respondents involved. Figure 13 specifies the results achieved in regards to the source of groundwater contamination from the perspective of community/public. The result clearly favours hazardous chemicals as a major pollutant to the groundwater source near landfill compared to bacteria. This result also reflects one of the key issues emphasised earlier on waste separation. If house hold hazardous waste (HHW) such as harmful chemicals from detergent and pesticides could be diverted from landfills, it is believed that the chance of having these hazardous chemicals polluting the groundwater source would be minimized.

Landfill management is another exceptional issue for the respondents. Most of the respondents are unaware of the key activities taking place at the landfill site and thus, their response on this question is moderately subjective. Figure 14 portrays the results from the survey where approximately 80% - 90% of the respondents see poor landfill management as one of the key factors that may lead to groundwater contamination at landfill sites.

All respondents involved in the survey were also asked about the issue of potential effects of HHW exclusion from landfill wastes to minimise groundwater contamination. Figure 15 illustrates the results obtained where the majority of the respondents (between 80% - 90%) believed that separating hazardous wastes from municipal solid waste at home would help minimise groundwater contamination at landfill sites. The results also indicate the level of awareness of the public/ community on the adverse impact that could be imposed by HHW on groundwater. Generally, it is important to know that public respondents are really conscious about the significance of groundwater and the possible sources that may lead to contamination.

CONCLUSION

Landfill is one of the most preferred disposal methods for solid waste management in Malaysia. Since they are among the key stakeholders for each and every landfill, it is important to generate views and perceptions of the public/community residing near to the site. In general, most of the respondents involved in this study are aware ofthe importance of solid waste management at home as well as effective landfill operation and management on site, which may lead towards groundwater contamination if these issues are not thoroughly looked into by appropriate parties. Although most of the public/ community respondents involved refused to cough up extra money for better solid waste management services and an improved landfill, they are fully aware of the significance of proper household hazardous waste (HHW) handling at home and waste separation impact towards groundwater contamination at landfill sites. This current level of awareness of the public/community could be enhanced further through road shows and exhibitions in the future, which would subsequently minimize the occurrence and impact of significant risks such as groundwater contamination at landfill sites in Malaysia.

REFERENCES

1. Tchobanoglous, G., Thiesen, H., Vigil, S. 1993. Integrated solid waste management, engineering principles and management issues. McGraw-Hill
2. Leao, S., I. Bishop and D. Evans, 2004. Spatial Temporalmodel for demand and allocation of waste landfills in growing urban region, Computers Environment Urban System, 28: 353-385.
3. Ali, M., A. Cotton and K. Westlake, 1999. Downtoearth: solid waste disposal for low-income countries, WEDC (Loughborough)
4. Sri Darwati, 2012. Sustainable Approach for Landfill Management at Final Processing Site Cikundul in Sukabumi City, Indonesia. Iranica Journal of Energy & Environment 3 (Special Issue on Environmental Technology), pp: 79-84.
5. Jokela, J., 2002. Landfill Operation and Waste Management rocedures in the Reduction of Methane and Leachate Pollutant Emissions from Municipal Solid Wastes, Jyväskylä Studies in Biological and Environmental Science, 113: 1-69.
6. Kementerian Perumahan dan Kerajaan Tempatan, 2012. Kementerian Perumahan dan Kerajaan Tempatan, Putrajaya viahttp://www.kpkt.gov.my/ Access on 22 May 2012
7. Tarmudi, Z., M.L. Abdullah and A.O. Md Tap, 2009. An overview of municipal solid wastes generation in Malaysia, Jurnal Teknologi, 51(F): 1-15.
8. Westlake, K., 1997. Sustainable landfill – possibility or pipe dream?, Waste Management & Research, 15: 453-461.
9. ASCE., 1976. The ASCE solid waste management committee of the environmental engineering decision, Sanitary landfill', NewYork, pp: I-1-IV-28.
10. Nahman, A., 2011. Pricing landfill externalities: Emissions and disamenity costs in Cape Town, South Africa, Waste Management, pp: 2046-2056.
11. KementerianPerumahandanKerajaanTempatan (KPKT)., 2010. Executive summary of Detailed Environmental Impact Assessment (DEIA) for Pagoh Sanitary Landfill in Muar, Malaysia via https:// www.elaw.org/ system/files/Executive-Summary-DEIA-Sanitary-Landfill-Pagoh.pdf Access on 27 March 2013
12. Johari, A., S.I. Ahmed, H. Hashim, H. Alkali and M. Ramli, 2012. Economic and environmental benefits of landfill gas from municipal solid waste in Malaysia, Renewable and Sustainable Energy Reviews, 16(2012): 2907-2912.
13. Islam M. Rafizul and Muhammed Alamgir, 2012. Influence of Landfill Operation and tropical seasonal Variation on Leachate Characteristics: Results from Lysimeter Experiment. Iranica Journal of Energy & Environment, 3(Special Issue on Environmental Technology): 50-59.
14. American Public Health Association (APHA), 2005. Standard methods for the examination of water and wastewater, Washington D.C
15. Tarmudi, Z., M.L. Abdullah and A.O. Md Tap, 2010. Evaluating municipal solid waste disposal options by AHP-based linguistic variable weight, Matematika, 26(1): 1-14.
16. Fatta, D., A. Papadopoulos and M. Loizidou, 1999. A study on the landfill leachate and its impact on the groundwater quality of the greater area, Environmental. Geochem. Health, 21(2): 175-190.
17. Department of Statistics Malaysia, 2010. Population Distribution And Basic Demographic Characteristic Report 2010 http://www.statistics.gov.my/portal/index.php?option=com_content&id=1215 Access on 30 March 2013

18. Engineering and Environmental Consultants 1993. Preliminary Environmental Impact Assessment for the Development of a Sanitary Landfill for Majlis Perbandaran Taiping,'Unpublished', pp: 9-45.
19. Samuding, K., I. Abustan, M.T. Abdul Rahman and M.H. Isa, 2009. Distribution of Heavy Metals Profile in Groundwater System at Solid Waste Disposal Site, European Journal of Scientific Research, pp: 55-62.
20. Samsudin, A.R., B.E. Abdul Rahim, W.Z. Wan Yaacob and U. Hamzah, 2007. Mapping of contamination plumes at municipal solid waste disposal sites using geoelectric imaging technique: Case studies in Malaysia', Journal of Spatial Hydrology, pp: 13-22.
21. Department of Environment (DOE), 2009. EnvironmentalQuality (Industrial Effluents) Regulations 2009,Ministry of Science and Technology, Malaysia.
22. Taha, M.R., W.Z. Wan Yaacob, A.R. Samsudin and Z. Yaakob, 2011. Groundwater quality at two landfill sites in Selangor, Malaysia, Bulletin of the Geological Society of Malaysia, 57: 13-18.
23. Department of Environment (DOE) 2004. Detailed Environmental Impact Assessment of a Proposed Bukit Tagar Sanitary Landfill, Department of Environment, Ministry of Science and Technology, Malaysia.
24. Anderson, R., 1987. Solid waste and public health In: Greenberg, Guilford Press, New York, pp: 173-206.
25. Petts, J., 1992. Incineration risk perceptions and public concern: Experience in the UK improving risk communication, Waste Management and Research, 19: 169-182.
26. Elliot, S.J., S.M. Taylor, S. Walter, D. Stieb and J. Eyles, 1993. Modelling psychosocial effects, Science and Medicine, 37: 791-804.
27. Munton, D., 1996. Sitting by choice: Waste facilities, NIMBY and volunteer communities, Georgetown University Press, Washington DC., pp: 23-71.