Built Environment Journal

Faculty of Architecture, Planning and Surveying

Volume 13 No. 2 July 2016 ISSN 1675-5022

Built Environment Journal is jointly published by Faculty of Architecture, Planning and Surveying and UiTM Press, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.

ASSESSMENT OF SOLID WASTE MANAGEMENT (SWM) PRACTICES IN PANGKOR ISLAND MALAYSIA

Kok Weng Tan*[1], Huoy Huoy Ong[1] & Nor Hanisah Mohd Hashim[2]

[1]Department of Environmental Engineering, Faculty of Engineering and Green Technology, Universiti Tunku Abdul Rahman (UTAR), 31900 Kampar, Perak, Malaysia.

[2]Centre of Studies for Park and Amenity Management, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
Email: tankokweng@utar.edu.my

ABSTRACT

This study aimed to characterize recyclable and non-recyclable solid waste generation and identify the impacts of solid waste to the Pangkor island ecology. Methods used in this study were field investigation, opinion survey and domestic waste sampling. The data obtained from field sampling was analyzed by using reliability test (0.753), descriptive test, ANOVA single factor and Pearson Correlation Analysis. Through field investigation and sampling activity, the waste generated in Pangkor Island was found to be 0.34 kg/capita/day which slightly lower than Malaysian average waste generation of 1.3 kg/capita/day. Opinion survey and interview which included 34 items were conducted to local community for understanding; awareness and practice of local communities towards solid waste management (SWM). Result showed that total 34.0 % of respondents chose dumped solid waste into ocean, river or land. Only 43.6 % of respondents practiced recycling and composting in their own house. Result from Pearson Correlation analysis shows that knowledge of local communities towards SWM does not influence their attitude towards recycling (Pr > 0.05). Due to time restraints, language barrier, lack of numerators and expert's opinion, the study did not carry out the field sampling in Malay and Indian communities in Pangkor Island which became major limitation for this study.

Keywords: *Solid waste management (SWM), Municipal waste management (MWM), sustainable development, Pangkor Island*

INTRODUCTION

Increases of population, rapid economy growth and urbanization have posed challenge to sustainable solid waste management. In developing countries, the generation rate of solid waste has increased dramatically (Minghua et al., 2009). Main waste management responsibility is dedicated to local authorities in most developing countries which encounter issues pertaining to human and financial resources constraints as well as identify suitable landfill for disposal (Sujauddin et al., 2008). Apart from waste management, water resources pollution due to illegal solid waste disposal are often reported and become major environmental problem.

There are some issues and challenges in managing waste in places such as islands in Malaysia and Pangkor Island is one of the examples. Firstly, the dumpsites are poorly located on the island, combined with uncontrolled scavenging and lack of rubbish bin in the island, it makes the issue worst. Inefficient

waste collection and transportation are due to inadequate management and maintenance of equipment where there also poses a problem in solid waste management (SWM). Lack of public awareness on solid waste management issues leads to low waste separation and rarely practice of reduce, reuse and recycle (3R) of the waste. Illegal burning and ocean dumping is common in Pangkor Island. Wastes generated in the island are causing environmental pollution, safety hazards and aesthetic problems in the site. The crucial part of the SWM is the high transportation cost and inadequate budget for the waste management (Agamuthu and Nagendran, 2010).

Waste collection in Pangkor Island is contracted out to a private firm yearly. In term of disposal methods, Pangkor Island depends on the location of landfill in the island. Landfill in Pangkor Island is operating as mere open-dumps, which lack proper lining system and leachate treatment. At the open-dumps, there is a layer of natural lining layer, which composed of clay as prevention for leachate leakage to the water table buried beneath the landfill. Currently, no cell system is being practiced at the site and no proper treatment or drainage is allocated for the leachate produced by the waste. Thus, landfill in Pangkor Island has a waste-related aesthetic problem, leachate contamination, and landfill gas or odour problems which are the concurrent problem in Malaysia. Obviously it shows that waste collection in Pangkor Island is an ineffective disposal method. Hence, it gives negative impacts to the environment consequently. Since there is a limitation on landfill disposal site in Pangkor Island, an alternative landfill site is not available. Thus, the incinerator is used as the disposal method for the waste (Agamuthu and Nagendran, 2010).

The municipal solid waste (MSW) is increasing daily and without any preventive action, substantial negative environmental impacts such as air, soil and water pollutions will continue to occur and become the major environmental challenge to Malaysia (Siti and Noraziah, 2014). To further elaborate on its negative pressure to Malaysia, the existing of health and safety problem will skyrocket as the garbage heaps attracted insects and rodents. Besides, the vector diseases associated with different forms of pollution will grow exponentially. Meanwhile, landfill leachate will contaminate the groundwater and adjacent water bodies, whereas the gases of the landfill; greenhouse gases (GHG) are released freely into the atmosphere and contributing to climate change (Zeeda and Jaron, 2013). Thus, the efficiency of the SWM in Pangkor Island becomes a major social and environmental concern (Suna Erses Yay, 2015).

Pangkor Island is located in the state of Perak and under the authority of Manjung Municipal Council (MMC) (MMC, 2010). It is coordinated at 4.2200 ^{o}N, 100.5550 ^{o}E. It is surrounded by Dinding Straits and Malacca Straits. Pangkor Island experiences a tropical climate and temperature ranges from 25 to 35^{o}C. The size of Pangkor Island is 18 km^2 while the population is approximately 20,000 people (MMC, 2010). Fishing, exportation of marine products and tourism are the major industries on the island (Pazim and Rosli, 2011).

Definition of Solid Waste Management (SWM)

A Waste Management Hierarchy (Figure 1) is introduced to minimize the amount of waste entering landfill. In the Waste Management Hierarchy, the top three initiatives are 3R (Reduce, Reuse and Recycle). It is vital to educate the public by organizing awareness program towards implementation of the 3R. By implementing 3R, it can reduce human ecological footprint and improve waste management system. Besides that, it also allows prevention of the loss of resources and reduces environmental impacts from waste disposal; simultaneously lengthen the lifespan of landfills operation. 3R is a successive process in developed countries compare with the developing countries (Jayashree *et al.*, 2012).

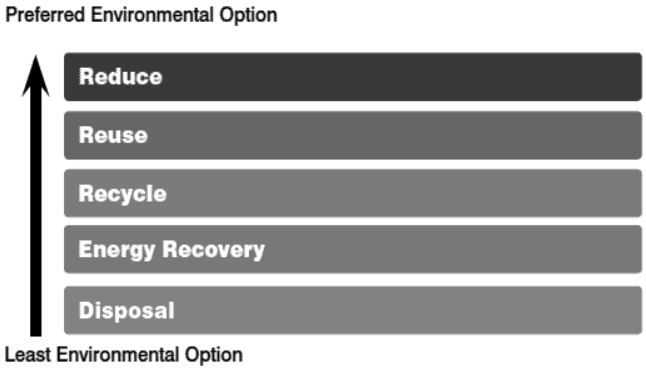

Figure 1: Waste Management Hierarchy (The Scottish Government, 2011)

Solid Waste Issues and Importance

In year 2007, solid wastes generated in Malaysia were enough to fill up 42 buildings that have the same size as the world-renowned Petronas Twin Tower in Kuala Lumpur, which is about 7.34 million tons. Statistics shows solid waste generated is approximately 1 kg/day/capita. On the other hand, due to the factors of urbanizations, changing in living standards and consumption behaviors of the people, the volume of solid waste is boosting at the rate of 1.5 % per year (Idrus *et al.*, 2008).

Malaysia is spending 75% of municipal budget for waste collection (Shamshiry *et al*., 2011). This statistic showed intentionally costly waste management in Malaysia. The waste generation studied in all islands in Malaysia is also increasing yearly. Approximately 400 metric tons/day of solid waste are generated in the islands of Malaysia. The data of population and solid waste generation in Langkawi, Pangkor, Redang and Tioman islands are summarized in Table 1 (Agamuthu and Nagendran, 2010).

Table 1: Population and Waste Generation Rate in the Four Islands

	Langkawi	**Pangkor**	**Redang**	**Tioman**
Size (km^2)	478.5	18	10.87	131
Population	79,000	26,000	1,400	3,400
Waste generated (metric ton/day)	85	13	2.7	6.95
Waste generation rate (kg/capita/day)	1.08	0.48	0.86	0.87

(Source: Agamuthu and Nagendran, 2010)

In Table 2, the comparison of waste composition between islands is summarised. The result shows that approximately 30% of waste is from food waste. Tourism activity at the island has contributed to the increment of recyclables waste disposal. The wastes include Styrofoam food containers, mineral water bottles, magazines, carton boxes and shopping bags. The study illustrates that about 82% of the waste can be diverted from the landfill, if both the compostable and recyclable items (food waste, paper, plastic, yard waste, textile and metal) are successfully separated at source in Pangkor Island.

Table 2: Waste Composition in Malaysian Islands (% by weight)

Component	Redang	Pangkor	Langkawi	Tioman
Food waste	31.0	30.3	36.3	29.8
Paper	24.7	20.7	19.5	18.9
Plastic	13.1	15.1	15.1	13.9
Yard waste	11.8	10.8	8.4	14.1
Diapers	4.7	5.5	4.8	4.8
Glass	5.2	3.4	3.7	5.6
Wood	3.2	5.3	2.9	4.2
Rubber/Leather	2.4	2.8	3.6	3.4
Textile	2.3	2.6	3.2	3.4
Metal	1.0	2.2	1.8	1.0
Hazardous waste	0.1	0.2	0.1	0.2
Others	0.6	0.9	0.7	0.7

(Source: Agamuthu and Nagendran, 2010)

TECHNOLOGIES FOR WASTE DISPOSAL AND MANAGEMENT

Different Types of disposal technologies are applied in Malaysia namely landfill, incineration, composting and recycling.

Incineration

Incineration provides a solution to deal with the problems of solid waste, especially in the country where the land is limited and the rate of SWM is escalating speedily. In fact, incineration is reducing 90% of the wastes volume and only the remaining ash will go to landfill. So, the life span of the landfill will be extended. Besides, incineration could offer energy recovery and the income would offset the high operation cost of incineration if the technology of zero to waste is available (Idrus *et al.*, 2008).

Advantages of incineration are listed in the following, such as less emission during the waste transfer. Meanwhile, decrease in the weight of waste effectively hinder the production of methane after it was disposed to landfill. Since the production of ashes during incineration, majority of the components is an inorganic material which, is in a stable form, where it can be recycled to make profit. Therefore, incineration may be treated as a pre-treatment for landfill. Other than to reduce the waste amount, the main objective of incineration is for the generation of renewable energy. Hence, the function of this waste disposal method will become more attractive. If waste combustion is used sustainably, it is a vital source of energy for energy recovery. Incineration is about introducing another option to burn fossil fuels in an environmental friendly way from the perspective of energy. In a nutshell, incineration is providing a great source of solid waste reduction in terms of volume and weights. It is expensive when waste enters to the landfill, as it requires higher funds for construction of landfill. In addition, there is the need of a principal to monitor and maintain the landfill in long term, once the landfill is established. Next, due to the odour of the landfill, there is reduction of the land value of surrounding areas (Shamshiry *et. al.*, 2014).

However, there are some disadvantages from incineration; such as the incinerated ash contains high level of heavy metals will have higher possibility of leaching rate. In term of energy recovery, not all waste is adequate for incineration. Fuel supplement for combustion might need for waste with low calorific value. With a high moisture and low organic content of combustible materials, waste contributes to a lower calorific value, especially in developing countries. Thus, energy recovery is not economical, since the incineration of wastes with lower calorific values is generally unable to self-sustaining. Furthermore, for the countries which are facing technical constraints in controlling the potential air pollution, the incineration technology is not appropriate to be implemented (Idrus *et al.*, 2008). For instant, the facilities of the “Waste to Energy” in the US had generated 81 mercury tons in

1989. Besides, the emissions of incineration are significant, as it threatens human health, plants and the surrounding environment. The emissions of GHG from incineration are CO_2 and N_2O which are major contributors to climate change (Shamshiry *et. al.*, 2014).

Composting

Wilson (1981) expressed composting process happens when the organic portion of the waste undergoes aerobic degradation and the product of this process can be only used as a soil conditioner. However, Agamuthu (2001) holds the opposite view that compost is important for plant growth and development, and can improve the soil texture as it is a nutrient rich substance. The advantages of using composting as a treatment for solid waste can reduce the volume of solid waste significantly, particularly in those countries where generation of organic waste and yard waste are in high volume. Yet, if high percentages of non-compostable waste such as glass, metals, plastic, and rubber are consisted, separation needs to be done before composting in order to produce an acceptable grade of compost and to avoid contamination of compost with hidden toxic metals. In general, composting is hygienic, environmental friendly and contains substances with only low toxicity. This technology has been available for many years, however, around the world, there are only few composting plants which are successfully economically (Idrus *et al.*, 2008).

Recycling

Recycling is reverting waste materials to productive system in terms of the usage in the manufacturing of goods, through the perception of conservation which viable to scarce and non-renewable resources in order to promote sustainable development as interpreted by Gilpin (2000). Some fundamental issues faced by waste recycling such as recovery of the reusable and recyclable materials through separation of waste materials. Besides, in the market, issues such as specification and identification of the recovered materials are noted free from contamination and homogeneity (Idrus *et al.*, 2008).

There are two principal benefits of recycling. First, the need for waste disposal capacity, emission from landfills and incinerators and litter are cut down by recycling. Next, the energy use and emission from industrial would decrease, simultaneously fewer raw materials are extracted or manufactured, and raw materials are conserved through recycling. Moreover, recycling is providing the lower income group as an additional income source (Nadi *et al.*, 2011).

In recycling field, the type of waste that can be recovered depends on the demand and potential uses of the recovered materials. These only cover materials that only have high commercial value, such as paper and cardboard, plastics, glass, aluminium, ferrous metal, and for which recycling technologies already exist. Facilities are costly to set up and operate for the recyclable materials. Therefore, it may not be practicable to invest in a central material recovery and processing facility, if there are insufficient of recyclable materials generated (Idrus *et al.*, 2008).

METHODOLOGY

This study adopted the case study approach which focuses on sustainable SWM in Pangkor Island. Four methods were chosen for this study specifically domestic waste segregation, field investigation, opinion survey, and statistical data analysis.

Domestic Waste Segregation

In order to characterize solid waste generated in Pangkor Island, 18 households were surveyed from four different villages around the Island. These areas were Sungai Pinang Kechil, Sungai Pinang Besar, Pekan Pangkor, and Taman Desa Pangkor as shown in Figure 2. Each household was requested to collect their daily solid waste and sort into two categories such as recyclable waste and non-recyclable waste,

as shown in Table 3. The samples were collected once a week by determining the weight of the wastes and the number of members in the household. The solid waste segregation was conducted for three months (November 2015 – January 2016).

Table 3: Classification of Recyclable and Non-Recyclable Wastes

Recyclable	Non-recyclable
Paper	
Newspapers	Soiled paper
Office papers	Wax or plastic-coated paper
Phone books	Paper laminated with foil or plastic
Paper grocery bags	Magazines and catalogs
Paper egg cartons	Used paper towels, napkins, tissues and paper plates
Cardboard	
Packing boxes	Waxed cardboard
Cereal boxes (single wall cartons)	Waxed milk cartons
	Soiled pizza or frozen food boxes
Glass	
Jars	Light bulbs
Bottles (clear, green or brown)	Window panes
	Glassware (cups, glasses, plates)
	Mirrors
Metal	
Aluminium cans	Bottle and jar lids with plastic liners
Tin cans	Cans used for chemicals or paints
Scrap metal	Aerosol spray cans
Plastics	
Plastic soda and juice bottles	Grocery and plastic bags
Milk jugs	Styrofoam (cups, plates, packing materials)
Detergent, oil and antifreeze bottles	
Batteries	
Dry cell household batteries	

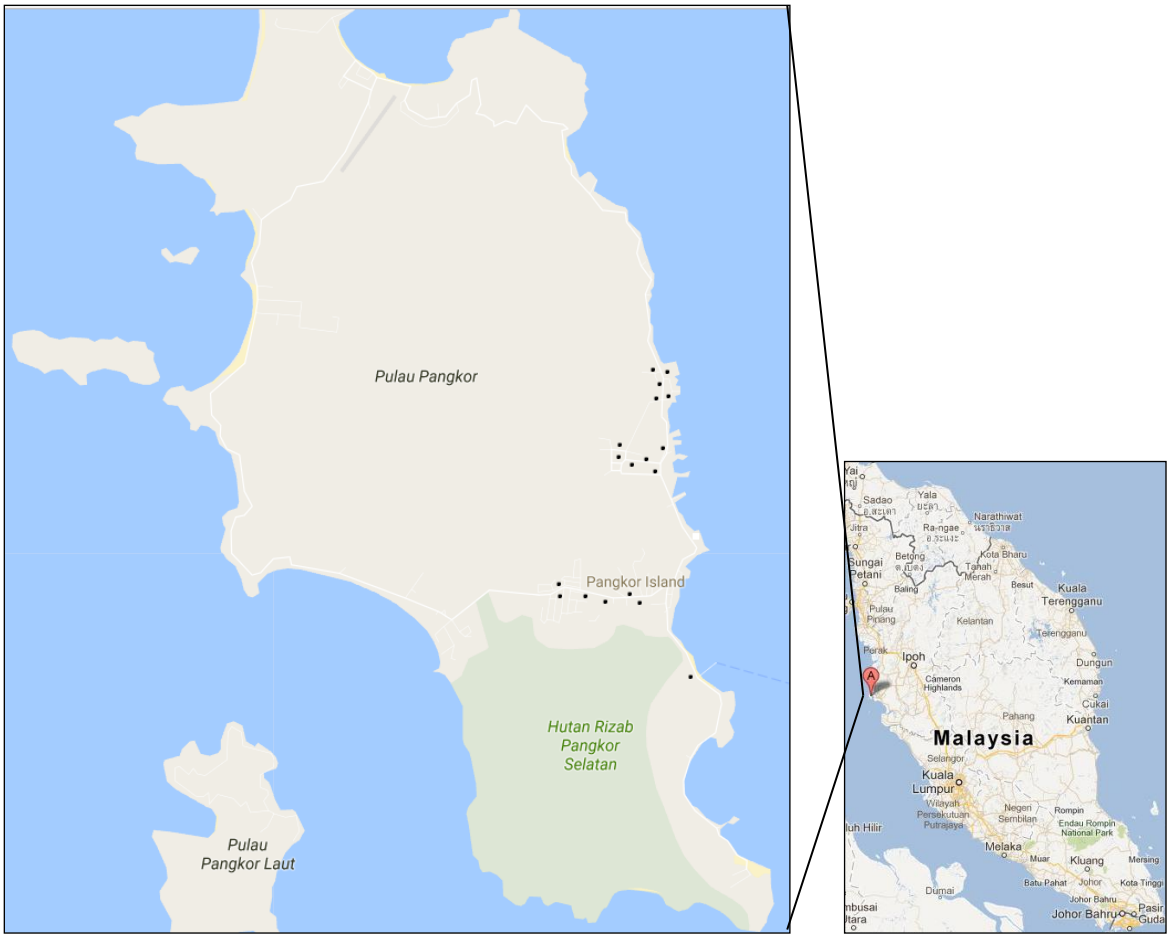

Figure 2: Location 18 Households for domestic waste segregation sampling

Field Investigation

Besides, the environmental impact of the solid waste generated in Pangkor Island was identified in five villages such as Sungai Pinang Kechil, Sungai Pinang Besar, Kampung Teluk Kecil, Kampung Teluk Gedung, and Teluk Dalam, as well as tourist attraction in Teluk Nipah through field investigation.

Opinion Survey

The awareness, understanding and attitude of the communities towards the importance of SWM were identified by using close-ended questionnaire. The questionnaire was designed by using Likert scale. A series of questions with five response alternatives were used in Likert scale: strongly disagree, disagree, neutral, agree and strongly agree (Harry and Deborah, 2012). The pilot survey was conducted in order to determine the reliability of design questionnaire. In total, 94 respondents from seven villages such as Sungai Pinang Kecil, Sungai Pinang Besar, Pekan Pangkor, Kampung Teluk Kecil, Kampung Teluk Gedung, Taman Desa Pangkor, and Teluk Dalam, had been participated in this survey from November 2015 to January 2016.

Reliability analysis was used to measure the 34 variables from 94 respondents towards understanding regarding knowledge towards SWM, understanding and awareness towards SWM, and awareness and attitude towards recycling. The value of Cronbach's Alpha in opinion survey conducted to 94 respondents is 0.753, According to Institute for Digital Research and Education (2015), the Cronbach's Alpha value which is representing of questionnaire should be higher than 0.6, so that the questionnaire is considered reliable. Thus, the opinion survey in this study was reliable and acceptable.

Statistical Data Analysis

The data was analysed by using Statistical Package for the Social Sciences (SPSS Statistics) (IBM Corporation, 2012). Descriptive statistics was used to analyse the descriptive data and inferential statistics such as Pearson Correlation analysis, Analysis of Variance (ANOVA) Single Factor were employed to further explore the differences between the groups of respondents.

RESULTS AND DISCUSSION

Descriptive Analysis

The survey outcome was interpreted with frequency table to describe the data statistically. Thus, all 34 variables were analysed to understand Pangkor's residents' knowledge, behaviour and attitude towards solid waste issue in Pangkor Island as shown in Table 4, 5, 6 and 7.

Table 4: Descriptive analysis for Knowledge of Respondents towards SWM

Symbol	Variables	Value (%)
B1	I understand the Solid Waste Management (SWM) practices	78.7
B2	I aware about Solid Waste Management (SWM) practices	87.2
B3	I attended talks/activities related to Solid Waste Management (SWM)	36.2
B4	I know how much of wastes that my house generated daily.	66.0
B5	I know the function of incinerator	75.5
B6	I recognize the gases generated by the operation of incinerator.	51.1
B7	I know the location of incinerator in Pangkor Island	75.5
B8	I know what illegal landfill is	71.3
B9	I know the location of illegal landfill in my residential area	53.2
B10	I know what are environmental pollutions and its impacts on human health.	94.7
B11	I aware about environmental pollution in my residential area.	63.8
B12	I attended talks/activities related to environmental pollution.	43.6
B13	I know how to conduct recycling practice.	93.6
B14	I have conducted recycling and composting activity in my house.	43.6
B15	I attended talks/activities related to recycling.	52.1

Table 5: Behaviour of Respondents in Household Waste

Symbol	Item	Dump it into sea/river/land (%)	Burn it (%)	Legal solid waste collector (%)
B16	How do you dispose of the household waste?	17.0	17.0	66.0

Table 6: Awareness of Respondents towards SWM

Symbol	Item	Disagree / Strongly Disagree (%)	Neutral (%)	Agree / Strongly Agree (%)
SWM1	SWM is important.	0.0	18.1	81.9
SWM2	MMC is responsible for the waste collection of my house.	13.8	17.0	69.1
SWM3	Privatized company is responsible for the waste collection of my house.	58.5	18.1	23.4
I1	The gases generated by the operation of incinerator are harmful to health.	1.1	45.7	43.2
I2	The incinerator operated in Pangkor Island often breakdown.	11.7	67.0	21.3
IL1	Illegal landfill is carried out during the breakdown of incinerator of Pangkor Island.	24.5	54.2	21.3
IL2	Illegal landfill generates unpleasant smell.	1.1	34.0	64.9
EP1	Environmental pollution is caused by human activities e.g. illegal dumping of solid wastes.	0.0	12.8	87.2
EP2	The aquatic living organisms consume the wastes accidentally.	3.2	18.1	78.7
EP3	Environmental pollution had caused the reduction of marine products.	2.1	29.8	68.1

Table 7: Attitude of Respondents towards Recycling

Symbol	Item	Disagree / Strongly Disagree (%)	Neutral (%)	Agree / Strongly Agree (%)
R1	Recycling is important.	2.1	20.2	77.7
R2	There are someone who influences me to do recycling.	40.4	31.9	27.7
R3	Practicing waste separation is complicated and troublesome.	33.0	29.8	37.2
R4	Practicing recycling used up a lot of time.	38.3	26.6	35.1
R5	Practicing recycling needs a lot of effort.	39.4	24.4	36.2
R6	Practicing recycling needs a lot of space.	34.0	33.0	33.0
R7	Recycling could generate unpleasant smell.	41.5	48.9	9.6
R8	Recycling bins are unsightly.	6.4	24.5	69.2

Total 78.7% of the respondents understand solid waste Management (SWM) best practices, 87.2% and 36.2% of the respondents aware about SWM practices and attended relevant talks or activities, respectively and a total 66.0% of the respondents know how much of wastes their house generated daily (Table 4). Although 75.5% of the respondents know what are incinerator and its function, only 51.1% of the respondents recognize the gases generated by the operation of incinerator. Another 75.5% of the

respondents know the location of incineration in Pangkor Island. While 71.3% of the respondents know what illegal landfill is, more than half of the total respondents which is 53.2% of the respondents know the illegal landfill in their residential area or village. Based on Elizabeth (2006), people used to dispose of their wastes in unpermitted areas to avoid time and effort needed to dispose properly at landfills or recycling centres. Additionally, due to lack of understanding of laws or the inadequacy of existing laws, it leads to the illegal disposal of wastes.

Total 94.7% of the respondents know what environmental pollution is and its impact on human health, whereby only 43.6% of the respondents attended talks or activities related to environmental pollution. Besides, another 63.8% of the respondents understand the environmental pollution occurred in their residential area or village (refer Table 4).

Table 4 shows that 93.6 % of the respondents understand what recycling practice is, but less than half of them practice recycling and composting activities in their own house. Nevertheless, 52.1 % of the respondents attended talk or activities related to recycling. Department of Environment Quality (2015) stated that people who do not conduct recycle practice is due to the reasons such as, time consuming, inconvenient to conduct recycling and also do not know what materials can be recycled. However, from the result, the percentages of respondents who attended to talk or activities which related to SWM practices, environmental pollution, and recycling are different, which are 36.2%, 43.6 %, and 52.1 % respectively.

The understanding, awareness and practice of the local communities towards SWM were also studied through opinion surveyed and interviewed. Based on the result shown in Table 4, 5 and 6, a total 94.7% of respondents knew what environmental pollution is and its impacts to human health while 87.2% of respondents agreed that environmental pollution is caused by human activities such as illegal dumping of solid waste, 81.9% of respondents agreed SWM is important, and only 34.0% of respondents chose their dumping methods to the sea or river or land and even burning it. At the same time, although 93.6% of respondents knew what recycling practice is and 77.7% of respondents agreed that recycling is important, only 43.6% of respondents practiced recycling and composting in their backyard. In layman terms, although local communities aware about SWM, their practice of solid waste disposal is diminutive in order to improve the environment of Pangkor Island. Thus, education of SWM best practices to the local communities is significant for good practice of waste disposal.

Pearson Correlation Analysis

Pearson Correlation Analysis was used to determine the strength of the correlation between the variables of the attitude of respondents towards recycling (Table 7). The correlation was significant at the 0.01 level as shown in Table 8. The strongest linear relationship is between R3 and R4 which is $r = 0.892$, and follow by R4 with R5 which is $r = 0.865$, both are positive very strong correlation. Next, the r value is 0.777 for R3 with R5, it is known as positive strong correlation. Then, the correlation of R5 with R7 is positive strong as $r = 0.681$. For R1 and R2, the r value is 0.634 which is positive strong correlation. In addition, R7 has the same r value with R3 and R4, which is 0.633, a positive strong correlation. As a conclusion, the relationship between R3, R4 and R5 are strong, which means the respondents were strongly agree/ agree that practicing waste separation is complicated and troublesome, a lot of time and effort needed to practice waste separation.

Besides, for the correlation is significant at the 0.05 level, the highest correlation is when $r = 0.232$ for R6 with R7, yet it is known as positive weak correlation. Then, it is followed by R5 with R6 when $r = 0.210$, also known as positive weak correlation. Moreover, r value for R6 with R3 is only 0.191, which is positive very weak correlation. Generally, for the R6 and R7, many of the respondents do not agree with recycling could generate unpleasant smell, but agree with recycling bins are unsightly.

Table 8: Pearson Correlation Analysis

	R1	R2	R3	R4	R5	R6	R7	R8

R1	Pearson Correlation	1	.634**	-.390**	-.477**	-.425**	.012	-.397**	-.220*
R2	Pearson Correlation	.634**	1	-.298**	-.441**	-.465**	-.061	-.319**	-.090
R3	Pearson Correlation	-.390**	-.298**	1	.892**	.777**	.191*	.633**	.040
R4	Pearson Correlation	-.477**	-.441**	.892**	1	.865**	.169	.633**	.051
R5	Pearson Correlation	-.425**	-.465**	.777**	.865**	1	.210*	.681**	-.020
R6	Pearson Correlation	.012	-.061	.191*	.169	.210*	1	.232*	-.300**
R7	Pearson Correlation	-.397**	-.319**	.633**	.633**	.681**	.232*	1	.042
R8	Pearson Correlation	-.220*	-.090	.040	.051	-.020	-.300**	.042	1

**. Correlation is significant at the 0.01 level (1-tailed).
*. Correlation is significant at the 0.05 level (1-tailed).

Domestic Waste Segregation practices in Pangkor Island

A total of 18 households participated in this domestic waste segregation as shown in Table 9. The averages recyclable and non-recyclable from the 18 households per week were 4.45 kg and 6.50 kg. Thus, in average, the total waste from a household with four family members is 10.95 kg in a week and 2.39 kg of waste generated by per capita per week. Hence, generation of waste in Pangkor Island was determined as 0.34 kg/capita/day, which was lower than the finding of Agamuthu (2010), 0.48 kg/capita/day. Besides, the result was also lower than the average Malaysian waste generation, 0.8 kg/capita/day (Zamali et al. 2009). The standard deviation of recyclable waste and non-recyclable waste in a week are 1.46 kg and 3.62 kg respectively, whereas the standard deviation for total waste in a week is 4.18 kg. Then, the standard deviation for waste generation per capita in a week is 0.53 kg.

In order to identify the difference between the variables of recyclable waste (RW) and non-recyclable (NRW) and total waste (TW) and waste generated per capita (PC), analysis of variance (ANOVA) single factor was conducted in this study. Based on the result (Table 10), the F values of RW and PC were 0.123 and 0.175($F<1.000$). The p values as known as sig. of RW and PC were 0.972 and 0.599 ($P>0.05$). Hence, the H_1 was rejected and there was no significant difference between group for recyclable waste and waste generation per capital in Pangkor Island. Besides, the p values for NRW and TW were lower than 0.05, hence, the H_0 was rejected and there was significant difference between group for non-recyclable waste and total waste generation. The result indicated that improving recycling practice in Pangkor Island could help to reduce the total waste generated per capita as the total recyclable waste generated from each household was not significant difference in Pangkor Island.

Table 9: Average for Recyclable and Non-Recyclable Wastes Generation per week of 18 Households

Household	Recyclable waste (kg)	Non-recyclable waste (kg)	Total (kg)	Number of members	Per capita (kg)
1	0.23	1.95	2.18	2	1.09
2	2.35	1.62	3.96	3	1.32
3	1.71	4.83	6.54	3	2.18
4	2.99	3.36	6.35	3	2.12
5	5.66	3.22	8.88	3	2.96
6	2.23	7.35	9.58	4	2.40
7	4.27	5.13	9.39	4	2.35
8	2.00	5.73	7.74	4	1.94
9	1.66	4.01	5.67	4	1.42
10	2.91	5.38	8.28	4	2.07
11	2.33	6.25	8.59	4	2.15
12	1.45	7.56	9.01	5	1.80
13	6.10	5.64	11.74	5	2.35
14	2.77	7.60	10.37	5	2.07
15	4.14	16.03	20.17	6	3.36
16	2.59	9.26	11.85	6	1.98
17	3.77	10.24	14.00	7	2.00
18	2.93	11.82	14.74	7	1.80
Average	4.45	6.50	10.95	4	2.39
Standard Deviation	1.46	3.62	4.18	-	0.53

Table 10: ANOVA of Domestic Waste Segregation

		Sum of Square	**DF**	**Mean Square**	**F Value**	**Sig.**
RW	Between Groups	1.111	4	0.278	0.123	0.972
	Within Groups	29.447	13	2.265		
	Total	30.558	17			
NRW	Between Groups	161.831	4	40.458	13.569	0.000
	Within Groups	38.761	13	2.982		
	Total	200.592	17			
TW	Between Groups	175.214	4	43.803	8.465	0.001
	Within Groups	67.267	13	5.174		
	Total	242.481	17			
PC	Between Groups	.699	4	0.175	0.710	0.599
	Within Groups	3.198	13	0.246		
	Total	3.897	17			

RW = recyclable wastes, NRW = non-recyclable wastes, TW= total wastes, PC = waste generated per capita.

CONCLUSIONS

In order to change the attitudes and willingness of Pangkor Island community towards the current issues on sustainable solid waste management practices, the SWM education is proposed to begin with students as early as primary school age, whereby to instil good practice or behaviour at their tender age. Apart from that, local authority should consult non-governmental organisations (NGOs), such as EcoKnight, Reef Check Malaysia and Environmental Protection Society Malaysia (EPSM), to carry out some environmental campaigns to the local communities of Pangkor Island as well as to the primary and secondary school students in order to educate and inculcate them about the importance of SWM by showing them the severity of the current SWM issues that resulting to human health problem or even to the next generation if the issues persist. Example of themes of the educational campaign can be tips and skills of SWM to Pangkor Island community; thus, they know ways to manage solid waste themselves.

This study was unable to obtain participation of the three major ethnic community's i.e. Malay, Chinese and Indian due to lack of manpower for solid waste segregation and language barrier. Inability to speak fluently in Malay and Tamil languages, hinder the Malay and Indian communities to take part in the solid waste segregation study.

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