Journal of Asian Scientific Research

journal homepage：http://aessweb.com/journal-detail.php?id=5003

# INTERRELATIONSHIP BETWEEN AFFLUENCE AND HOUSEHOLD SIZE ON MUNICIPAL SOLID WASTE ARISING: EVIDENCE FROM SELECTED RESIDENTIAL AREAS OF PUTRAJAYA

**D. Irwan**[1]
**N.E.A Basri**[2]
**K. Watanabe**[3]

## ABSTRACT

*Municipal solid waste (MSW) has always been an unavoidable byproduct of human habitation and activities. As the world now sees an exponential growth in population, so does it sees an alarming increase in the quantity of generated MSW. If managed and disposed of improperly, MSW is a major cause of adverse environmental conditions. Rapid development, urbanization, changes in consumption patterns and elevated levels of affluence in recent decades have only exacerbated the issue, especially in developing countries such as Malaysia. Hence, the impetus to handle these problems and to manage MSW in an efficient yet environmentally sound manner is reaching an apogee currently. Determining per capita MSW generation rate and understanding it's influencing factors is one step towards efficient MSW management. The objectives of this study are twofold; to determine current per capita residential MSW arising rate and subsequently to discern if a correlation exists between MSW generation rate, affluence and household size. Three discrete housing neighborhoods in Putrajaya were selected as the areas under study. To capture varying socioeconomic levels, the selected study areas consists of bungalow, semidetached and terraced houses. Primary data was obtained by door-to-door weighing of MSW for 12 consequent days which makes up a sampling phase. This was conducted concurrently in all study areas, with a total of 3 sampling phases done over a 1 year period. A face-to-face survey was then performed on all households under study to obtain relevant socioeconomic data. From the analysis done, it is found that generally, household size has an inverse relationship on MSW arising. The affect of affluence on MSW discharge rate is found to be positive. From this study, concerted efforts to reduce MSW arising can be better focused on selected target groups and demographics, bringing us a step closer to sustainable waste management practices.*

**Key Words:** MSW, Municipal solid waste, Generation, Affluence, Household size

[1] Department of Civil Engineering, National University of Malaysia, Malaysia

[2] Department of Civil Engineering, National University of Malaysia, Malaysia

[3] Taekyo University, Tokyo, Japan

## INTRODUCTION

Every human activity produces waste. Anywhere that is inhabited by humans, there is waste. Humankind has always produced waste in one form or another. In it's solid and most abundant form, it is called municipal solid waste (MSW) or trash, in layperson's terms. After cement production, MSW is the single largest mass generated by humanity (Matsunaga 2002). Generally, MSW constitutes what one consumes or make use of and then dispose of everyday. It is difficult to be more specific in the definition of MSW, as what is considered to be waste in one society, culture or country may not be considered as such in another. Indeed, the very category of waste or trash is exceptionally dynamic (Strasser 1999) and is so dependent on various factors and circumstances. Strasser (1999) states that nothing is inherently trash and that waste is actually produced by the act of sorting. In short, waste is dynamic and relative to the one producing it. This varying definition of waste is one of the hurdles in the proper management of waste.

Ultimately, it cannot be denied that MSW generation has been on the rise year on year, most notably in the past several decades. The increase in MSW generation can be attributed to several factors, namely the exponential world population boom, rapid development, increased consumer buying power and a plethora of other causes. This situation is particularly acute in developing countries such as Malaysia, where the fast pace of development has brought along rapid urbanization and increased rural-urban migration patterns. It has been estimated by Mansor (1999) that MSW generation in Kuala Lumpur will increase from 2620 tons per day in 1995 to 3070 tons in 2000. Murad et al. (2007) reports that in the year 2000, Kuala Lumpur's actual MSW generation stood much higher at 4000 tons per day.

On a smaller scale, the national average for per capita waste generation in Malaysia was 0.68 kg/capita/day in 2001 (UNEP 2010). That figure has increased in 2006 to roughly 0.85 kg/capita/day resulting in a total of 7.34 million tons of MSW generated in the nation as a whole for that year (Siraj 2006). So far, other studies have been unable to come up with a definitive and consistent figure for waste generation in any given area that is under study. This is primarily due to several factors such as the varying definition of waste from area to area, the method of analysis and problems during measurement (Watanabe 2010).

One of the most influential factors thought to play a major role in determining waste generation rates is the affluence or income level of a particular household or person. A positive correlation between affluence and waste generation rate means that the more affluent a person is, the more waste he will produce due to his possession of expendable income that is used to buy and consume more products. On the other hand, a negative correlation could denote that the more money a person earns, then they are more apt to eat out and be more aware of environmental concerns, thus producing less waste per capita. Hitherto, prior researchers have found conflicting indications showing the correlation between waste generation rates and affluence. Wertz (1976) and Jenkins

(1993) found there is a direct positive correlation, while Cargo (1978) have found otherwise. Still others such as Hockett (1995) find the relation to be inconclusive.

The relationship between affluence and municipal waste generation is very close. AAAS (2000) found that a 40 percent increase in the GDP of countries belonging to OECD since 1980 has been accompanied by the same percentage increase in municipal waste generated. ]Even more troubling is the fact that the OECD predicts there will be a further 70 to 100 percent increase in GDP in its region by 2020. Unless the link between waste generation and GDP is severed totally, there could be a corresponding and commensurate increase in waste arising in these countries. This is further exacerbated by certain social trends, such as the increase in single person households due to higher divorce rates, lesser desire to raise a family and the aging population, particularly in the developed world. As the developing world industrializes and grows more affluent, it too can expect an increase in waste generation, unless an absolute decoupling of waste generation from GDP occurs.

Other factors thought to have an influence on the rate of MSW generation are spatial in nature, such as neighborhood area and housing type. Preceding researchers have found that the number of persons per household has a negative affect on amount of waste generated (Jenkins 1993). Demographic and geographical factors, such as population density, size of land area and average age of the populace, ethnicity and others like it also has a bearing on the generation of waste to a certain extent (Matsunaga 2002).

MSW management has been defined as the discipline of controlling generation (Tchobanoglous et al. 1993). Hence, apart from establishing average per capita waste generation in the study areas, this study also aims to investigate what socioeconomic factors influence our decision-making process the most in producing trash.

## METHODOLOGY

Three housing neighborhoods in Putrajaya were selected as the areas under study. Table 1 shows the neighborhoods selected, the housing type present and the number of houses on which this study was performed. To best capture varying socioeconomic levels, the selected study areas were deliberately selected so that they consist of bungalow, semidetached and terraced housing elements which are discrete and discontinuous from each other. The households selected for this study is presumed to be representative of the entire neighborhood and other similar housing projects in other localities in the country.

The first phase of the study is the waste weighing or sampling phase which spanned a period of one year. Primary generation data from the households under study was obtained by simple door-to-door weighing of MSW for 12 consecutive days from Mondays to Saturdays. This makes up a data sampling phase and was conducted concurrently in all study areas, with a total of 3 sampling

phases done in predetermined months over a 1 year period. Sampling phases 1 was performed in February 2011, phase 2 was done in May 2011 and finally phase 3 took place in December 2011.

**Table-1.** Type and number of houses present in the selected study areas

| Study Area | Precinct P14A | Precinct P14A | Precinct P16D |
|---|---|---|---|
| Housing type | Bungalows | Semidetached | Terraced |
| Number of sampled houses | 25 | 51 | 66 |
| Number of sampled houses post-sporadic exclusion | 13 | 30 | 26 |

The door-to-door MSW weighing activities were conducted by 3 teams with each team having 2 to 3 personnels. Each team used standardized digital electronic weighing scales with a maximum capacity of 40 kilograms, a resolution of 10 grams and a readability of 10 grams. Standard operating procedure are for the team members to identify, withdraw and then uncover the waste bin of the house under study, take out all the waste that has been discharged within and then weigh the same using the digital scale. Waste that are 'loose' or those that has been scattered inside the waste bin were repackaged in new litter bags and then weighed whenever possible. Materials that were sorted into distinct categories, meaning those that were obviously sorted with a purpose to facilitate recycling activities, were weighed and recorded separately from commingled waste.

Houses that were vacant or that discharged waste too sporadically such as guesthouses and houses that were only occupied on the weekends were precluded from the final data analysis to preserve data accuracy and avoid outliers in the analysis. A particular house is designated as being sporadic if it has more than 4 zero readings in one sampling phase. After all sporadic and questionable premises were eliminated, the number of houses included in the final analysis is shown in Table 1. This set of houses is identified as the APP (All Periods Present) dataset, signifying houses that consistently produced good data and discharged waste regularly throughout the whole one year sampling period.

A face-to-face survey was performed on all households under study after the third sampling phase to obtain relevant socioeconomic data of the occupants. The survey took place in November 2011 and went on for 3 weeks. Trained student enumerators were used during this phase of the study. We employed the face-to-face method because it has been shown to be the most reliable questionnaire survey approach, especially in the collection of socioeconomic figures (Afroz 2011). The questionnaire consisted of 24 questions pertaining to the demographic, socioeconomic status and waste management habits of the household under study. Among the more pertinent questions is one regarding the number of persons living in the house. Another salient question asks the

respondent to state the approximate combined monthly income of their entire household. To avoid undue suspicion and to increase the respondent's willingness to answer, the answer to this latter question is given as set ranges as shown in Table 2. Each income group shown in Table 2 has an inferred socioeconomic strata linked to it.

**Table-2.** Income groups and corresponding inferred socioeconomic strata of survey respondents

| Income group | Total monthly household income range (RM) | Socioeconomic strata |
|---|---|---|
| 1 | Below 1,000 | Impoverished |
| 2 | 1,000 to 2,000 | Low income |
| 3 | 2,000 to 5,000 | Middle income |
| 4 | 5,000 to 10,000 | Upper middle income |
| 5 | Above 10,000 | Wealthy |

Call cards were left in the mailboxes of houses that were vacant and those that seemed to be devoid of occupant even after repeated visits by the enumerators. Call cards were also given to uncooperative or aggressive respondents. These call cards implored the reader to visit the URL of a website which in turn leads to a link that enables them to download a soft copy of the survey questionnaire form. They can then fill out the questionnaire form at their convenience after which they were instructed to submit the form they filled out to the study team via email.

Subsequently, the MSW generation data is compiled and then analyzed with the prime aim being to determine average per capita per day waste generation figures. The socioeconomic data acquired from the questionnaire survey exercise is then studied in parallel with the aforementioned waste arising figures.

## RESULTS AND DISCUSSION

Table 3 and Table 4 shows salient socioeconomic data pertaining to affluence level and household size which was obtained from the questionnaire survey for all 3 study areas. The proceeding average per capita daily MSW generation results and subsequent discussion will be split into 4 sections, that is demographics, waste arising data and subsequently the relationship between arising, affluence level and household size of the houses under study.

## DEMOGRAPHICS

**Table-3.** Number and percentages of houses in each income group

| | Income group 1 | Income group 2 | Income group 3 | Income group 4 | Income group 5 |
|---|---|---|---|---|---|
| P14A Bungalows (%) | 0 (0) | 0 (0) | 0 (0) | 3 (23) | 10 (77) |
| P14A Semidetached (%) | 0 (0) | 1 (3.33) | 1 (3.33) | 16 (53.33) | 12 (40) |
| P16D Terraces (%) | 1 (3.8) | 0 (0) | 4 (15.2) | 7 (27) | 14 (54) |

Table 3 shows the distribution of households that falls into each income group in the study areas. The above data is in accordance with the general assumption that the more expensive or the bigger a house is, then the more likely it is that the occupants will have a higher total monthly income level. P14A bungalows has the highest number of houses in income group 5, while P14A semidetached and P16D terraced housing areas have more income group 3 and income group 4 houses. There are more residents in P14A semidetached houses that earns between RM5,000 - RM10,000 per month (income group 4) when compared to the P16D terraced housing area. The same is true for income group 3. It is important to note that there are more houses in P16D terraces which belong to income group 5 than in P14A semidetached. The reverse should be expected, as semidetached housing are more expensive than terraced houses. However, it should be mentioned here that several houses in P14A semidetached area are actually being used as staff quarters for the public sector. Hence, the residents of these staff quarters may not earn an income commensurate with their housing type as essentially their housing cost is paid for or subsidized by the government, in whole or in part.

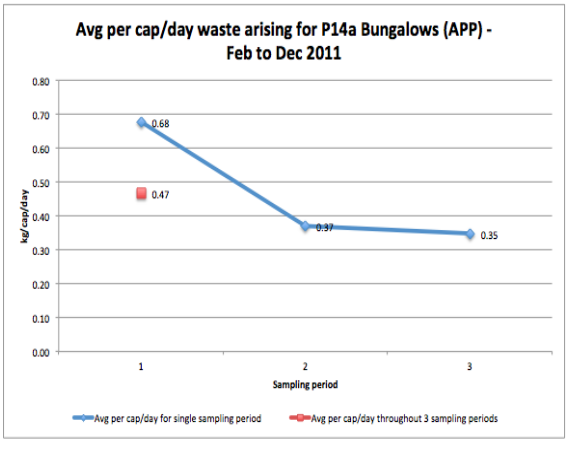
From Table 4, we can see that more than half of the houses under study have 3 to 5 occupants. This is inline with the findings of Mok (2011) which states that the average household size in Malaysia is 4.3 persons and that 56% of Malaysian households have less than 5 members. The next highest percentage of the houses under study are the households that have 6 to 8 persons in it, which can be considered as medium in size. Note the abnormally high percentage of 1 to 2 persons households in P14A bungalows.

**Table-4** Number of persons per household data

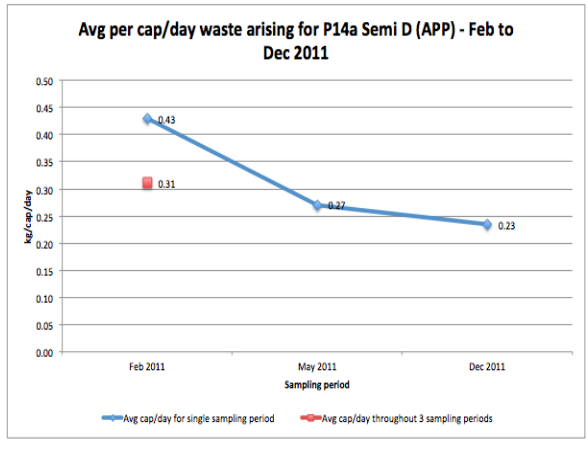
| | 1 - 2 pax | 3 - 5 pax | 6-8 pax | 9-10 pax |
|---|---|---|---|---|
| P14A Bungalows (%) | 3 (23) | 7 (53.8) | 2 (15.4) | 1 (7.7) |
| P14A Semidetached (%) | 2 (6.66) | 16 (53.33) | 12 (40) | 0 (0) |
| P16D Terraces (%) | 0 (0) | 15 (57.7) | 10 (38.5) | 1 (3.85) |

## WASTE ARISING DATA

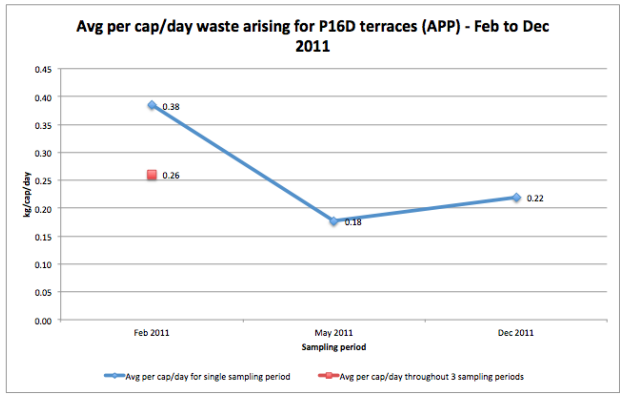
**Figure-1.** Average per capita per day MSW generation of (a) P14A bungalows, (b) P14A semidetached and (c) P16D terraced houses




(a)




(b)




(c)

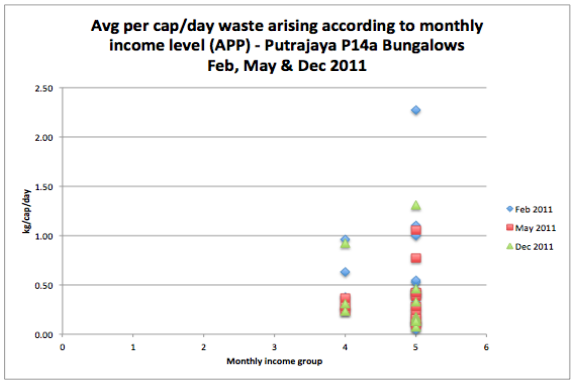
Figure 1 shows the average daily per capita waste arising figure of the households being studied throughout the 3 sampling phases. Average per capita waste generation figures for each sampling phase is also shown. It can be seen that P14A bungalows has the highest average waste discharge rate throughout the study period which stands at 0.47 kilograms/capita/day. This is followed by P14A semidetached houses with an average daily waste discharge rate of 0.31 kilograms/capita/day. P16 terraced housing area has the lowest average daily waste generation of 0.26 kilograms/capita/day throughout all 3 sampling periods. Therefore, the average per capita daily waste generation figures obtained in this study are lower than those cited by Siraj (2006) and UNEP (2010). However, it is critical to note that both preceding studies neglected to mention which level of society or what type of housing area was being studied.

When looked at a temporal aspect, it is seen that the sampling phase carried out in February 2011 recorded the highest average per capita per day waste generation figures. All subsequent sampling phases recorded lower values except for P16D terraces which recorded a slight spike at the end of 2011. The cause of this temporal fluctuation of waste discharge with time remains unclear.

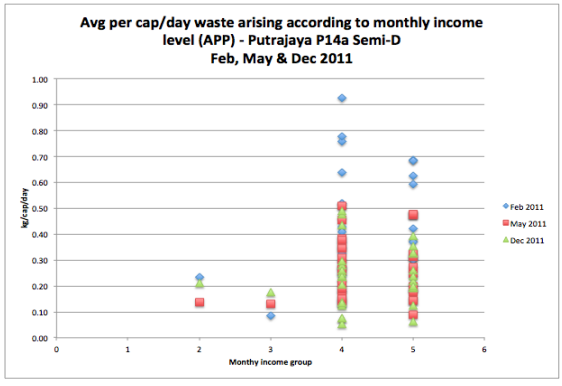
## WASTE GENERATION AND AFFLUENCE

Figure 2 shows the average per capita daily waste discharge rates of the household under study according to their total monthly income level. Assuming that the monthly income figures given by the respondents in the questionnaire study is 100% accurate, then it is found that the higher income groups as denoted by income group 4 and income group 5 produces the most waste. In certain cases, average per capita daily waste generation exceeded 1 kilogram per capita per day. This is especially true for households in P14A bungalows which most probably has the highest number of well to do families. Households that reported a lower total monthly income consistently recorded much lower average per capita daily MSW generation rates, as can be seen in Figure 2 (b) and (c). Note that there are several instances in P14A semidetached houses whereby income group 4 houses produced more waste per day when compared to income group 5 houses. Again, this inordinate number of houses with disproportianately high rate of MSW discharge could be linked to the fact that some houses in the said area are used as staff quarters for the public sector.

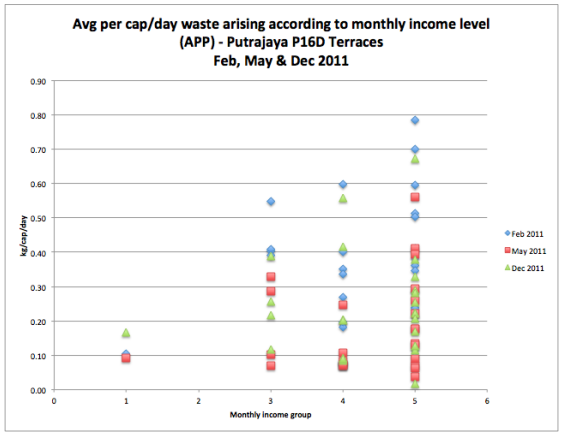
**Figure-2**. Average per capita per day waste discharge rates according to monthly income level




(a)




(b)




(c)

## HOUSEHOLD SIZE

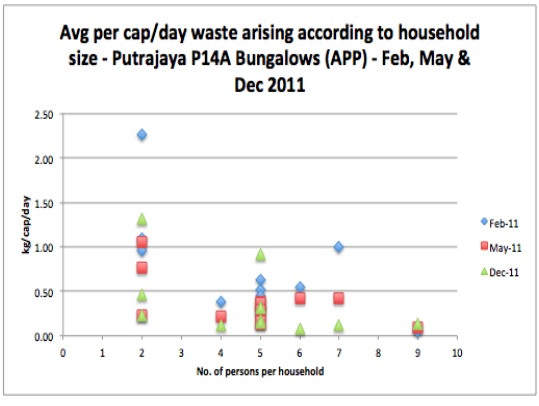
Figure 3 shows the average daily per capita MSW discharge rate according to the number of persons that makes up a household. Outwardly, bigger households with more than 5 members have a lower average daily waste discharge rate per capita when compared to households that have a lesser number of residents. Going into more detail, it is important to keep in mind the average Malaysian household size as reported by Mok (2011) is 4.3 persons. We also take note of each study area's average daily per capita waste discharge rate throughout 3 sampling phases as shown in Figure 1.

We theorize that the households that produce more waste per capita daily are the ones whose residents number less than the national average of 4.3 persons. We also hypothesize that households that have more than 4.3 residents produce less waste per capita per day. Consequently, the households whose number of residents is above the national average of 4.3 persons and have a daily per capita waste arising that is lower than the average rate throughout the 3 sampling phases is designated to be of interest. Conversely, households that discharged more waste per capita per

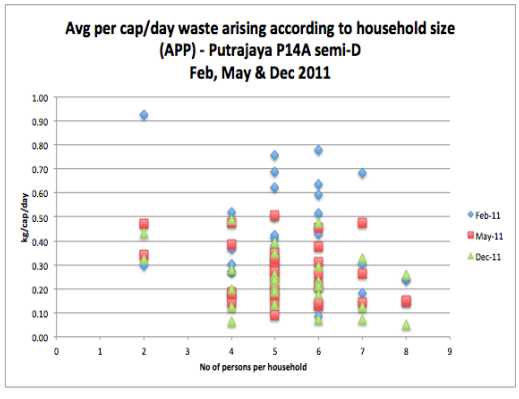
day than the 3 sampling phases average and also have less than 4.3 residents are also singled out. The findings are shown in Table 5.

From Table 5, the majority of houses in each study area does adhere to the above postulation. Thus, the hypothesis that household size has an inverse affect on waste generation is found to be supported by the findings of this study.

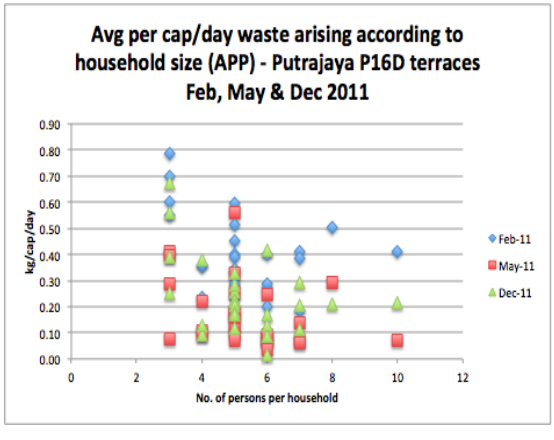
**Figure-3.** Average per capita per day waste discharge rate according to household size




(a)




(b)




(c)

## CONCLUSION

From the study that was carried out, it can be surmised that generally in Putrajaya, smaller households and households with higher income produces more waste than their counterparts. Thus, waste generation rate has a positive correlation with affluence and an inverse relationship with household size. Everything that we buy and use today will eventually require a decision; keep it or throw it away. This decision hinges very much on human behavior and socioeconomic factors. It is hoped that the results from this study will help us shed more light on MSW management and the crucial discipline of controlling it's generation.

## REFERENCES

**Afroz, R., & Masud, M. M. (2011)** "Using a contingent valuation approach for improved solid waste management facility: evidence from Kuala Lumpur, Malaysia" Waste management (New York, N.Y.), Vol.31, No.4, pp.800-8.

**The American Association for the Advancement of Science (2000)** The AAAS Atlas of Population and Environment, Population, Waste and Chemicals, online publication.

**Cargo, D.B (1978)** Solid Wastes: The Factors Influencing Generation Rates, University of Chicago.

**Hockett, D., Lober, D.J., Pilgrim, K (1995)** "Determinants of Per Capita Municipal Solid Waste Generation in the Southeastern United States" Journal of Environmental Management, No.45, pp.205-217.

**Jenkins, R.R (1993)** The Economics of Solid Waste Reduction: The Impact of User Fees, Edward Edgar Publishing.

**Mansor, W.G (1999)** "Waste Prevention: A Consumerist Approach to Waste Management" Paper Presented in EPSM Seminar on Local Communities and the Environment March, Vol. 27.

**Matsunaga, K. (2002)** Effects of affluence and population density on waste generation and disposal of municipal solid wastes. Earth Engineering Center Report,, pp.1-28.

**Murad, M. W., Raquib, M. A., & Siwar, C. (2007)** Willingness of the Poor to Pay for Improved Access to Solid, pp.84-101.

**Mok, T. P., & Dalziel, P. (2011)** "Household Size Economies : Malaysian Evidence" Economic Analysis & Policy, Vol.41, No.2, pp.203-224.

**Saeed, M. O., Hassan, M. N., & Mujeebu, M. A. (2009)** "Assessment of municipal solid waste generation and recyclable materials potential in Kuala Lumpur, Malaysia" Waste management Vol.29, No.7,pp. 2209-13.

**Strasser, S. (1999).** Waste and want: A Social History of Trash (1st ed., p. 355). New York: Owl Books, Henry Hold and Company LLC.

Siraj, M., Waste Reduction: No Longer An Option But A Necessity: In Bernam. Kuala Lumpur, 2006.

**Tchobanoglous, G., Theisen, H., Vigil, S. (1993).** Integrated Solid Waste Management-Engineering Principles and Management Issues (p. 978). New York: McGraw-Hill.

United Nations Environment Programme (UNEP), Division of Technology Industry and Economics

http://www.unep.or.jp/Ietc/Publications/spc/State_of_waste_Management/2.asp (March 2010)

Watanabe, K., Waste Analysis and Statistics, a seminar held at LESTARI, UKM, July 2010.

Wertz, K.L., 1976. Economic Factors Influencing Households' Production of Refuse, Journal of Environmental Economics and Management, Vol.2 Issue 4, April 1976, Pg 263-272

**Table-5.** Household size and waste arising findings

| | Number of households with above average household size & below average daily per capita waste discharge (%) | Number of households with below average household size & above average daily per capita waste discharge (%) | Total number of conforming households (%) |
|---|---|---|---|
| **P14A Bungalows** | 7 (53.8) | 3 (23) | 10 (76.9) |
| **P14A Semidetached** | 11(36.6) | 4 (13.3) | 15 (50) |
| **P16D Terraces** | 13 (50) | 5 (19.2) | 18 (69.2) |