Household waste generation, composition and expenditure: a growing waste challenge in Iskandar Malaysia

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Abstract: Iskandar Malaysia, a rapidly developing zone in Johor Bahru faces an alarming waste generation rate. This study aims to evaluate the average daily household waste generation rate, composition and expenditure per household; and how they relate to the waste growth in the zone so that a sustainable management plan could be put up. 100 households/respondents in the area were selected using structured survey. Results showed that major waste compositions are food waste (47.0%), miscellaneous waste (17.3%), paper waste (13.0%), plastic waste (7.4%), glass waste (4.6%), metal waste (3.4%), garden waste (3.2%), textile (1.6%), rubber waste (1.0%), leather waste (0.8%) and hazardous waste (0.7%). The average daily household waste generation rate per household was 1.36 kg/household/day. Average daily household expenditure per household was RM 88.40/household/day. It was also found that a significant positive relationship between household waste generation and household expenditure ($r = 0.273$, $p < 0.01$) exist. Household waste generation was also found to be positively correlated with number of persons in household ($r = 0.376$, $p < 0.01$), household expenditure was correlated with household income ($r = 0.356$, $p < 0.01$) and with the number of persons in households ($r = 0.308$, $p < 0.01$).

Keywords: Household waste generation, Iskandar Malaysia, expenditure, waste generation rate

INTRODUCTION

Globalization, industrialization and rapid development in both economic and population had caused a disturbing rate of solid waste generation [1]. World Bank [2] reported that urbanization waste generation rate and income level are highly correlated. As income and living standards increases, consumption of goods and services increase as well. This then reflects into increase in the amount of waste generated. Breaking the historic link between waste creation and wealth creation remains a challenge for a modern industrial country [3]. Malaysia, one of the developing countries, had generated approximately 7.34 million tonnes of solid wastes in 2006 [4]. Fauziah et al. [5] estimated that local authorities and waste management consortia in Malaysia have to deal with approximately 170,000 tonnes of MSW everyday throughout the country. In a related development, the amount of MSW generated in 2010 in Kuala Lumpur, the capital city of Malaysia, was reported to be 2000 tonnes per day [6]. The population of Kuala Lumpur then was 1.67 million people [7]. With that, the MSW generation average per capita was 1.2 kg per day. The report further stated that 74% of MSW generated in the city for that year was of food waste and its mixtures, followed by plastics (21%), others (2%). Paper, mixed organic and wood constituted the rest (1%).

Ferrara [11] reported that in 2005, households accounted for over 75% of MSW in Korea, Germany, United Kingdom, Mexico, Belgium, Netherlands, Slovak Republic, Luxembourg, Denmark and Spain. Malaysia too faces the same situation as noted earlier [5]. They reported that the largest contributor to generated MSW in Malaysia is household waste. The composition in MSW of the households in Kuala Lumpur is seen to be due to uncontrollable consumption, because of increasing population, attitude towards shopping and high living standards [12]. Department of Statistic Malaysia [8] found that in 2009 and 2010, the average monthly household expenditure in Malaysia is RM 2190 (RM 73/household/day) or USD 671, an increase of RM 237 compared to 2004 and 2005. This shows that the
living standards in Malaysia have increased compared to what was obtained in the past five (5) years. In the official census conducted by the Department of Statistic Malaysia [9] in 2010, the highest percentage household expenditure per household in 2009 to 2010 was from housing, water, electricity, gas and other fuels (27%). It is then followed by food and non-alcoholic beverages (20%), transport (15%) and restaurants and hotels (11%). Under the restaurants and hotel expenditure, this consisted three categories namely, expenditure on food away from home (8.9%), expenditure on beverages away from home (1.8%) and accommodation services and others (0.3%).

Iskandar Malaysia faces the challenge of rapid waste generation as well [19, 13]. It is a new developing economic region in the most Southern state of Johor in Malaysia, established on July 2006 under the Ninth Malaysia Plan [14]. The aim was intended to provide economic income, promotes social status, and conforms with modern developmental sustainability to the southern part of Malaysia, neighbouring Singapore. It is the third largest metropolitan in Malaysia, with population of 1.2 million in 2010 [7]. A study conducted by Ng [15] revealed that in Johor Bahru district, mainly consisting of the areas under Johor Bahru City Council and Johor Bahru Tengah Municipal Council, MSW generation rate in 2010 was 1500 tonnes per day, which is equivalent to 547,700 tonnes per year. The population of the area then was 1.01 million [9]. Thus, the MSW generation rate for a person at year 2010 was 1.5 kg/capita/day. This is higher compared to the MSW generation rate for Kuala Lumpur (1.2 kg/capita/day) [12].

With the average annual population growth rate from 2000 to 2010 of 2.0% [7], it was predicted that the population in Johor Bahru district will continue increasing, which then translate to increase in MSW generation as well. As household waste is the main contributor to MSW generation [16, 17, 5]; the purpose of this study is to understand the household waste generation, composition and expenditure in Iskandar Malaysia while examining the relationship between waste generation and household expenditure.

**METHODOLOGY**

The study is conducted in Iskandar Malaysia, comprising the local authorities of Johor Bahru City Council (MPJB), Johor Bahru Tengah Municipal Council (MPJBT), Pasir Gudang Municipal Council (MPPG) and Kulai Municipal Council (MPKu). Several survey forms were administered to different household (100 households) and of different income as well. Respondents were monitored for 10 days, and were requested to record waste generated according to waste segregation type and household type daily. To this effect, inventory form was developed and distributed to the respondents for daily data recording [31]. Monitoring was meant to ensure that respondents provide honest and accurate information. Furthermore, monitoring was scheduled once every three days and respondents were asked to take photos to ascertain that they were really complying with requirements of the survey. Weighing scales, plastic bags, baskets, labelling stickers, survey form were given to respondents in form of survey kits. 120 respondents participated in the survey. The distribution for respondents in each municipality is as follows: 40 (33.4%) are from MPPG, 37 (30.8%) from MPJB, 31 (25.8%) from MPJBT and 12 (10.0%) from MPK municipal area councils. Housing types consisted of single storey terrace, double storey terrace, low cost apartment houses and flat housing settings. Others constituted semi-detached and Malay village style housing types. Bungalow and condominium were not included as it is hard to recruit residents.

**RESULT AND DISCUSSION**

*Household Income*

In the survey, household income was one of the aspects investigated to study its relationship with solid waste generation. Income was classified into high, middle and low categories. High income category consisted of income above RM 8,000, whereas income below RM 3,000 is categorised low. Middle income ranges from RM 3,000 to RM 8,000. Figure1 shows the distribution of the household income among the respondents in the study. It shows that 19 (15.8%) respondents are of high income household, where each household earns above RM 8,000. On the other hand, 30 (25%) of the respondents are low income households, where each household earns income below RM 3,000, whereas the middle income 71 (59.2%) ranged from RM 3,000 to RM 8,000. As RM 3,000 to RM8, 000 is a wide range; it is further decomposed into 5 sub categories; RM 3,000 to RM 3,999, RM 4,000 to RM 4,999, RM 5,000 to RM 5,999, RM 6,000 to RM 6,999 and lastly, RM 7,000 to RM 7,999. In these category, 27 (22.5%) of the respondents are within the range of RM 3,000 to RM 3,999. Then, those with income ranging from RM 4,000 to RM 4,999 constituted (15, (12.5%)). Both income range of RM 5,000 to RM 5,999 and RM 7,000 to RM 7,999 constituted the same proportion (12 (10.0%)) each. Lastly, (5 (4.2%)) of the respondents had household income ranging from RM 6,000 to RM 6,999.
The distribution of number of persons in household in the study area is included in the report of the current study. This is necessary because size of household persons dictate the amount of waste generated in households. It is also important to have the inventory of the persons involved in the survey so that generation per capita can be established in the survey area. The figure shows that 30 (25.0%) households have 4 persons. 27 (22.5%) had 3 persons in their household. 22 (18.3%) had 5 persons in their households, while 16 (13.3%) had 2 persons in their household. Others included 10 (8.3%) having 6 persons in their households, then 8 (6.7%) households with 7 persons in each household, 5 (4.2%) having 8 persons in a household, and finally, 2 (1.7%) households with persons exceeding 8.

Household Waste Generation in Iskandar Malaysia

The total amount of waste generated in the 10 days sampling period is 1782.17 kg. The total number of persons involved in the survey is 524; therefore, the household waste generated per person per day is 0.34 kg/capita/day. With the average of 4 persons in a household, household waste generated by an average household per day in Iskandar Malaysia is 1.36 kg/household/day. The results of the study on waste generation are summarized in Table 1.

Maunsell Malaysia [18] forecasted that in 2010, the household waste generated in Iskandar Malaysia was 670,028t/y. The number of population in Iskandar Malaysia then was forecasted to be 1,731,785 capita. With that, the household waste generation rate per capita in the region was 1.06 kg/p/d. Comparing this with the forecast of household waste generation rate per person using the statistics found by [18], the household waste generation rate per person obtained through this study is significantly lower than expected (0.34 kg/p/d); which is much lower than the forecasted in 2010 (1.06 kg/p/d). However, it corresponded to the lowest range reported by [20]. In the same report, it is stated that in a global perspective, middle income countries residential waste generation rates should be within 0.35 kg/p/d to 0.65/kg/p/d. The amount in study area is then is expected because most of the respondents in Iskandar Malaysia are of working class population; they would prefer to eat in the restaurants and café [21]. It also explains why the household expenditures (as shall be seen latter) in restaurants and cafes were the second largest expenditures incurred in the households.

Table 2 shows a comparison of low, middle and high income countries showing respective generation rates in 2005; with increasing rates as a function of economic growth. This was confirmed in another report indicating that Hong Kong with GDP per capita (PPP) of US$34,000, had a much higher MSW generation rate (1.59 kg/capita/day) compared to India (with GDP US$3,400 and generation rate of 0.50 kg/p/d) despite the higher population of the latter [22]. Several studies had found that the amount of waste generated by a country was proportional to its population and
mean living standards of the people [23, 25]. Hence, it can be said that the status of economic development of a country increases its rate of MSW generation. Consequently, Malaysia a middle income country, lower household waste generation rate is expected.

Nevertheless, it should be noted that the generation rates showed in Table 2 are of MSW generation, not specifically on household waste generation rate. Although it was reported that MSW generation rate for Malaysia was 0.80 kg/capita/day in 2005 [30], it would be possible for the household waste generation rate then to be lower than that if a survey similar to the current one was to be conducted. However, household waste would still remain as the major contributor to MSW generation in Malaysia and other countries as well [5, 26, 28, 29, 30].

**Table 2: Comparison of MSW generation rate at year 2005 in low, middle and high income**

<table>
<thead>
<tr>
<th>Countries</th>
<th>GDP Per Capita (PPP) (US Dollar)</th>
<th>Population (p in million)</th>
<th>MSW Generation Rate (kg/p/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Income</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2,100¹</td>
<td>144.3¹</td>
<td>0.41²</td>
</tr>
<tr>
<td>India</td>
<td>3,400¹</td>
<td>1,080.3¹</td>
<td>0.50³</td>
</tr>
<tr>
<td><strong>Middle Income</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>8,600¹</td>
<td>65.4¹</td>
<td>0.66⁴</td>
</tr>
<tr>
<td>Malaysia</td>
<td>12,000¹</td>
<td>24.0¹</td>
<td>0.80⁵</td>
</tr>
<tr>
<td><strong>High Income</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>28,600¹</td>
<td>4.4¹</td>
<td>1.59⁶</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>34,000¹</td>
<td>6.9¹</td>
<td>2.42⁷</td>
</tr>
</tbody>
</table>

Source:

1 United States Central Intelligence Agency (CIA) (2011)
2 Enayetullah and Hashmi (2006)
3 Anepu (2012)
4 Cerdsatirkul (2012)
5 Government of Malaysia (2006)
6 Zhang *et al.* (2010)
7 Government of Hong Kong (2012)

**Household Waste Composition in Iskandar Malaysia**

Food waste constitutes the largest composition, 47.0%. Since sampling period was conducted during the end of year, it had coincided with some local fruit production season. This contributed to the increase in the generation of food waste. Miscellaneous waste is the second largest component residential waste generated where about 17.3%. This consisted of diapers, feminine hygiene products and tissues. In addition, wastes that do not fall into any other listed category, for example the waste on the sponge of a water filter, are categorized as miscellaneous waste as well. Paper waste constituted about 13.0% of the total waste. Paper waste included newspapers, magazines, boxes and other paper products. Some respondents included students on holidays; they may throw out used exercises books that resulted in the increase of paper waste generation. Plastic contributed 7.4% of the total waste generated. Glass constituted 4.6%. Then metal waste 3.4%, garden waste 3.2%, textile waste 1.6%, and rubber waste 1.0%. Garden waste was higher than its supposed proportion due to the raining season of the local weather at the end of the year. Strong wind and rains, contributed to fallen leaves and sticks, ultimately generating more waste than the normal. Leather is the second least component, with 0.8%. Leather products are expensive, thus throwing away these products would be less. Hazardous waste is the least, 0.7%. The waste compositions are summarized in Table 3.

**Table 3: Waste Composition in Iskandar Malaysia by Weight and Percentage (%)**

<table>
<thead>
<tr>
<th>Primary Waste Segregation Type</th>
<th>Weight (kg)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>837.19</td>
<td>47.0</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>308.90</td>
<td>17.3</td>
</tr>
<tr>
<td>Paper</td>
<td>232.18</td>
<td>13.0</td>
</tr>
<tr>
<td>Plastic</td>
<td>131.20</td>
<td>7.4</td>
</tr>
<tr>
<td>Glass</td>
<td>81.06</td>
<td>4.6</td>
</tr>
<tr>
<td>Metal</td>
<td>60.29</td>
<td>3.4</td>
</tr>
<tr>
<td>Garden Waste</td>
<td>57.73</td>
<td>3.2</td>
</tr>
</tbody>
</table>
In a similar pattern of waste composition, JICA [24] had reported that food (organic) waste (49.3%), others (18.2%), paper (17.1%), plastic (9.7%), glass (3.7%) and ferrous metal (1.6%) and 0.4% aluminium constituted the major component of household waste in Malaysia (Table 4). This confirms a report by Maunsell Malaysia (2009), stating that they expected the waste composition for Iskandar Malaysia would be similar with the waste composition in Malaysia especially in the early kick off of the project.

Table 4: Household Waste Composition Patterns in Malaysia by Percentage (%)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage of Composition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic waste</td>
<td>49.3</td>
</tr>
<tr>
<td>Others</td>
<td>18.2</td>
</tr>
<tr>
<td>Paper</td>
<td>17.1</td>
</tr>
<tr>
<td>Plastic</td>
<td>9.7</td>
</tr>
<tr>
<td>Glass</td>
<td>3.7</td>
</tr>
<tr>
<td>Ferrous metal</td>
<td>1.6</td>
</tr>
<tr>
<td>Aluminium</td>
<td>0.4</td>
</tr>
</tbody>
</table>

(Source: JICA, 2006)

Furthermore, Maunsell Malaysia [18] stated that, the composition of paper, plastic and other man-made items will decrease in the years to come, with the composition of organic waste not significantly decreasing due to the rapid development in the economic status within Iskandar Malaysia. The waste will then be relatively greater than the waste composition in Table 4. The reason is again because Iskandar Malaysia will be wealthier, more developed and industrialized than the average Malaysia cities. Rapid development and industrialization is a key ingredient in the waste composition increase [30].

Household Expenditure in Iskandar Malaysia

The total household expenditures recorded during the 10 days sampling period by all the 100 respondents is RM 115,767.40 for the 524 persons involved in this survey. With that, the average expenditure per person in a day is RM 22.10 (USD 6.8), whereas for average expenditure per household in a day is RM 88.40 (USD 27.4). This translates to an average monthly household expenditure to RM 2,652 (USD 822). This is higher than the average monthly household expenditure (RM 2,192 or USD 679) according to the Department of Statistic Malaysia [8]. There is an increase of 21.0% (RM 460) in the average monthly household expenditure from those periods to 2013. This could be due to income rise and corresponding increase in living standards of the populace. Expenditure on food accounted for the largest expenditures amounting to RM 31,160.42 (26.9%). Food items include: vegetables, meat, rice, fruits, snacks and others. RM 20,969.78 (18.1%), were expended on water and electricity bills. 17.1% (RM 19,835.28) of the total household expenditures were incurred in restaurant and cafeteria, including dining in the restaurant and take away food items. [21, 32, 33] reported that higher income households in Malaysia would prefer having meals outsides than home-cooked food. Miscellaneous goods and services like parking fee, toll fee, tuition fee, pocket money for children, car maintenance, beauty products and many more that could not be included in other type of expenditures, had constituted 11.5% (RM 13,305.78) of the total household expenditures. According to [21], higher income households do spend on good and services such as miscellaneous goods and services as they have more spendable income. Fuel petrol constituted 6.1% (RM 7,110.68). Clothing and footwear constituted 6.0% (RM 6,936.42). Beverages consume (4.1%), furnishings, household equipment and routine household maintenance (3.4%) of RM 4,706.73 and RM 3,886.57 respectively. Household cleaning products consume (2.1%), toys and sports equipment (1.6%), reading materials (1.6%) and medical expenses (1.5%). The expenditure for households in Iskandar Malaysia are summarized in Table 5.

Table 5: Household expenditure in Iskandar Malaysia in (RM) and Percentage

<table>
<thead>
<tr>
<th>Type of Household Expenditure</th>
<th>Total Amount Spend (RM)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>31,160.42</td>
<td>26.9</td>
</tr>
</tbody>
</table>
Utilities  |  20,969.78 |  18.1  
Expenditure in restaurant and cafe |  19,835.28 |  17.1  
Miscellaneous goods and services  |  13,305.78 |  11.5  
Petrol  |  7,110.68 |  6.1  
Clothing and footwear |  6,936.42 |  6.0  
Beverages  |  4,706.73 |  4.1  
Furnishings, household equipment, and routine household maintenance |  3,886.57 |  3.4  
Household cleaning products |  2,401.38 |  2.1  
Toys and sports equipment |  1,860.40 |  1.6  
Reading materials  |  1,829.60 |  1.6  
Medical expenses |  1,764.32 |  1.5  
TOTAL: |  115,767.36 |  100.0

[34] observed that as Malaysia experienced significant economic growth over the years that lead to higher standard of living, the overall level of spending and consumption of general public had increased as well. As a result, waste generation rates have increased considerably [30, 35]. [36] too reported that there is a significant and strong relationship between income and wealth with household expenditure as well as waste generation. Moreover, [37] stated that higher income groups tend to spend their on restaurants, holiday packages, entertainment items and reading materials than lower groups. This demonstrates why these group generate more packaging wastes; while food and household wastes are mostly generated by low income households due to often house cooking. They further stated that essential needs items like home-cooking provisions, clothing, health supplements and services, and personal care items, both high and low income groups do willing to spend money on them and as such partake equally in their waste related generations. Middle income earners would prefer to dine in restaurants and cafes, thus resulting less waste generated but more expenditure on food.

**Brief view of correlations for assessments**

An important instrument used for the analysis of the result is correlations between waste generation, expenditure, households and number of persons.

[40] has proposed that the strength of relationship, r, can be interpreted by its value. Value of equal to or more than 0.70 was computed for the strength of relationship. It could be interpreted that the relationship has a much larger than typical strength. This shows the existence of typical strength of relationship, where the value of r would be around 0.50. Lastly, if the value approximately approaches 0.10, the strength of the relationship is defined as small or smaller than typical value. With that, we can see that most of the relationships found for this study are of medium strength. The probabilities of all the three relationships identified are less than 0.01, where the null hypothesis of the study can be rejected.

**Household waste generation and expenditure**

Spearman Rho correlation test is chosen to see whether a relationship exists between household waste generation and household expenditure, and also the strength of the relationship [38]. As the data for both waste generation and household expenditure are not normally distributed, non-parametric tests are used [39]. Result of the Spearman correlation between household waste generation and expenditure is shown in Table 6.

**Table 6:** Result of Spearman Correlation between Household Waste Generation and Household Expenditure

<table>
<thead>
<tr>
<th>Household expenditure</th>
<th>Correlation Coefficient, r</th>
<th>Significance (2-tailed), p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Waste Generation</td>
<td>0.273</td>
<td>0.003 (p &lt; 0.01)</td>
</tr>
</tbody>
</table>

It was found that there exists a significant positive relationship between household waste generation and expenditure (r = 0.273; p < 0.01). According to [40], the strength of the relationship could be typically strong, small or smaller than typical. The interpretation of the strength of a relationship proposed by [40] is shown in Table 7. [41] found that there is a significant positive relationship between household expenditure and waste generation by physical categories. Saeed [12] agreed observed that the high amount of MSW generation in Kuala Lumpur, capital city of Malaysia, is due to uncontrollable consumption, due to the increasing population, attitude towards shipping and high living standards. World Bank [2] and United Nations, [17] further warned that as income and living standards increases, consumption of goods and services increases as well leading to more expenditures and waste generations.
### Table 7: Interpretation of the Strength of a Relationship

<table>
<thead>
<tr>
<th>General Interpretation of the Strength of a Relationship</th>
<th>$d$</th>
<th>$r$ and $\phi$</th>
<th>$R$</th>
<th>$\eta$ (eta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much larger than typical</td>
<td>$\geq</td>
<td>1.00</td>
<td></td>
<td>$\geq</td>
</tr>
<tr>
<td>Larger or larger than typical</td>
<td>$</td>
<td>0.80</td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>Medium or typical</td>
<td>$</td>
<td>0.50</td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>Small or smaller than typical</td>
<td>$</td>
<td>0.20</td>
<td></td>
<td>$</td>
</tr>
</tbody>
</table>

(Source: Cohen, 1988)

#### Household waste generation and number of persons in household

It was found that there is a significant relationship between household waste generation and number of person in household. Spearman Rho correlation test is performed, where a significant positive correlation ($r = 0.376$, $p < 0.01$) is found between household waste generation and number of person in household, as shown in Table 8.

#### Table 8: Spearman correlation between household waste generation and number of person in household

<table>
<thead>
<tr>
<th>Number of Person in Household</th>
<th>Correlation Coefficient, $r$</th>
<th>Significance (2-tailed), $p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Waste Generation</td>
<td>0.376</td>
<td>0.000 ($p &lt; 0.01$)</td>
</tr>
</tbody>
</table>

Afroz [43] observed a strong and positive relationship between waste generation and household size. They found that larger families generate more waste than smaller families. Related developments were reported by several studies such as: [44, 45, 25, 41, 46, 23]. However, [41] found negative relationship between waste generation and household size. They reported that the larger the number of persons in a household, the more the waste generation per capita decreases. [47] explained that households with higher number of persons would prefer to dine-out which then reduced the generation of household waste. Nonetheless, a recent case study conducted by [48] concluded that the generation of household sold waste is positively correlated with family size, stating that families with more persons generate more waste. Dangi [49] too agrees that the generation of household waste increases with the family size.

#### Household expenditure and household income

In this study, it was discovered that household expenditure is significantly positive correlates with household income ($r = 0.356$, $p < 0.01$), as shown in Table 9. The strength of the relationship is of medium or typical [40]. It is quiet common for households with high income to spend more. Reports by [50, 51] observed that the higher the income, the higher the total expenditures. They further learnt that once the income level increase even 1%, the total expenditure tends to be proportionately higher.

#### Table 9: Result of spearman correlation between household expenditure and household income

<table>
<thead>
<tr>
<th>Household Income</th>
<th>Correlation Coefficient, $r$</th>
<th>Significance (2-tailed), $p$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.356</td>
<td>0.000 ($p &lt; 0.01$)</td>
</tr>
</tbody>
</table>

#### Household expenditure and number of persons in household

It was determined that the household expenditure is significantly positive correlates with number of persons in household ($r = 0.308$, $p < 0.01$), as shown Table 10. According to [40], the strength of the relationship is medium or typical. In other words, it can be said that, with more number of person in household, the household expenditure will be higher as well. Similar to waste generation discussed previously. [52] stated that family size affects expenditures and further reported that the ratio of one person’s income to one household’s expenditure is smaller, when the household has more number of persons in it.

#### Table 10: Result of Spearman Correlation between Household Expenditure and Number of Person in Household

<table>
<thead>
<tr>
<th>Number of Person in Household</th>
<th>Correlation Coefficient, $r$</th>
<th>Significance (2-tailed), $p$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.308</td>
<td>0.01 ($&lt; 0.01$)</td>
</tr>
</tbody>
</table>
Future trends of waste in Iskandar Malaysia

Projection of future household waste generation in Iskandar Malaysia

With the waste generation rate of 0.34 kg/capita/day, an estimation of future trends of waste generation in Iskandar Malaysia from year 2015 to year 2030 is estimated, as shown in Error! Reference source not found.. The amount of waste generated by a country is proportional to its population and the average living standards of the people [23, 53]. Due to industrialization and rapid growth in economic and population, the generation of waste is directly affected [25, 6, 54]. Generally the higher the socioeconomic development and degree of urbanization, the greater the amount of waste produced [25]. With that, it is assumed that the number of population would increase linearly in the years to come, as proposed by [18].

Moreover, annual generation rate had to be taken into account for the estimation of future trend of waste in Iskandar Malaysia. Several authors reported further trends and fate of waste in the region and the country as well. [30] stated that the annual growth rate of waste generation in developing nation was 2 to 3%. In Malaysia, [55] discovered that the generation of MSW increased averagely 2% annually and further expected it to grow to 2.5-3% due to rapid development in both population and economics. [56] found that the waste generation in Malaysia increased by 3% annually. Therefore, in the projection of future trend for waste generation in Iskandar Malaysia, annual growth of 3% in the waste generation was foreseen. Consequently, it was estimated that the number of population in Iskandar Malaysia would be 2.1 million, with 0.27 million tonnes of wastes generated by 2015. This concurs to similar estimation by [30] for the region though covering only 3 municipalities in Iskandar Malaysia region. The number of population is expected to increase by 19.0% to 2.5 million, thus resulting in an increase to 0.32 million tonnes of waste generated that year. In 2025, with the population of 3.1 million in Iskandar Malaysia, it is estimated that 0.40 million tonnes of waste would be produced. Lastly, by 2030, 0.47 million tonnes of wastes are expected to be generated by the 3.7 million people in Iskandar Malaysia with the annual growth rate of 3%. Table 11 summarizes the projection of future household waste generation in Iskandar Malaysia from 2015 to 2030.

Table 11: Projection of future household waste generation in Iskandar Malaysia

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Population (million capita)¹</th>
<th>Number of Waste Generated (million tonnes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>2.1</td>
<td>0.27</td>
</tr>
<tr>
<td>2020</td>
<td>2.5</td>
<td>0.32</td>
</tr>
<tr>
<td>2025</td>
<td>3.1</td>
<td>0.40</td>
</tr>
<tr>
<td>2030</td>
<td>3.7</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Source: ¹Maunsell Malaysia (2009)

CONCLUSION

Household average daily waste generation rate per household in Iskandar Malaysia is computed as 1.36 kg/household/day. Food waste (47.0%) had constituted almost half of the amount of waste generated. Miscellaneous waste is also found to be outrageous (17.3%). This indicates that waste in this model region, waste is not separated from source. Paper waste constitute (13.0%), while plastic make up (7.4%) and glass waste (4.6%). Metal waste comprises 3.4%, then garden waste (3.2%). Textile makes up (1.6%), while rubber constitute (1.0%), leather and hazardous waste make up (0.8%) and (0.7%) each. So far, the waste composition of Iskandar Malaysia is similar to the waste composition of Malaysia. The average expenditure in Iskandar Malaysia per household for a day is RM 88.40.

Furthermore, there is significant positive relationship found between household waste generation and household expenditure (r = 0.273, p < 0.01). This agrees with the findings of [41]. He found that there is a significant positive relationship between household expenditure and household waste by physical categories. This is due to increasing income and living standards, increase in consumption which then lead to increases in waste generation [2, 17]. It was also found that household waste generation is positively correlated with number of persons in households (r = 0.376, p < 0.01).

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