The Effect of Household’s Age Structure to Waste Generation in Palembang City

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Abstract. Empirical facts suggested a particular household’s waste highly correlated to the specific age of the household’s inhabitant. The current study aimed to measure the effect of the household’s age structure on household waste generation. In addition to the household’s age structure, we included the food expenditure per capita, household’s average years of schooling, and the household’s net income in the waste generation model. The study used a Zero Truncated Negative Binomial Regression to estimate the effect of the variables. The findings showed the household’s age structure variable gave a better explanation of household waste generation rather than the household’s total population. The effect of the food expenditure per capita and the household’s average years of schooling found to be more significant when combined with the household’s age structure rather than combined with the household’s total population. In contrast, the effect of the household’s net income to waste generation found lesser. The study findings implied that the household’s age structure would be more useful in waste generation estimation, especially for the city with a relatively high fertility rate.

1. Introduction

Understanding waste generation (WG) and the composition is critical in municipal solid waste (MSW) management. Unfortunately, these specific data have not been adequately recorded in many developing countries [1]. The previous studies have developed various WG estimation models to solve these kinds of problems by used the city’s population, Gross Domestic Product, or household expenditure combined with other proxies. Alas, WG depends on local characteristics [2], implying that these estimation models could not readily use for another city that has relatively similar features due to differences in a micro-level situation, such as differences in a household age structure (HAS). Of MSW source, household waste generation (HWG) holds essential roles in MSW management. For example, the HWG has contributed to around 74.68% of Palembang City’s solid waste [3].

From an household economic activities (HEA) perspective, a household could consider as a consumption unit or a production unit that generates waste at a different level [4]. A consumption unit means all household needs (goods and services) are produced by others, whereas a production unit means some of their needs are produced by its own household members. Consumption activities mainly produce packaging material waste, whereas some of production activities waste contains raw material. A household typically produces less waste when it acts as a consumption unit than as a production unit. Previous studies showed four group factors had driven a household’s consumption: demographic, economic, mental related [5], and cultural factors [6]. In contrast, the household’s production had driven by its available human capital [7]. Every household member played these two kinds of HEA at different scales, giving more variation to HWG. Empirical facts suggested that particular waste positively correlated to a specific age. For example, diaper associated with baby,
sanitary napkins linked to women at childbearing age, etc. Consequently, using HAS predicted to give a more reliable WG estimation than the total population. Therefore, the study aimed to compare variables between the HAS and the entire household dweller, which variables would give a better prediction to waste generation in Palembang City.

2. Methods

The study used the HAS and the household’s total population to represent a demographic factor; the food expenditure per capita represents an economic factor; the household’s average years of schooling represent a mental-related aspect; whereas the household’s net income to describe the household’s production (Table 1). This study used 175 households taken from the Social and Economic National Survey (SUSENAS) 2013 datasets.

| Code | Variables description |
|------|-----------------------|
| Y    | household’s waste generation was a number of bags of waste disposed of daily (measured in a count data: one, two or three bags) |
| x1   | the ratio of under-five-year-olds to the household’s total population |
| x2   | the proportion of women at childbearing age to the household’s total population |
| x3   | the food expenditure per capita was the total amount of money spent monthly by the household divided by the whole household’s member |
| x4   | the household’s average years of schooling was the mean of years of schooling gained by all household’s member aged over five years |
| x5   | the household’s net income was the sum of net monthly income (in the form of salary or goods converted to market prices) gained by all household members |
| x6   | the household’s total population defined as the total number of people usually lived in a house |

This study developed two estimation models. Model 1 was the WG estimation model that used HAS variables (i.e., x1 and x2), whereas Model 2 used the household’s total population (i.e., x6). Since a household always produces waste, then zero waste becomes impossible. Therefore, the study used the Zero-truncated Negative Binomial Regression to estimate HWG. Thus, the regression equation for each model was:

Model 1: \[
\log y = \beta_1 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5
\]  

Model 2: \[
\log y = \beta_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6
\]

3. Results and discussion

The household consisted of around 4.04 persons, but it had a relatively wider range of 1 to 12 people. In terms of net income, households in Palembang had an average income of IDR. 4,103,296 with a median of IDR. 2,575,000. As much as 78.8% of households produced one bag of waste per day, 16.3% produce two bags per day, and 4.9% produce three bags or more (one bag has a volume of approximately equivalent to five liters).

The statistic showed that only net income variable that had a significant effect to waste generation in both Model. Nevertheless, the impact of insignificant variables could not abandon [8] since those variables were the waste generation determinant in previous studies. The effect (\(e^\theta\)) of the food expenditure per capita and the household’s average years of schooling variables on the HWG in Model 1 found to be greater than in Model 2. In contrast, the effect of the household’s net income to waste generation in Model 1 found lesser than in Model 2. Increases HH total population found to be reduced the HWG. This study also found increasing the ratio of under-five-year-old children or the proportion of women at childbearing age would decrease the HWG, which in line with previous findings [9]. In general, a negative sign of the parameter estimate indicated that every increase in the predictor variable would decrease the HWG and vice versa. Based on the value of -2 Log Likelihood,
AIC, and BIC [10], the statistics test revealed that the Model 1 would give a better HWG estimation than the Model 2 (Table 2).

| Variables                        | Model 1 Parameter Estimate (DF = 170) | Model 2 Parameter Estimate (DF = 170) | $p$ | $p$ |
|----------------------------------|---------------------------------------|---------------------------------------|-----|-----|
| Intercept                        | -6.859                                | -8.861                                | .175| .099|
| The ratio of under-five years old| -3.060                                | -                        | .05 | .110|
| The ratio of women at childbearing age | -.065                               |                        | .94 | .943|
| The food expenditure per capita  | -1.132                                | -                        | .32 | .187|
| HH average years of schooling    | -.055                                 | -                        | .95 | .324|
| HH net income                   | 1.974*                                | 2.388*                                | .002| .003|
| HH total population              | -                                     | -                        | -.076| .93 |
| Alpha                            | .277                                  | 1.61                                | .616| .562|

Note : *Significant at .05 level

Overall, the amount of waste generated that predicted by using Model 1 was 27.51% lesser compared to using Model 2. The effect of demographic factors on HWG in Model 1 was increasing than in Model 2. The impact of mental-related factors also increased in Model 1 than in Model 2, while the economic factors decreased (Table 3). This study's findings highlighted the importance of considering the HAS effects on HWG. Aside from statistically giving a better HWG estimation, the HAS also allow exploring to predict a more specific waste, mostly that generated by under-five-year-old children. An under-five-year-old is more prone to sickness, which makes households frequently keep pharmaceuticals. This behavior could increase pharmaceuticals waste in the regular bin [11], which leads to environmental problems in the future. The previous study showed that more than half of the respondents were unaware that unsafe medication disposal practices could harm the environment and population health [12]. Aside from pharmaceutical, under-five-year-old also related to an increase in demand for diapers that could reach 11-12 diapers per week [13], making waste treatment more difficult.

| Variables                        | Model 1 Effect change (Model 2 as basis, in %) | Model 2 Effect change (Model 2 as basis, in %) | $p$ | $p$ |
|----------------------------------|-----------------------------------------------|-----------------------------------------------|-----|-----|
| Demographic                      |                                              |                                              | .05 | -   |
| The ratio of under-five years old| -.94                                          | -                                             | .93 | .645|
| HH total population               | -                                             | -                                             | .93 | .3388|
| Total effect                     | .99                                           | .93                                           | .93 | .6280|
| Economics                        |                                              |                                              | .32 | .30 |
| The food expenditure per capita  | 7.20                                          | 10.89                                        | .119| .1305|
| HH net income                   | 7.52                                          | -                                             | .95 | .215|
| Total effect                     | 9.46                                           | 13.05                                         | .93 | -27.51|

Table 2. Parameter estimates for household waste generation model

Table 3. Changes in the effect of variables to HWG
4. Conclusion

The study concluded a waste generation model that took account of household age structure into the model would give better estimation than a model that accounted for the household's total population.

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