Replacing single use plastic bags with compostable carriers: socio-economic approach

A H Harianja¹,², G S Saragih¹ and R Fauzi¹

¹Center for Research and Development of Quality and Environmental Laboratory, Gedung 210
PUSPIPTEK Serpong, Banten, Indonesia.
²e-mail: alfonso_hrj@yahoo.com

Abstract. Disposable plastic bags have already become global environmental problems due to their long durability. Plastic bags can be decomposed into microplastics thus harmful to the environment. This paper will describe socio-economic factors that determine plastic bag consumption and willingness to pay (WTP) for compostable shopping bags in Yogyakarta. Respondents were chosen using simple random sampling adopting Slovin formula. At a critical value of 4.82%, the sample size was 450 households. Socio-economic factors affecting the use of plastic bags are tested by employing multiple regressions. The result showed that the average use of plastic bags in Yogyakarta is 8 bags/household/week. Factors that influence the usage of plastic bags were the intensity of shopping in the supermarkets/grocery/convenience store, monthly shopping expenditure, and the intensity of the use of non-degradable plastic bags. WTP for compostable shopping bags is IDR 615 per bag. Since the traditional market was the first choice of respondents for daily or weekly shopping, plastic bag levy policy that applied in supermarkets has a limited impact on reducing plastic bag usage.

1. Introduction
Disposable plastic bags have already become a global environmental problem due to their long durability [1–4]. Some types of plastic bags can be decomposed into microplastics [1] thus harming creatures by contaminating the food chain [1], [5–7] or increasing the risk of environmental and human health quality when burnt [8]. Indonesia was the second biggest contributor of plastic waste into the sea after China [9]. In Canada and the United States, a strategy to reduce plastic waste so called The Honolulu Strategy is applied by focusing on market-based instruments (for example the implementation of a tax for the plastic bags) and by issuing a policy/regulation/legislation to reduce marine debris, for example banning the use of microbeads [10].

One of the steps undertaken by the government of Indonesia to overcome the plastic waste problem is by issuing a Circular Letter Number SE-06/PSLB3-PS/2015 by the Director General (DG) of Waste, Liquid Waste and Hazardous Toxic Materials, Ministry of Environment and Forestry (MOEF) in 2015. It enforces the local governments and business owners to apply plastic bags levy on modern
retailers. The core of this circular letter is the Government, the Consumer Protection Agency of Indonesia, and the Indonesian Consumers Foundation. The Indonesian retailer’s association (APRINDO) agrees on the selling price of a plastic bag during the trial plastic bags levy, amounted to at least IDR 200 per bag. In the following year, Banjarmasin became the first city in Indonesia that prohibits the use of disposable plastic bags in retail and grocery or convenience store which is stated in Mayor of Banjarmasin’ Regulation Number 18/2016.

As an alternative to disposable High-Density Polyethylene (HDPE) plastic bags, compostable plastic bags made from a mixture of tapioca flour and vegetable oils. It will decompose in two up to six months in soil. However, these eco-friendly bags have a higher selling price than the regular ones. Therefore, research on the willingness to pay (WTP) of communities for the compostable shopping bag is needed. This study aims to determine the correlation of the socio-economic characteristics of communities to plastic bags usage in Yogyakarta and the communities’ WTP to replace plastic bags with compostable ones.

2. Methodology

The research was conducted in the Special Region of Yogyakarta, Indonesia in 2017. The interviews took place in 30 subdistricts: 8 sub-districts in Yogyakarta city (Jetis, Kotagede, Pandean, Pakualaman, Umbul Harjo, Danurejan, Mantrijeron, and Gondokusuman), 13 subdistricts in Bantul (Sedayu, Banguntapan, Bantul, Jetis, Imogiri, Sanden, Piyungan, Kretek, Pleret, Sewon, Srandakan, Panda, and Bambanglipuro) and 9 subdistricts in Sleman Regency (Depok, Sleman, Godean, Kalasan, Berbah, Ngaglik, Pakem, Mlati, and Gamping). The subdistricts location in each city or regency is presented in figure 1.

![Figure 1. Geographical and administrative location](image-url)

This research used a survey method employing a direct interview with the respondents. The respondents were selected using criteria such as the age of the respondents (above 18 years old) and residents of Bantul Regency, Sleman Regency, and Yogyakarta City. The numbers of respondents was determined using Slovin formula and distributed proportionally in Yogyakarta City, Sleman Regency,
and Bantul Regency. The total household population of Yogyakarta province is 1,120,477 households. Using a critical value of 4.82%, the sample size was calculated to be 450 respondents.

Socio-economic and demographic characteristics, shopping pattern and shopping bags usage of the respondents were analyzed descriptively. Socio-economics and demographic factor that influencing the usage of plastic bags were analyzed using regression analysis with regression model:

$$Y_i = \alpha_0 + \alpha_1 X_{1i} + \alpha_2 X_{2i} + \ldots + \alpha_k X_{ki} + \varepsilon_i \quad (1)$$

where \(Y\) represents the dependent variable, \(X_1, X_2, X_k\) are the explanatory variables, \(\alpha_0\) is the intercept term, \(\alpha_1\) and \(\alpha_2\) are the partial regression coefficients, \(\varepsilon\) is the stochastic disturbance term, \(i\) is the observation. Explanatory variables were listed in table 1, adopted similar studies [11–14]. Data were entered into SPSS and analyzed employing STATA.

| Symbols | Variable Definition |
|---------|---------------------|
| \(Y\)   | Plastic bags usage  |
| \(X_{1}\) | Level of respondent’s education |
| \(X_{2}\) | Household income |
| \(X_{3}\) | Shopping frequency in the traditional market |
| \(X_{4}\) | Shopping frequency in retailer/supermarket/convenience store |
| \(X_{5}\) | Knowledge of 3R (reuse, reduce, recycle) |
| \(X_{6}\) | Knowledge of plastic bags levy |
| \(X_{7}\) | Experience in paying plastic bags levy |
| \(X_{8}\) | Price of plastic bags levy |
| \(X_{9}\) | Shopping place preference |
| \(X_{10}\) | Monthly expenditure |
| \(X_{11}\) | The frequency of compostable plastic bags usage |
| \(X_{12}\) | The frequency of non-degradable plastic bags usage |
| \(X_{13}\) | Knowledge of compostable plastic bags |
| \(X_{14}\) | Knowledge of non-degradable plastic bags |
| \(X_{15}\) | Willingness to pay for compostable bags |

3. Results and Discussion
3.1. Socio-economic Characteristics of Respondents
Respondents were spread proportionally in the Yogyakarta City (87 respondents), Sleman Regency (200 respondents), and Bantul Regency (163 respondents). The respondents consisted of 29.11% male respondents and 70.89% female. The majority of respondents were educated in high school, belonged to a family with only 4 (four) persons, worked in the private sector and had monthly incomes less than IDR 2,000,000 (figure 2). Despite the low figure, the average monthly income of the respondents is yet higher than the monthly minimum wage in Yogyakarta City (IDR 1,572,200), Sleman Regency (IDR 1,448,385), and Bantul Regency (IDR 1,404,760) (According to Decree of Governor of Yogyakarta, 2016).
Figure 2. Respondents Characteristics, the majority of respondents have monthly income less than IDR 2 million, work in private sector and civil servant, experience high school education level and have 4 persons family size.

3.2. Shopping Behavior, Plastic Bags Usage, and Influencing Factors

Most of the respondents (41%) preferred to shop in the neighborhood kiosk, which is called “warung”, and occasionally carry their own shopping bags (56%). There were not many minimarkets surrounding their residential area so that the respondents more often shopping in the traditional market or nearby kiosk. The “warung” tended to wrap different things in different plastic bags especially vegetables, spices, meat, rice, and other daily needs in order to avoid possible cross-contamination [15]. This pattern led to the high consumption of plastic bags, which is similar to other countries in Africa [15], [16]. In Yogyakarta City and Sleman Regency, the respondents were more often shopping in a traditional market, while in Bantul Regency, the majority of the respondents frequently shop at the residential kiosk. The numbers of plastic bags usage in the research area are ranging from 0 up to 30 plastic bags per week. The average number was 8 plastic bags per week/household.

The result of the interviews with the community showed that the plastic bags levy policy had a temporary impact. People responded to that policy by bringing their shopping bags or used a cardboard box. In the short term, this reduced plastic bags when shopping at the supermarkets. After a few months, the public then adjusted their expenditure, back to their old habit using plastic bags. This phenomenon also found in previous studies where plastic bags levy or tax has a short-term effect in
reducing plastic bags consumption in Botswana [3], [17] and Argentina [18]. However, it was effective in reducing plastic bags consumption in some countries such as in Portugal [19], Uganda [20], Jordan [21] while in another country such as China plastic bags levy was not effective [22].

In Ireland started in 2002, one piece of a plastic bag is charged € 0.15, and it managed to reduce more than 90% use of plastic bags [23]. The success of the program in Ireland does not occur in South Africa. The implementation of 46 cents levy of South African Rand per plastic bag in 2003 was only effectively to reduce the use of plastic bags during the first 3 months [24]. In the city of Toronto, Canada, the implementation of the regulation of paid plastic bags (US$0.05/bag) has varied impacts [25]. The effect of the implementation of these policies is more visible within the upper class of the community who already often carries a reusable bag. The implementation of the plastic bag levy has not changed the usage of plastic bags in the middle and bottom classes in the Yogyakarta area.

The second factor that made plastic bags levy was ineffective was the object of the regulation. This levy was applied to modern shopping centers such as supermarkets or convenience stores. As the majority of the respondents preferred to shop in a traditional market, the plastic bags levy policy has no direct impact on reducing plastic bags in the traditional market and ‘warung’ in research sites. This was also found in Malaysia [26], where the consumers are supportive of the plastic bag ban in the supermarkets but not in other types of public markets. The plastic bag tax policy is not able to reach transactions that are still using plastic bags in the traditional market. The trial implementation of the plastic bag levy is not effective to suppress or reduce the use of plastic bags and reduce plastic waste significantly in the research site.

Socio-economic and demographic factors that were assumed to be influencing the usage of plastic bags were tested using regression analysis. These independent variables (X1…X15) include the education level, monthly income, shopping frequency in traditional or modern market, knowledge of 3R (reuse, reduce, recycle), knowledge of plastic bags levy, experience in paying plastic bags levy, price of plastic bags levy, shopping place preference, frequency of compostable plastic bags usage, frequency of non-degradable plastic bags usage, knowledge of compostable plastic bags, and willingness to pay for compostable plastic bags. The result of the regression analysis of those independent variables to the number of plastic bags usage is presented in table 2.

### Table 2. Estimated Factors Influencing Plastic Bags Usage

| Symbols | Variable                                      | Coefficient | Standard Error | Significance |
|---------|-----------------------------------------------|-------------|----------------|--------------|
| X1      | Level of respondent’s education               | -0.025363   | 0.020794       | 0.22         |
| X2      | Household income                              | 0.018459    | 0.030305       | 0.54         |
| X3      | Shopping frequency in traditional market      | 0.070069    | 0.044785       | 0.12         |
| X4      | Shopping frequency in retailer/supermarket    | 0.110386    | 0.049082       | 0.03**       |
| X5      | Knowledge of 3R (reuse, reduce, recycle)      | -0.015228   | 0.016657       | 0.36         |
| X6      | Knowledge of plastic bags levy                | -0.060000   | 0.044465       | 0.18         |
| X7      | Experience in paying plastic bags levy        | 0.051031    | 0.054844       | 0.35         |
| X8      | Price of plastic bags levy                    | 0.018917    | 0.043152       | 0.66         |
| X9      | Shopping place preference                     | -0.039317   | 0.038483       | 0.31         |
| X10     | Monthly expenditure                           | 0.083793    | 0.040239       | 0.04**       |
| X11     | The frequency of compostable plastic bags     | 0.026299    | 0.037571       | 0.48         |
| X12     | The frequency of non-degradable plastic bags  | 0.102876    | 0.034409       | 0.00***      |
| X13     | Knowledge of compostable plastic bags         | -0.008338   | 0.038268       | 0.83         |
| X14     | Knowledge of non-degradable plastic bags      | -0.060713   | 0.043244       | 0.16         |
| X15     | Willingness to pay for compostable plastic    | -0.000004   | 0.000013       | 0.75         |

Source: Primary data, n = 450. Prob > F 0.00012***, R square = 0.095. *** Significance level 1 %, ** significance level 5 %
The regression analysis showed that the model could be used to calculate socio-economic and demographic factors that affect the usage of plastic bags since the model is significant at a confidence level of 99 percent (prob. < 0.01). The value of R squared is small (0.0945) means that the fifteen independent variables are only able to explain changes in the usage of plastic bags amounted to 9.45 percent, the rest 90.55% was influenced by other variables. Based on the regression analysis, it is known that the usage of plastic bags is significantly influenced by shopping frequency in retailer/supermarket/convenience store, monthly expenditure, and intensity of non-degradable plastic bags usage. The environmental awareness of respondents which is encompassed by level of education and knowledge of 3R (reuse, reduce and recycle) variables were not significantly influenced the number of plastic bags usage, in contrary to previous studies in other countries stated that level of education and social awareness are effective in reducing plastic bags usage [6], [12], [13], [18], [27].

The majority of respondents use one to two pieces of plastic bags when shopping. Frequency of shopping at the supermarket or convenience store and the cost of the monthly expenditure has significant and positive influence (p < 0.05). The more often the respondents shop at the supermarket or convenience store the higher the usage of plastic bags. The greater the monthly expenditure the higher the consumption rate of the respondents, thus increasing the usage of plastic bags. The intensity of non-degradable plastic bags usage also has a significant and positive influence (p < 0.01) on the number of plastic bags usage. If the respondents use non-degradable more often, the number of plastic bags usage is increasing. This is because the price of non-degradable plastic bags is cheaper than eco-friendly plastic bags [16], [28], [29].

3.3. Willingness to Pay for Compostable Shopping Bags

Only a minority of respondents have heard or used compostable shopping bags. Some of the respondents who claimed to know degradable plastic bags consider that the white plastic bags given by a convenience store or supermarket are compostable plastic bags. Actually, plastic bags used in supermarkets are mostly o xo-degradable plastic bags that are claimed to be decomposed into small pieces when exposed to UV-sunlight [30]. Using simulation price for degradable plastic bags, 115 respondents (25.6%) were not willing to pay for eco-friendly shopping bags. The others were willing to pay between IDR 100 up to IDR 15,000. The WTP for compostable shopping bags in Yogyakarta City, Sleman Regency, and Bantul Regency is IDR 1,140, IDR 686 and IDR 347, respectively. Meanwhile, the WTP value for the whole province is IDR 615.

The value of WTP is influenced by factors of education and shopping place preference [3], [11], [31–33]. WTP for compostable bags in this study is lower than the WTP in other studies in Jakarta and Bandung which amounted to IDR 1,322, in which the respondents most frequently shop at the supermarket and know about the plastic bag levy policy [34]. Furthermore, research stated that after the plastic bag levy policy was implemented in Bogor [35], 42% of respondents willing to carry their own shopping bags and also suggested the price of a plastic bag between IDR 500 – IDR 1,000/piece.

The interesting findings of this research were that the plastic bag levy in the Yogyakarta area has no significant effect on reducing plastic bags in the long term, especially in low- and middle-class society. Plastic bags levy was implemented in modern supermarket or convenience store, while the low- and middle-class society are usually shopping in the traditional market and vegetable hawkers which are not affected by plastic bag levy policy. Nevertheless, replacing plastic bags to compostable shopping bags is a potential strategy, but should be based on economic consideration, such as the consumers’ willingness. Other economic instruments such as ‘pay-as-you-throw’ charges can be applied [36], along with other appropriate interventions based on consumer behavior and shopping place preference. Calculated WTP for compostable shopping bags in the research area, which was
higher than conventional plastic bags price implying positive support for producing compostable carriers.

4. Conclusion
This research showed that the average use of plastic bags in Yogyakarta is 8 bags/household/week. Factors that influence the usage of plastic bags were the frequency of shopping in the supermarkets/grocery/convenience store, monthly shopping expenditure, and the frequency of the use of non-degradable plastic bags. WTP for compostable shopping bags is IDR 615 per bag. Since the traditional market was the first choice of respondents for daily or weekly shopping, plastic bag levy policy that applied in supermarkets has a limited and short-term impact in reducing plastic bag usage. Replacing plastic bags to degradable shopping bags is a potential strategy considering the socio-economic characteristics of the people in this research area.

References
[1] Duis K and A Coors 2016 Environ Sci Eur 28 1–25
[2] Kratsch H A and M Hefner 2016 in Bioplastic Container Cropping Systems: Green Technology for the Green Industry, SchraderJ. ., H. . Kratsch and W. . Graves, Eds. Sustainable Hort. Res. Consortium, Ames, IA, USA., 2016, 183–214
[3] Madigele P K, G E J Mogomotsi and M Kolobe 2017 Chinese J Popul Resour Environ 15 255–261
[4] da Silva L F, A J de Hoyos Guevara, E D R Santibanez Gonzalez and P S G de Oliveira 2019 Environ Dev Sustain 21 1291–1320
[5] Miranda D D A and G F De Carvalho-souza 2016 Mar Pollut Bull J 103 109–114
[6] Chow C-F, W-M W So, T-Y Cheung and S-K D Yeung 2017 in Emerging Practices in Scholarship of Learning and Teaching in a Digital Era 2017 125–140
[7] Bonanno G and M Orlando-Bonaca 2018 Environ Sci Policy 85 146–154
[8] Verma R, K S Vinoda, M Papreddy and A N S Gowda 2016 in Procedia Environmental Sciences, 2016, 35, 701–708
[9] Jambeck J R et al. 2015 Science (80-) 347 768–771
[10] Xanthos D and T R Walker 2017 Mar Pollut Bull 118 17–26
[11] Seth K, S Jerry Cobbina, W Asare and A Ballu Duwiejuah 2014 Am J Environ Prot 2 74–78
[12] Kuppumary M and B Gharleghi 2015 Asian Soc Sci 11 174–182
[13] Arie E and V Yilmaz 2017 Environ Dev Sustain 19 1219–1234
[14] Chang S-H and C-H Chou 2018 Sustainability 10 1–14
[15] Musa H M, C Hayes, M J Bradley, A Clayson and G Gillibrand 2013 Nat Environ 1 17–23
[16] Madara D S, S S Namango and C Wetaka 2016 J Environ Earth Sci 6 12–36
[17] Dikgang J and M Visser, 2012 South African J Econ 80 123–133
[18] Jakovcevic A et al. 2014 J Environ Psychol 40 372–380
[19] Martinho GN Balaia and A Pires 2017 Waste Manag 61 3–12
[20] Mugisha J and G Diro 2015 J Agric Environ Sci 4 216–224
[21] Saidan M N, L M Ansour and H Saidan 2017 J Chem Technol Metall 52 148–154
[22] Xing X and H Liu 2018 J Sustain Dev 11 158–165
[23] Convery F, S McDonnell and S Ferreira 2007 Environ Resour Econ 38 1–11
[24] Dikgang J, A Leiman and M Visser 2012 Appl Econ 44 3339–3342
[25] Rivers N, S Shenstone-Harris and N Young 2017 J Environ Manage 188 153–162
[26] Zen I S, R Ahamad and W Omar 2013 Environ Dev Sustain 15 1259–1269
[27] Setyowati R and S A Mulasari 2013 *J Kesehat Masy Nas* 7 562–566
[28] Yamaguchi K and K Takeuchi 2016 *Waste Manag* 48 540–547
[29] Deepak B, S Nizarudin, J Gokul, R A Choodan and A Mathai 2016 *Int J Adv Res Trends Eng Technol* 3 10–15
[30] Listyarini A and W Pudjiastuti 2014 *J Kim Dan Kemasan* 36
[31] Agyeman C M and D Badugu 2017 *Int J Res Econ Soc Sci* 7 71–84
[32] Ellison B, B Kirwan and A Nepal 2015 2015, 1–15
[33] Khan M I 2015 Pakistan Institute of Development Economics, 2015
[34] Suryani A S 2016 *J Kaji* 21 359–376
[35] Novianti A I and L Kartika 2017 *J Ris Manaj Dan Bisnis Fak Ekon UNIAT* 2 81–94
[36] Oosterhuis F, E Papyrakis and B Boteler 2014 *Ocean Coast Manag* 102 47–54