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**Article**

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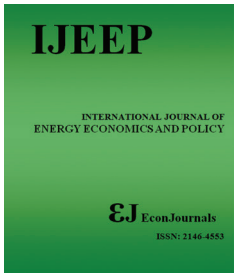

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# The Importance of Sustainable Waste Management Due to Socio-Economic Changes

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**ABSTRACT**

Environmental pollution due to garbage never ends because waste is related to human activities. This study aims to analyze the impact of economic and social activities on environmental pollution in the form of waste generation. Using secondary data for a period of 20 years (2000-2019), with panel data regression analysis techniques. The results showed that the volume of waste generation was more dominated by economic factors, namely industrial activities and the increasing income per capita of the community. Meanwhile, the social aspect that drives the increase in waste generation is the increase in population.

**Keywords:** Waste Generation, Waste, Economic, Social, Industrial, Environmental
**JEL Classifications:** O44, Q56

## 1. INTRODUCTION

Economic development can have a positive impact on people's welfare, but it can also have a negative effect, namely environmental pollution. Environmental pollution based on the place is divided into 3, namely air pollution, water pollution, and soil pollution (Sumampouw, 2015). One source of problems causing environmental pollution is the generation of waste that is not managed properly.

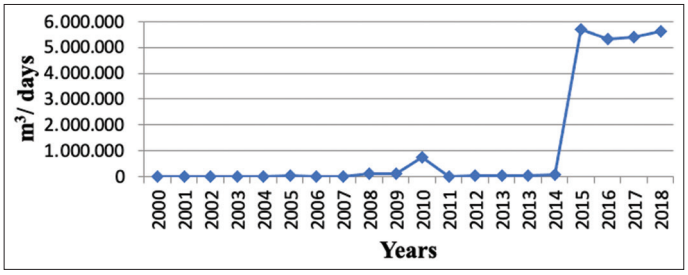
The waste problem has not been resolved because waste is related to human activities both in the economic and social fields. According to Iftikhar and Aziz (2017), human activities can lead to an increase in the amount of waste, including food waste, plastic waste, paper waste, and metal waste. Most of this waste ends up in landfills without processing and utilization. In fact, if used and managed properly, waste will have economic value.

The volume of waste from time to time tends to increase. In 2012, global municipal waste was estimated at 1.3 billion metric tons. Furthermore, the predicted volume of waste in 2025 will reach an increase of up to 2.2 billion metric tons (Hoomweg and Bhada-Tata, 2012). Rapid economic growth, population growth, and urbanization have generated large amounts of urban waste, especially in developing countries such as China (Chen, 2010; Fand and Liu, 2011). Meanwhile, developing countries also experience complex problems related to the volume of urban waste (Zulfinar and Emenda, 2105). Several previous studies have shown that there is an imbalance in waste management, namely the gap between the waste produced and the ability to manage it (Iftikhar and Aziz, 2017; McAllister, 2015; Rizal, 2011).

The volume of waste in Central Java is estimated at 5.7 tons or 15,671 $m^3$/day. Waste generation in Central Java in 2000-2019 tends to increase every year (Figure 1). The highest waste generation occurred in 2016 which was 5,691,309 $m^3$/day, so that systematic waste management efforts were needed to reduce it.

Increasing the amount of waste requires environmentally friendly waste management, so as to minimize the possibility

**Figure 1:** Total Waste Generation of Central Java Province 2000-2019




Source: BPS, processed

of environmental pollution. According to Petrick (in Chalik et al., 2011) Indonesia as a developing country has had problems arising from the construction of new cities or the development of large cities. The problems that arise are increased urbanization, slum settlements, inadequate sanitation conditions, transportation congestion, lack of availability of clean water, as well as increased landfills as a result of increasing population activities and consumptive behavior. Sharholy et al. (2008) explained that the increasing number of residents and their activities have resulted in an increase in the amount of waste, because it is considered useless and waste is disposed of at will. Based on this, it shows that an increase in the economy has an effect on environmental pollution in the form of increasing waste generation (Kaushal, 2012; Kariuki, 2015).

## 2. LITERATUR REVIEW

Based on previous studies and the identification of the problems that have been described, economic and social factors are thought to have an effect on increasing waste generation in developing countries including Indonesia. Further research is needed to formulate appropriate strategies in sustainable waste management in order to maintain environmental quality.

The American Public Health Association (Sumantri, 2010) provides a definition of waste as something that can no longer be used so that it is disposed of, and is sourced from human activities or activities. Meanwhile, the World Health Organization (in Dobiki, 2018) explains that waste is something that is no longer used, unused, not liked or something that is thrown away comes from human activities and does not happen by itself.

The amount of waste that results from the activities of living things in a certain period of time is called waste generation. Waste generation is the amount or amount of waste in gravimetric units of weight (kilograms) or volume (liters) volumetric (Tchobanoglous, 1993). The amount of waste generated is obtained from direct measurements in the field of waste from various sources through representative sampling. The procedure for the provision of sampling is contained in SNI-19-3964-1994 regarding the method of taking and measuring generated samples, the composition of urban waste.

The use of resources, especially fossil energy in the production process continues to increase. The impact of excessive energy use is the increase in carbon dioxide ($CO_2$) gas. Carbon dioxide gas (CO2) is a kind of chemical compound consisting of two oxygen atoms covalently bonded to a carbon atom. It is a gas at standard temperature and pressure and is present in the Earth's atmosphere. Usenobong and Godwin (2012) mention that since the 1850s the global use of fossil fuels (coal, oil and gas) has increased and dominated the world's energy consumption and supply. The research of Sheinbaum-Pardo et al. (2012) in Mexico for the period 1990-2008 found several important changes in the effect of structures that can reduce emissions in 10 sub-sectors of the manufacturing industry. The energy intensity and carbon index tested had negative effects on all subsectors with the exception of cement and some other subsectors.

Chen's (2007) study in China found that the relationship between environmental damage and per capita income is in the form of a U-curve. Bartz and Kelly's (2004) study of the relationship between welfare and environmental degradation, concluded that welfare affects environmental degradation in a pattern as shown by the Environmental Kuznet Curve (EKC).

## 3. RESEARCH METHOD

This study uses a descriptive analysis approach to test hypotheses about the influence of economic and social factors on waste generation in water catchment areas in Central Java, namely Kebumen Regency, Purworejo Regency, Wonosobo Regency, Magelang Regency, Temanggung Regency, and Magelang City.

Waste generation as the dependent variable is influenced by per capita income, consumption expenditure, industrialization, population, average years of schooling, HDI. Secondary data for the period 2000-2019, comes from the Central Statistics Agency, the Ministry of Environment and Forestry, the Public Works Office of Central Java Province. Quantitative analysis uses a panel data regression model, which is a combination of time series data and corss section data (Gujarati, 2010). Time series data for a period of 20 years (2000-2019), and cross section data from six regencies/cities. The panel data regression model to answer the research objectives is formulated in the following equation:

$$WEST_{it} = \alpha_0+\beta_1 INC_{it}+\beta_2 POP_{it}+\beta_3 IND_{it}+\beta_4 EDU_{it}+\beta_5 CONS_{it} +\beta_6 HDI_{it}+e \quad (1)$$

$$LogWEST_{it} = \alpha_0+\beta log1INC_{it}+\beta_2 \log POP_{it}+\beta_3 \log IND_{it} +\beta_4 \log EDU_{it}+\beta_5 \log CONS_{it}+\beta_6 \log HDI_{it}+e \quad (2)$$

Noted: WEST: Waste generation; INC: Per capita income; POP: Population; IND: industrialization; EDU: Average years of schooling; CONS: Consumption expenditure; HDI: human development index; $\alpha$: constant. $\beta$ (1,2,3,4,5,6): regression coefficient of each independent variable i: research area; t: time; e: error term.

## 4. RESULTS AND DISCUSSION

The research area covers six regencies/cities, namely: Kebumen Regency, Purworejo Regency, Wonosobo Regency, Magelang

Regency, Temanggung Regency, and Magelang City. The population and area of the research area in 2019 are as follows:

Based on Table 1, the largest population and area of Magelang Regency is 1,290,591 people, and the area is 1102.93 km$^2$. Magelang City is the area with the least population (122.111), and the smallest area (16.06 km$^2$).

Waste generation is the amount of waste created by the community in an area. The greater the generation of waste, the greater the threat of environmental pollution. By 2030, each country will substantially reduce waste generation through reduction, prevention, recycling and reuse. This is one of the targets of the Sustainable Development Goals (SDGs) to ensure sustainable production and consumption patterns.

Based on Table 2, it can be seen that the generation of waste in the study area tends to increase every year. This is due to an increase in population, the process of industrialization, an increase in the average income of the population, the quality of education, and the quality of life of the community which is not accompanied by good management of the remaining consumption. In addition, there are still limitations in the government's ability to manage waste.

Data management with panel data regression model is carried out through several stages of testing first. Chow test is a test to determine which model is the most appropriate, between Common Effect or Fix Effect in estimating panel data.

Based on Table 3, the results of the Chow test show that the probability value of the resulting Chi-square Cross-section is 0.00001. This shows that the probability value is less than the significance level of 5% (0.05), so it can be seen that the fixed effect model is more appropriate to use than the common effect model. The test results with the fixed effect model are shown in Table 4.

From Table 4 the results of panel data regression with a fixed effect approach using the Eviews 10 program, the following equation is obtained:

$$\text{Log(WEST)} = -199.4216+1.222642\ \text{Log(INC)}+9.467113\ \text{Log(POP)}+1.658036\ \text{Log(IND)}+7.226355\ \text{Log(EDU)}+0.024761\ \text{Log(CONS)}+13.37792\ \text{Log(HDI)}+e$$

Based on the F test, it shows that the independent variables together statistically significantly affect the dependent variable (waste generation) in the study area during 2000-2019, with an R2 of 0.59.

Based on the results of the analysis, it shows that per capita income is positive and significant to waste generation with a coefficient value of 1.222642. Shows that every time there is an increase in per capita income of 1 percent, assuming other variables are constant, waste generation increases by 1.222642%. People's per capita income tends to increase, along with increasing economic growth. Increased economic growth due to the production of goods and services. The increase in people's purchasing power for consumption contributes greatly to the quantity of waste generated.

**Table 1: Number of Population and Area in 2019**

| No | Region | Total population (people) | Large (km$^2$) |
|---|---|---|---|
| 1 | Kebumen regency | 1.197.982 | 1211.74 |
| 2 | Purworejo regency | 718.316 | 1091.49 |
| 3 | Wonosobo regency | 790.504 | 981.41 |
| 4 | Magelang regency | 1.290.591 | 1102.93 |
| 5 | Temanggung regency | 772.018 | 837.71 |
| 6 | Magelang city | 122.111 | 16.06 |

Source: BPS, 2020

**Table 2: Garbage generation in kedu residency year 2000-2019**

| Years | Waste volume (m$^3$/days) | Years | Waste volume (m$^3$/days) |
|---|---|---|---|
| 2000 | 1738.75 | 2010 | 74295.5 |
| 2001 | 1627.44 | 2011 | 3242.0 |
| 2002 | 1411.56 | 2012 | 3390.2 |
| 2003 | 1401.56 | 2013 | 5581.7 |
| 2004 | 2048.56 | 2014 | 5545.5 |
| 2005 | 2088.98 | 2015 | 13837.2 |
| 2006 | 3108.81 | 2016 | 13837.2 |
| 2007 | 2994.87 | 2017 | 856837.0 |
| 2008 | 2928.43 | 2018 | 861841.0 |
| 2009 | 2970.29 | 2019 | 814990.4 |

Source: BPS, 2000-2019

**Table 3: Chow test results**

| Effects test | Statistic | d.f. | Prob. |
|---|---|---|---|
| Cross-section F | 5.281439 | (5,108) | 0.0002 |
| Cross-section Chi-square | 26.249126 | 5 | 0.0001 |

Source: EViews 10, 2021

**Table 4: Panel data regression results with fixed effect approach**

| Variable | Coefficient | SE | t-Statistic | Prob. |
|---|---|---|---|---|
| C | –199.4216 | 77.19434 | -2.583371 | 0.0111 |
| LOG (INC) | 1.222642 | 0.368504 | 3.317853 | 0.0012* |
| LOG (POP) | 9.467113 | 5.146309 | 1.839593 | 0.0686** |
| LOG (IND) | 1.658036 | 0.495480 | 3.346325 | 0.0011* |
| LOG (EDU) | 7.226355 | 5.673073 | 1.273799 | 0.2055 |
| LOG (CONS) | 0.024761 | 0.153553 | 0.161257 | 0.8722 |
| LOG (HDI) | 13.37792 | 9.005349 | 1.485552 | 0.1403 |
| R-squared | 0.590386 | Mean dependent var | 7.064407 | |
| Adjusted R-squared | 0.548666 | S.D. dependent var | 2.481656 | |
| Log likelihood | –225.2893 | Hannan-Quinn criter. | 4.068023 | |
| F-statistic | 14.15115 | Durbin-Watson stat | 1.218856 | |
| Prob (F-statistic) | | 0.000000 | | |

Sumber: Data Sekunder yang diolah dengan EViews 10, 2021

The results of this study are in line with the research of Kannangara et al. (2018); Sun and Chungpaibulpatana (2017), which states that per capita income has a positive influence on waste generation. According to Madden et al. (2019), per capita income has a significant influence on the generation of waste generated. Medina (in Khan, 2016) also states that waste generation directly depends on income level, and income individuals tend to consume

more industrial products, their waste contains more recyclable materials than income community waste. The pattern of household consumption is directly related to an increase in income which results in changes in the composition and amount of household waste.

The next finding is that the population has a positive and significant value on waste generation with a coefficient value of 9.467113. The increase in population by 1%, encourages an increase in waste generation by 9,467113%. The population has a positive and significant influence on waste generation, because an increase in population causes the demand for goods and services to increase. This results in an increase in the amount of waste produced by the community, because the waste management carried out by the community is still conventional, namely waste is only transported to a temporary waste disposal site and then disposed of in a final disposal site without any management.

This study supports the research of Wang and Wang (2013) which states that population growth has a significant positive relationship to waste generation. Research by Prajati and Pesurnay (2020), states that the most significant factor influencing waste generation in the capital city of Sumatra Island Province is population density.

The results of the next study stated that industrialization had a positive and significant effect on waste generation with a coefficient value of 1.658036. The increase in the number of industries by 1%, encourages an increase in waste generation by 1.7%. Industrialization in the research area in 2000-2019 tends to increase. This is due to the increase in community economic activities in various sectors. Increased industrialization encourages increased production as well as people's purchasing power and consumption levels. Most of the industries in this area are made from wood and tobacco. The industry has managed its waste properly by recycling it into organic waste, so that the waste produced can be used as organic fertilizer.

According to Kaushal (2012), industrialization causes the amount of waste produced to increase and the quality and composition of the waste to change due to products that have expired. Small and medium-sized industries have difficulty in reducing waste due to constraints on the ability and cost of waste management. According to Khan (2016), industrialization has a significant influence on municipal solid waste generation. In addition, according to Nguyen (2020), business expansion, especially in the industrial and service sectors, has a positive and significant impact on waste generation.

Education seen from the average length of school has no effect on waste generation. The average length of schooling for residents in the study area is still low, at 6 to 7 years. As a result of these problems, improvements in the mindset and mentality of people who have low environmental insight and have not been able to manage waste properly continue to be improved.

According to Arbulu et al. (2015), the higher the education level of the population will significantly increase the commitment to care for the environment. Chen (2010) also argues that universities will produce more graduates with environmentally conscious behavior. Meanwhile, Asare et al. (2015) stated that high and low income and education levels consider waste as something that cannot be reused so that they do not enforce waste segregation in the household. In addition, Maulina's research (2012) states that the level of community participation in waste sorting activities is still low with the form of participation limited to participation at the individual level.

Consumption expenditure has no effect on waste generation. Public consumption expenditure is the impact of increasing people's income. Increased consumption expenditure, can lead to an increase in the generation of waste generated. However, public consumption expenditure is relatively small and stable, so it does not have an impact on waste generation. The results of this study support Saladie's (2016) research that there is no correlation between waste generation and per capita income. Chen's research (2010) states that income can only partially explain the variation in waste generation.

HDI has no effect on waste generation. The results of this study are supported by the research of Spinola et al. (2019) which states that there is no relationship between HDI and waste generation. However, it is different from the results of research by Li and Xu (2021) which state that increasing investment in human development has a direct and significant effect on environmental quality. According to Giannakitsidou et al. (2016), HDI has a significant influence on waste generation and has a positive effect on the waste recycling program.

## 5. CONCLUSION

Income per capita has a positive and significant effect on waste generation. An increase in per capita income will increase waste generation. The number of residents has a positive effect on waste generation. Increasing population will increase waste generation. Industrialization has a positive and significant effect on waste generation. The development of industrialization will increase the generation of waste in the research area.

The level of education seen from the average length of school has no effect on waste generation. The average length of schooling does not always result in an increase in waste generation. Expenditure for consumption also has no effect on waste generation. The relatively small consumption in the study area does not always result in an increase in waste generation. HDI has no effect on waste generation. The increase in HDI does not always result in a decrease in waste generation if it is not followed by awareness of environmental quality.

Based on the research findings, the researcher provides suggestions to stakeholders for sustainable waste management in order to maintain environmental pollution, namely: (1). Implementing a waste recycling program based on the 3R concept (Reduce, Reuse, Recycle). (2) implementing a zero-waste lifestyle, namely by shopping without packaging, refusing to use single-use plastic packaging, sorting waste from home, and recycling consumption waste into compost or craft products.

## REFERENCES


Arbulu, I., Lozano, J., dan Rey-Maquieira, J. (2015), Tourism and Solid Waste Generation in Europe: a Panel data assesment of the environmental Kuznets curve. Waste Management, 46, 628-36.

Asare, W., Andrews, A., dan Asare, R. (2015), Household Solid Waste Generation and Disposal in Some Selected Communities in Ejisu-Juaben Municipality, Ghana. Journal of Scientific Research and Reports, 6(5), 371-382.

Azkha, N. (2006), Analisis Timbulan, Komposisi Dan Karakteristik Sampah Di Kota Padang. Jurnal Kesehatan Masyarakat, 1(1), 14-18.

Chalik, A.A., Lay, B.W., Fauzi, A., dan Etty, R. (2011), Formulasi Kebijakan Sistem Pengolahan Sampah Perkotaan Berkelanjutan (Studi Kasus: DKI Jakarta). *Jurnal Pemukiman,* 6(1), 18-30.

Chen, C. (2010), Spatial Inequality in Municipal Solid Waste Disposal Across Regions in Developing Countries. *International Journal of Environment Science and Technology,* 7(3), 447-456.

Dobiki, J. (2018), Analisis Ketersediaan Prasarana Persampahan di Pulau Kumo dan Pulau Kakara di Kabupaten Halmahera Utara. Jurnal Spasial, 5(2), 2442-3262.

Giannakitsidou, O., Tsagkanos, A., dan Giannikos, L. (2016), Correlation of Municipal Solid Waste Production and Treatment with Socioeconomic Indexes. International Journal of Environmental and Waste Management, 18(4), 303-316.

Gujarati, D.N., dan Porter, D.C. (2010), Dasar-Dasar Ekonometrika Buku 1. Jakarta: Salemba Empat.

Hoomweg, D., dan Bhada-Tata, P. (2012), What a Waste a Global Review of Solid Waste Management. *Washington Urban Development & Local Government Unit World Bank.*

Iftikhar, S., dan Aziz, B. (2017), Analysis of factors affecting solid waste management: A study of cities municipalities. *Gomal Journal of Social Sciences* and *Humanities, 1(1),* 48-60.

Kannangara, M., Dua, R., Ahmadi, L., dan Bensebaa, F. (2018), Modelling and Prediction of Regional Municipal Solid Waste Generation and Diversion in Canada Using Machine Learning Approaches. Waste Management, 74, 3-15.

Kariuki, C.W. (2015), Factors Influencing Solid Waste Management in Urban Centres: A Case of Thika Sub County, Kiambu County, Kenya. Nairobi, Kenya: University of Nairobi.

Kaushal, R.J., Varghese, G.K., dan Chabukdhara, M. (2012), Municipal Solid Waste Management in India-Current State and Future Challenges: A Review. *International Journal of Engineering Science and Technology* (IJEST), 4(4), 1473-1481.

Khan, D., Kumar, A., Samadder, S.R. (2016), Impact of Socioeconomic Status on Municipal Solid Waste Generation Rate. Waste Manage (Oxford), 49, 15-25.

Madden, B., Florin, N., Mohr, S., Giurco, D. (2019), Using the Waste Kuznet's Curve to Explore Regional Variation in the Decoupling of Waste Generation and Socioeconomic Indicators. Resources, Conservation, & Recyling, 149(4), 674-686.

Maulina, A.S. (2012), Identifikasi Partisipasi Masyarakat dalam Pemilahan Sampah di Kecamatan Cimahi Utara Serta Faktor yang Mempengaruhinya. Jurnal Perencanaan Wilayah dan Kota, 23(3), 177-196.

Mazzanti, M., dan Zoboli, R. (2009), Municipal Waste Kuznets Curve: Evidence on socioeconomic drivers and policy effectiveness from the EU. Environmental and Resorces Economics, 44(2), 203-230.

McAllister, J. (2015), *Factors Influencing Solid-Waste Management in the Developing World. Geography*. USA: Utah State University.

Medina, M. (1997), The effect of income on municipal solid waste generation rates for countries of varying levels of economic development: A model. Journal of Resource Management and Technology, 24(3), 149-155.

Nguyen, K.L.P., Chuang, Y.H., Chen, H.W., Chang, C.C. (2020), Impacts of socioeconomic changes on municipal solid waste characteristics in Taiwan. Resources, Conservation and Recycling, 161(1), 1-15.

Prajati, G. (2014), Identifikasi Pengaruh Faktor-Faktor Sosioekonomi dan Kependudukan terhadap Timbulan Sampah di Ibukota Provinsi Jawa dan Sumatra. Bandung: Institut Teknologi Bandung.

Prajati, G., dan Pesurnay, A.J. (2020), Analisis Faktor Sosiodemografi dan Sosioekonomi terhadap Timbulan sampah Perkotaan di Pulau Sumatera. Jurnal Rekayasa Sipil dan Lingkungan, 3(1), 8-16.

Rizal, M. (2011), Analisis Pengelolaan Persampahan Perkotaan (Sudi Kasus Pada Kelurahan Boya Kecamatan Banawa Kabupaten Donggala). *Jurnal SMARTek*, 9(2), 155-172.

Saladie, O. (2016), Determinants of Waste Generation Per Capita in Catalonia (North- Eastern Spain): The Role of Seasonal Population European. Journal of Sustainable Development, 5(3), 489-504.

Sharholy, M., Ahmad, K., Vaishya, R.C., dan Gupto, R.D. (2008), Municipal Solid Waste Characteristics and Management in Allahabad, India. Journal of Waste Management, 27(4), 490-496.

Sheinbaum, P.C., Ruiz-Mendoza B.J., Rodríguez-Padilla, V. (2012), Mexican energy policy and sustainability indicators. Energy Policy, 46(3), 278-283.

SNI 19-3964-1994. Metode Pengambilan dan Pengukuran Contoh Timbulan, Komposisi Sampah Perkotaan.

SNI, 19-3983-1995. Spesifikasi Timbulan Sampah untuk Kota Kecil dan Kota Sedang di Indonesia.

Sumampouw, O.J. (2015), Pencemaran Lingkungan. Manado: Universitas Sam Ratulangi.

Sumantri, A. (2010), Kesehatan Lingkungan dan Perspektif Islam. Cetakan Pertama. Jakarta: Kharisma Putra Utama.

Sun, N., dan Chungpaibulpatana, S. (2017), Development of an appropriate model for forecasting municipal solid waste generation in Bangkok. Energy Procedia, 138(4), 907-912.

Tchobanoglous, G., Theisen H., dan Vigil, S.A. (1993), Intergrated Solid Waste Management: Engineering Principle and Management Issue. New York: McGraw Hill Inc.

Wang, H., dan Wang, C. (2013), Municipal Solid Waste Management in Beijing: Characteristics and Challenges. Waste Management & Research, 31(1), 67-72.

Zulfinar, Z., dan Sembiring, E. (2015), Dinamika Jumlah Sampah Yang Dihasilkan Di Kota Bandung. Jurnal Teknik Lingkungan, 21(1), 18-28.