EVALUATING THE CONTRIBUTION OF PLASTIC WASTE TO ENVIROMENTAL POLLUTION IN INDONESIA: FINDINGS FOR POLICY IMPLICATION

First MUHAMMAD KHOLID BASYAIBAN[1*], Second ZIADATUR RIZQIYAH[2] , and Third MOHAMMAD ALAIKA RAHMATULLAH [3]
[1]*Affiliation of Badan Riset Urusan Sungai Nusantara (BRUIN)*
[2-n]*Affiliation of Institute of Technology Sepuluh November Surabaya*
[3th]*Affiliation of ECOTON*
[*]Email officialbruin@gmail.com

ABSTRACT

This research addresses the urgent issue of plastic waste pollution in Indonesia, which is one of the world's largest producers of plastic waste, generating approximately 9.13 million tons annually. The study involved the collection of 25,733 plastic waste items across 64 locations in 30 districts or cities in 13 provinces, revealing a significant presence of multilayer sachet and single-layer packaging primarily from food, beverage, and personal care products. The findings indicate that sachets constitute a major component of plastic waste, highlighting challenges in recycling due to their complex composition. Additionally, the research underscores the low public engagement in recycling practices and the need for improved waste management strategies. By analyzing the types and characteristics of plastic waste, this study aims to inform more effective policies and enhance public awareness regarding plastic pollution. Ultimately, the research advocates for a comprehensive approach to mitigate plastic waste impacts, aligning with the government's 4R initiative to promote sustainability.

Keywords: plastic waste, environmental pollution, Indonesia, waste management, recycling

INTRODUCTION

The problem of plastic waste in Indonesia is very urgent, considering that this country is one of the largest producers of plastic waste in the world, with a total of around 9.13 million tons per year. Plastic waste accounts for around 14% of total domestic waste production, equivalent to 5.4 million tons (Ismainar et al., 2021). In various cities, such as Medan and Padang, the proportion of plastic waste in waste generation is also quite significant, with Medan producing around 2,000 tons of waste per day, of which 14.7% is plastic (Indirawati et al., 2023). This problem is exacerbated by the lack of effective management, where much plastic waste is not managed properly, causing environmental pollution and serious health impacts. For example, in Padang City, around 62.42 tonnes of waste per day is unmanaged, and 15% of the waste transported to final disposal sites (TPA) is plastic (Putri et al., 2023).

Plastic waste not only pollutes the environment but also contains various dangerous active ingredients that can affect human health and the ecosystem (Rochman et al., 2013). Some active ingredients commonly found in plastic, such as Bisphenol A (BPA), phthalates, and heavy metals such as lead and cadmium, have been shown to cause hormonal disorders, reproductive problems, and cancer risk (Andrady, 2011). In addition, microplastics, which are small plastic particles, have polluted waters and can enter the food chain, hurting human health and marine organisms (Jambeck et al., 2015).

Sachets, which are often used for packaging food and beverage products, have characteristics that make them difficult to recycle. Typically made from various types of laminated plastic, sachets not only contribute large volumes to waste generation but also create major challenges in management and recycling. According to data, the use of sachets in Indonesia continues to increase, and many of these sachets end up in landfills or pollute the environment, including water.

The Waste Management Law and Minister of Environment and Forestry Regulation Number 75 of 2019 regulate waste reduction and producer responsibility. Implementation of this policy still faces various challenges. Many manufacturers do not fully comply with existing regulations, and public awareness of the importance of reducing sachet use is still low. This shows a gap between existing rules and practice in the field.

From this background, this research aims to analyze the characteristics and types of plastic waste that pollute Indonesia's aquatic ecosystem. It is hoped that this data can become the basis for making policies and programs more effective in dealing with waste problems. This research involved several communities and academics in Indonesia. The location is surveying several rivers and beaches in Indonesia. This research can also provide a

comprehensive picture of the culture of plastic use in Indonesian society. Surveys at various river and beach locations in Indonesia to get a comprehensive picture of plastic use in society.

LITERATURE REVIEW

Plastic is a synthetic organic polymer consisting of a chain of C-C chemical bonds, with the main raw materials coming from fossil fuels, coal, oil, and natural gas. Since the discovery of plastic in 1856, production has increased rapidly from 2 million tons in the 1950s to 359 million tons in 2018. Plastic production continues to increase until it reaches, an average estimate of 460 million tons in 2019. However, only 9% of the total plastic waste was successfully recycled, while 19% was burned and almost 50% was thrown into final landfills (TPA) or carelessly into the environment. This causes the accumulation of plastic in soil, freshwater, and oceans, which is difficult to decompose naturally and can persist for decades (Ashrafy et al., 2023).

The problem of plastic pollution in Indonesia is influenced by the unequal distribution of waste management systems in each region, this is also exacerbated by the lack of budget and the less-than-optimal implementation of policies and regulations for plastic handling in Indonesia. Most plastic waste is not well managed, with 61% of total plastic waste not collected in a managed system. As a result, as much as 19% of plastic waste is burned and 22% is thrown away carelessly, Serious environmental pollution. Excessive use of plastic and low post-use value of plastic waste are also the main factors causing plastic pollution in Indonesia (Sabila et al., 2023).

With this understanding, efforts to reduce plastic pollution in Indonesia require a comprehensive approach, including improving upstream waste management systems, reducing the use of single-use plastics, and increasing public awareness of the impact of plastic pollution on the environment.

METHOD

Method The data collection method in this research will use a quantitative and qualitative approach to obtain comprehensive information regarding plastic waste brands. The data collection technique used is purposive sampling, where samples are taken based on certain criteria that are relevant to the research, such as brand, type of layer, type of material, and type of plastic products that are often used by the public.

Quantitative data will be collected through recording techniques (drafting), catching (catching), trash netting (trash boom), photos of waste generation, and barcode scanning to identify the frequency of use of various brands of plastic, qualitative data will be obtained through in-depth interviews with several respondents who have special knowledge about environmental conditions, people's habits in using plastic and utilization of rivers in their environment.

Determining the location for research was carried out using a purposive sampling method with the following steps:

1. Identify aquatic ecosystems including rivers and beaches that have the potential to become rubbish dumps, illegal rubbish dumps, and densely populated areas.

2. Conduct initial surveys of several identified locations to confirm the potential for plastic waste pollution. The locations chosen are those that have a significant accumulation of plastic waste.

3. Determine 64 plastic waste census locations spread across 30 districts/cities in 13 provinces throughout Indonesia. Location selection takes the representativeness of geographic distribution and population activity centers.

Tabel 1. Sampling Location 2022-2023

Regency	Number of Location Point	Provincy
Jombang	1	
Kediri	1	
Surabaya	4	
Sidoarjo	2	
Tulunggagung	1	EAST JAVA
Gresik	3	
Malang	1	

Trenggalek	1	
Bangkalan	1	
Wonogiri	2	CENTRAL JAVA
Cilacap	1	
Bogor	10	WEST JAVA
Depok	13	
South Jakarta	3	
East Jakarta	3	
Central Jakarta	1	DKI JAKARTA
West Jakarta	2	
North Jakarta	1	
Bengkulu	1	BENGKULU
Ambon	3	MALUKU
Ternate - Barangka Dufa	1	NORTH MALUKU
Central Halmahera	1	
Gorontalo	1	GORONTALO
Sorong	1	WEST PAPUA
Palu	1	CENTRAL SULAWESI
Pesawaran	1	LAMPUNG
Bandar Lampung	1	
East Lombok	1	NUSA TENGGARA BARAT
Banjarbaru	1	KALIMANTAN SELATAN

Using the purposive sampling method, data collection can be focused on locations that are points of significant accumulation of plastic waste, so that the data collected can represent the condition of plastic pollution in Indonesia.

The Analysis of research results uses qualitative analysis, which makes it possible to analyze non-numerical data and gain richer insight into the perspectives of research subjectsof. This data collection will be presented in graphical form to visualize the proportion of use of various brands of plastic and provide a clear picture of existing trends and patterns. Thus, it is hoped that this research can provide useful information for formulating more effective plastic waste management policies and programs.

RESULTS AND DISCUSSION

In Results of data collection from this research. Research shows significant achievements in understanding the plastic waste problem in Indonesia. A total of 25,733 pieces of plastic waste were collected at 64 locations spread across 30 districts or cities in 13 provinces in Indonesia, reflecting the extent of the plastic pollution problem. The waste collected is dominated by multilayer (sachet) and single-layer packaging from food and beverage companies or FMCG (Fast Moving Consumer Goods), cosmetics, personal care, and unbranded plastic.
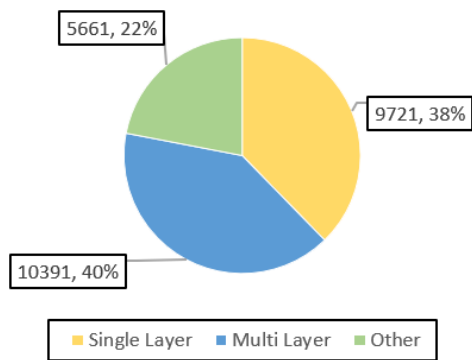
Figure 1. Graph of the results of the number of layers of plastic waste from 64 locations in Indonesia.

Results of identifying the types of layers that make up plastic (layers) from a total of 25,733 plastic waste collected, in Figure 1 show that sachet (multilayer) packaging dominates with a total of 10,391 pcs found. Then followed by single-layer packaging of 9,721 pcs, and other packaging of 5,661 pcs.

This finding is in line with previous research which shows that types of plastic such as sachets and food packaging are one of the main contributors to environmental pollution in various regions, as revealed in a study on plastic waste management in Karangjati Village which noted that 37.3% of plastic waste was food and beverage packaging (Sabila et al., 2023).

Apart from that, this research also highlights the challenges in managing plastic waste, where many people still do not fully implement the 3R (Reduce, Reuse, Recycle) concept effectively. A study in Wonosobo shows that despite efforts to reduce plastic use, recycling behavior is still in the low category, with only 29.1% of the community actively involved in recycling (Sari et al., 2023).

From the results of this data collection, it is hoped that it can provide a clear understanding of the role of plastic packaging in environmental pollution and become a basis for formulating more effective policies in managing plastic waste in Indonesia. This research also emphasizes the importance of increasing public awareness about waste management and implementing sustainable practices in daily life, in line with the government's efforts to implement the 4R concept to reduce the negative impacts of plastic waste (Wijaya et al., 2024).
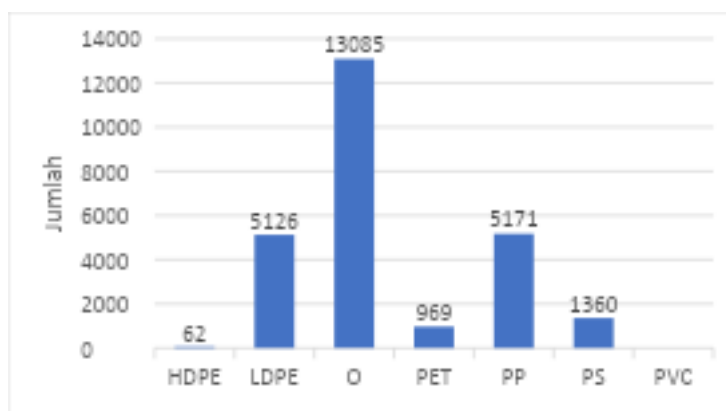

Figure 2. Graph of the results of the number of types of plastic waste material from 64 locations in Indonesia.

The results of identifying types of plastic waste material in this study show that plastic is the dominant component in the waste found in Figure 2. Of the total waste collected, O (others) plastic dominates with 13,085 pieces, followed by PP (Polypropylene) plastic with 5,171 pieces. LDPE (Low-Density Polyethylene) as many as 5,126 pieces. Apart from that, PS (Polystyrene) plastic was recorded at 1,360 pieces, while PET (Polyethylene Terephthalate) and HDPE (High-Density Polyethylene) plastic were found at 962 pieces and 62 pieces respectively. Interestingly, no PVC (Polyvinyl Chloride) type plastic was detected in this data collection.

These findings provide a clear picture of the composition of plastic materials that contribute to pollution in Indonesia and emphasize the need for better management efforts to reduce the negative impact of plastic waste on the environment. This finding matches the result of previous research conducted by Jambeck et al. (2015) in Padang City. In this study, the types of plastic most commonly found were PP, LDPE, and PS, with percentages similar to the results of this study. However, research by Jambeck et al. also found significant amounts of PVC-type plastic, which is different from the findings in this study.

Other research conducted by Andrady (2011) Stated that results of plastic waste in Medan City were dominated by PP, LDPE, and PS. This study emphasizes the importance of proper plastic waste management, especially for types of plastic that are difficult to recycle such as O (others) and PS.

These findings provide a clear picture of the composition of plastic materials that contribute to pollution in Indonesia and emphasize the need for better management efforts to reduce the negative impact of plastic waste on the environment. By comparing the results of this research with previous studies, it can be concluded that the types of plastic most commonly found in various regions in Indonesia tend to be similar, with some variations in the number of certain types of plastic.

The results of research regarding the types of plastic packaging products collected in the plastic waste census study in Indonesia show significant findings and provide a clear picture of the contribution of various types of packaging to environmental pollution in Figure 3. Of the total plastic waste found, food packaging products (FP) dominate with a total of 14,344 pieces, reflecting the high consumption of food products using plastic packaging in society (Rusniati Rusniati et al., 2023).
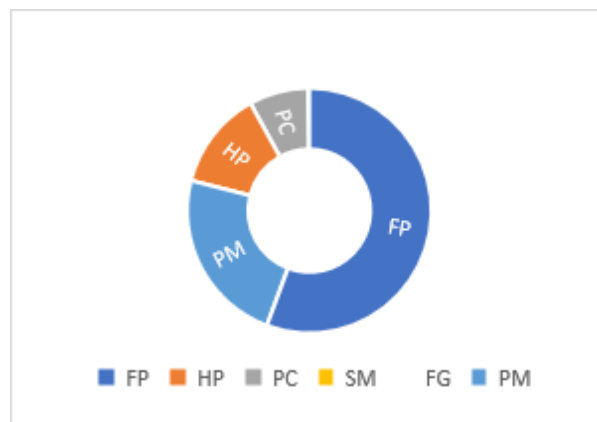

Figure 3. Graph of the results of the number of types of plastic waste packaging products from 64 locations in Indonesia

Furthermore, packaging equipment (PM) products were recorded at 6,004 pieces, indicating that packaging for packaging goods also contributes greatly to the generation of plastic waste. There were 3,358 household products (HP) found, which included packaging for various products used daily at home.

Personal care (PC) product packaging is also a concern, with a total of 2,022 pieces found, indicating the high use of plastic in beauty and personal hygiene products. Although the numbers are much smaller, smoking equipment (SM) was recorded at 45 pieces, while fishing equipment (FG) was not found at all, with a total of 0 pieces.

These findings underscore the importance of better understanding the types of plastic packaging products circulating in society and their causing the environment problem. With this data, it is hoped that more effective plastic waste management policies and programs can be formulated, as well as increasing public awareness about the importance of reuse of plastic packaging that is not environmentally friendly.

CONCLUSION

This research provides a clear picture of the contribution of plastic packaging to environmental pollution in Indonesia. Some key findings:

1. Plastic waste collected is dominated by sachet (multilayer) packaging and single-layer packaging from food, beverage, cosmetic, personal care products, and unbranded plastic.

2. The most commonly found plastic types are O (others), PP (Polypropylene), and LDPE (Low-Density Polyethylene). These findings are in line with previous research in Padang and Medan Cities.

3. Food packaging (FP) products dominate with a total of 14,344 pieces, followed by equipment packaging (PM) with 6,004 pieces and household products (HP) with 3,358 pieces. This indicates high consumption of products with plastic packaging in society.

The results of this research are expected to serve as a basis for formulating more effective policies in managing plastic waste in Indonesia. Efforts to increase public awareness and implement sustainable practices in daily life are also important, in line with the government's efforts to implement the 4R concept to reduce the negative impact of plastic waste.

ACKNOWLEDGMENT

REFERENCES

Andrady, A. L. (2011). Microplastics in the marine environment. *Marine Pollution Bulletin*, *62*(8), 1596–1605. https://doi.org/10.1016/j.marpolbul.2011.05.030

Ashrafy, A., Liza, A. A., Islam, M. N., Billah, M. M., Arafat, S. T., Rahman, M. M., & Rahman, S. M. (2023). Microplastics Pollution: A Brief Review of Its Source and Abundance in Different Aquatic Ecosystems. *Journal of Hazardous Materials Advances*, *9*(October 2022). https://doi.org/10.1016/j.hazadv.2022.100215

Indirawati, S. M., Salmah, U., Arde, L. D., & Hutagalung, D. S. (2023). Analisis Model Intervensi Pengelolaan Sampah Plastik Pada Generasi X Di Kota Medan. *Jurnal Kesehatan Lingkungan Indonesia*, *22*(2), 160–169. https://doi.org/10.14710/jkli.22.2.160-169

Ismainar, H., Marlina, H., Afriza, B., & Atika, W. (2021). Gerakan Mengurangi Sampah Plastik dan Resiko Membakar Sampah Dengan Pemberian Edukasi Kesehatan Melalui Penyuluhan. *Jurnal Pengabdian Kesehatan Komunitas*, *1*(3), 188–195. https://doi.org/10.25311/jpkk.vol1.iss3.1031

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, *347*(6223), 768–771. https://doi.org/10.1126/science.1260352

Putri, N. W., Fitriyani, F., Rahmalber, T. V., Falikha, D. D., Tafsia, S. I., & Setiawati, S. D. (2023). Pengetahuan, Sikap dan Partisipasi Masyarakat Dalam Penerapan Kebijakan Pengurangan Kantong Plastik sebagai Upaya Mengurangi Sampah Plastik di Kota Padang. *Jurnal Kesehatan Lingkungan Indonesia*, *22*(3), 259–267. https://doi.org/10.14710/jkli.22.3.259-267

Rochman, C. M., Browne, M. A., Halpern, B. S., Hentschel, B. T., Hoh, E., Karapanagioti, H. K., Rios-Mendoza, L. M., Takada, H., Teh, S., & Thompson, R. C. (2013). Policy: Classify plastic waste as hazardous. *Nature*, *494*(7436), 169–170. https://doi.org/10.1038/494169a

Rusniati Rusniati, Ahsanul Haq, RR. Yulianti Prihatiningrum, & M. Yudy Rachman. (2023). Penyuluhan Mengenai Kode Produk Kemasan Plastik Bagi Peningkatan Pengetahuan Ibu-Ibu Kelompok Yasinan As Salaam Banjarmasin. *Joong-Ki : Jurnal Pengabdian Masyarakat*, *2*(3), 774–784. https://doi.org/10.56799/joongki.v2i3.2326

Sabila, F. T., Setyaningsih, W., Hardati, P., & Nugraha, S. B. (2023). Literasi Lingkungan dan Pengelolaan Sampah Plastik di Kelurahan Karangjati Kecamatan Blora Kabupaten Blora. *Edu Geography*, *11*(1), 85–92. https://doi.org/10.15294/edugeo.v11i1.65558

Sari, D. A., Harfia, A. Z., & Heriyanti, A. P. (2023). Penyuluhan dan Pelatihan Pembuatan Ecobrick di Desa Pulosaren Sebagai Upaya Pemanfaatan Sampah Plastik. *Jurnal Bina Desa*, *5*(1), 45–53. https://doi.org/10.15294/jbd.v5i1.41080

Wijaya, D., Apriyani, & Suyatni, A. (2024). Pengolaan Sampah Dengan Konsep 3R di Kota Samarinda. *Jurnal Kesehatan Dan Pengelolaan Lingkungan*, *5*(1), 24–32. http://journal2.uad.ac.id/index.php/jkpl/index