

Household Plastic Waste Recycling: A Pathway to a Sustainable Green Economy

Berli Paripurna Kamiel¹, Endah Saptutyingsih^{2*}, Febby Ferlita Ardyanti³

¹Faculty of Engineering, Universitas Muhammadiyah Yogyakarta, Indonesia

^{2,3}Faculty of Economics and Business, Universitas Muhammadiyah Yogyakarta, Indonesia

Abstract. Improper handling and management of plastic waste led to various adverse environmental impacts. This research aimed to evaluate the community's awareness, practices, and attitudes regarding solid waste management programs in Wonokromo II, Bantul, Indonesia. Additionally, it sought to investigate the relationship between respondents' characteristics and their strategies for managing plastic waste. The study employed a post-program questionnaire survey method, involving forty-four households. Through a validated, self-administered instrument, data was collected and analyzed. The findings revealed an enhanced public understanding and awareness of waste sorting post-training. Households demonstrated awareness of existing solid waste management programs, engaged in waste sorting, and utilized machines to shred plastic waste, facilitating recycling into more useful products. The study underscores the challenges posed by insufficient plastic waste processing and suggests potential remedies to foster a healthier environment and mitigate climate change impacts.

1 Introduction

Industrial progress leads to a significant accumulation of waste in the environment due to human activities, generating a vast array of goods. There are three main ways that these wastes appear: gas, solid, and liquid [1-3]. Of these, plastic makes up a sizable amount of industrial waste, posing severe environmental challenges when disposed of in landfills [4-7]. Plastic finds ubiquitous use across various industries such as packaging, construction, electronics, agriculture, healthcare and automotive, ingrained into daily life routines. Its continued demand persists due to numerous benefits, including resistance to wear and tear, longevity, versatility, ease of production, and cost-effectiveness [8,9]. Non-biodegradable garbage is defined as plastic waste because of its sluggish rate of decomposition which allows it to survive in the environment for a longer period of time. These businesses raise a lot of concerns about the environment because they contribute significantly to the growing quantity of non-biodegradable plastic garbage produced worldwide [10].

Recycling has a significant potential to reduce the quantity of waste that is dumped in landfills and the requirement for fresh raw resources [11-13]. By conserving energy, reducing pollution from raw material mining, and creating jobs, it also benefits the environment [14]. Figure 1 illustrates the lifecycle of a plastic product, which includes use, disposal, and

* Corresponding author: endahsaptuty@umy.ac.id

recycling. Waste made of non-biodegradable plastic is being managed using a variety of techniques that have been developed. The two types of these technologies are those made for conventional plastic trash and those made for advanced plastic waste. There are two conventional approaches to dispose of plastic waste: landfilling and incineration. Each has drawbacks of its own. Incineration is not a sustainable solution even if it uses a lot of energy and produces dangerous pollutants [15]. Byproducts such as acidic gasses, particulate particles, CO₂, persistent organic compounds, and heavy metals are known to cause global warming and several health issues, including reduced lung function, increased cancer risk, and respiratory illnesses [16-17].

But there will be challenges in this urban area's way of efficiently managing solid waste management, such as a lack of funding, an insufficient administrative structure, environmental laws, a lack of experience with intricate systems, and unhygienic facilities [18]. Consequently, minimizing solid waste generation at its origin has been identified as the most effective approach to solid waste management [19]. To put this strategy into practice, active community participation in the solid waste management is highly recommended, particularly in nations with weak economies [20].

Starting a campaign to raise awareness in the community that emphasizes recycling, sorting, and solid waste minimization is necessary to ensure sustainability in the solid waste managementsystem [21]. Attempts to reduce solid waste at the source may be impacted by the status of the economy and societal standards [22]. Consequently, a lack of facilities and knowledge may make it more difficult for the community to participate in the solid waste reduction, reuse, and recycling (3Rs) program. Some may argue that they lack the time or space to takepart in programs aimed at reducing solid waste [23]. Community involvement in proper solid waste sorting and reduction methods can be sustained by implementing an active social strategy [24]. Moreover, the development of markets for products utilized in solid waste treatment can contribute to the sustainability of the 3Rs' initiatives [23]. Planning, utilize, control, maintenance, supervision, and legal enforcement are all part of environmental protection and management's objectives in order to preserve the environment's functionality and stop pollution or environmental damage [25]. A clean and healthy environment is a fundamental human right, as stated in Article 65 (1) of Law No. 32/2009, which acknowledges the interdependence of human existence and the environment [26]. Consequently, encouraging communities that are hygienic, visually beautiful, healthy, and sustainable calls for active community participation in the fight against pollution and environmental preservation. To guarantee a suitable and healthy living environment, the government and the society have a duty to protect and maintain the environment. The environment is defined as a comprehensive entity that encompasses space, all of its components, circumstances, and living beings by Law No. 32 of 2009, which deals with the Protection and Management of the Environment. This definition highlights the role of humans as significant influencers in environmental sustainability through efforts to mitigate pollution and manage the environment [27].

Environmental pollution avoidance might involve more than just collecting and disposing of waste; it can also involve processing waste to make it more valuable economically and have a positive impact on the environment. Two essential components of creating a tourism destination are using green spaces for local food cultivation and employing efficient waste management techniques to maintain clean, healthy, aesthetically pleasant, and sustainable environmental conditions. Declining environmental conditions can reduce the allure of tourism destinations [28]. Sustainable sanitation, the sixth Sustainable Development Goal, highlights the need to preserve the environment since dirty environments can lead to diseases that are detrimental to human health and, ultimately, to welfare in general. Sustainable development is predicated on four core principles: meeting human needs, preserving ecological balance, ensuring future generations' social justice, and upholding the

right to self-determination. One aspect of environmental stewardship that can improve wellbeing, provide for basic needs, and preserve a healthy environment for future generations is waste management [29,30].

Initial observations indicate a notable deficiency in environmental management practices in Wonokromo II, Bantul, Indonesia. Alongside roadsides, waste is frequently observed to be scattered, posing not only environmental hazards but also the risk of epidemic spread [31]. Waste, characterized as the residual solid byproducts of routine human activities or natural occurrences according to Law No. 18 of 2008, demands prompt attention due to its potential environmental and public health implications. Household waste, being a substantial contributor to overall environmental waste, underscores the significance of addressing this issue effectively [32].

It was discovered during the program's first phase that some homes lacked enough waste management awareness and understanding, and that local governments had not properly coordinated the disposal of community waste [33]. The main source of environmental problems is a lack of public appreciation for environmental management and the ecosystem's carrying capacity. This is caused by a variety of factors, such as changed environmental functions, declining carrying capacities and environmental quality, poor coordination among the numerous stakeholders involved in the management of natural, artificial, and human resources, environmental contamination, and wasteful use of land and space [34,35]. The public is ignorant of the technology's benefits for processing solid waste, particularly plastics, hence they are also ignorant of its drawbacks and consequences. Consequently, training is essential to empower residents of Wonokromo II, Bantul, with skills inherent to the community, aiming to heighten awareness of processing residential plastic waste to enhance its value. Sorting, washing, combining into commercial amounts, drying, compacting, and purifying are examples of value-adding procedures [36]. Sorting increases the value of plastic waste, claims Plastic Zero [37], whereas value addition raises the recovered waste materials' quality and financial value.

Rubbish collectors in poor countries retrieve the majority of the rubbish. [38, 39], underlining how crucial it is to evaluate different approaches for enhancing the recovered waste's value. Understanding the mechanics behind value addition is essential for enhancing sustainable value creation processes in the manufacturing and conversion sectors. Realizing circular economies requires giving sustainable value creation top emphasis.

2 Methodology

2.1. Study site

Conducted in Wonokromo II, Bantul, Indonesia, this study identified the necessity to manage plastic waste effectively by utilizing human resources within Wonokromo II to transform it into value-added products, such as shredded plastic, through the utilization of a shredding machine. This involves empowering local communities by engaging them in the planning, management, and sharing of opinions throughout the process.

2.2. Survey design and administration

To find out more about how locals handle their plastic garbage, we surveyed households in the research area. We used Slovin's formula to determine the sample size for homeowners [40, 41], in this investigation, with an estimation error of 10%. 45 families were chosen for the survey utilizing Slovin's algorithm. Using stratified random sampling, the number of home samples from different socioeconomic backgrounds was determined and then combined into a single sample [42]. The steps for designing the survey and questionnaire

are shown in Figure 1.

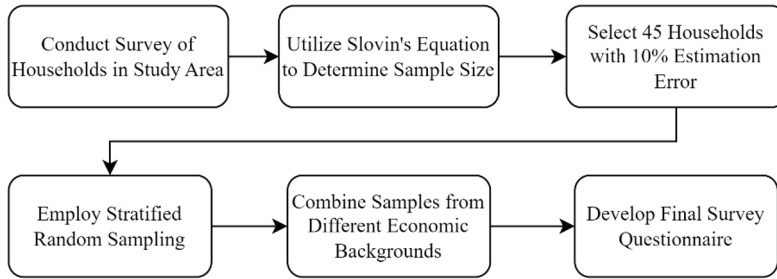


Fig. 1. The steps for designing the survey and questionnaire

The final survey questionnaire is divided into four pieces. Sociodemographic traits including age, income, marital status, and degree of education are included in Section A. In Section B, waste management knowledge inside the household is examined. Topics covered include trash sorting, greenhouse gas emissions, and how solid waste affects greenhouse gas emissions. Home waste management facilities, including solid waste banks and participation in the 3R (reduce, reuse, recycle) program, are covered in Section C. initiatives in education. The waste management procedures used in households, the existence of environmental cadres, the readiness to sort garbage, and the classification of non-organic waste categories are all covered in Section D. Last but not least, Section E discusses waste management technology and evaluates respondents' knowledge of it, readiness to use it, and perceptions of the advantages of doing so.

Table 1. List of predictor variables and scale of each variable.

Predictor	Scale	Predictor	Scale
Socio-demographic characteristics of the households		Household facilities related to waste management	
Age (X1)		Availability of solid waste bank (X8)	
<20	1	Not available	1
20-50	2	Available	2
>50	3	Availability of training program on 3R (X9)	
Marriage status (X2)		Not available	1
Married	1	Available	2
Unmarried	2	Household's activities to manage the waste	
Education level (X3)		Activities of waste management (X11)	
Elementary School	1	Manage	1
Junior High School	2	Doesn't manage	2
Senior High School	3	Willingness to sort waste (X12)	
Bachelor/Undergraduate	4	Willing	1
Income (X4)		Not willing	2
Low	1	Technology of waste management	
Middle	2	Knowledge of the technology (X14)	
High	3	No knowledge	1
Household's knowledge related to waste management		Sufficient knowledge	2

Knowledge in waste sorting (X5)		High level of knowledge	3
No knowledge	1	Willingness to apply the technology (X15)	
Sufficient knowledge	2	Willing	1
High level of knowledge	3	Not willing	2

2.3. Data Analysis

In SPSS software, the associations between predictor factors and response variables were investigated using the chi-squared (χ^2) correlation test. Increasing the value added of plastic waste (Y) using technology: Participants were given two nominal scales; a score of one denoted significant technology use, and a score of 2. The respondent variables were centered on community activities linked to recycling plastic waste. Table 1 compiles the predictor variables.

The following theories served as the foundation for assessing the relationship between the response variables (Y) and predictor factors (X):

1. The hypothesis (H0) is accepted if there is no association between the predictor variables (X) and the response variables (Y).
2. In the event of a correlation, the hypothesis (H1) is accepted.

Pearson χ^2 values and significance values (α) were used to find correlations between responder and predictor variables. The following methods were used to perform the correlation test between the predictor and responder variables:

1. If the calculated Pearson χ^2 value was more than the χ^2 value in the table or less than 0.1, there was a relationship between the predictor and response variables (accepting H1 and rejecting H0).
2. If the calculated Pearson χ^2 value was less than or more than 0.1, there was no connection between the response variables and the predictor (accepting H0 and rejecting H1).

3 Results and discussion

3.1 The composition of waste

Plastic makes up 73% of residential solid trash, with paper coming in second at 21%, metal at 3%, glass at 1%, and other materials at 2%. Paper, metal parts, and plastics are among the materials that trash generators like to sort and sell to waste collectors. As stated by Plastic Zero [29], sorting enhances the value of polymers by categorizing them based on purity, color, and type. This process enhances both the quality and market value of the recovered waste. Informal waste collectors are crucial to the retrieval of rubbish in emerging economies [37, 38], underscoring the importance of assessing various methods to add value to recovered waste. To improve sustainable value creation processes in the manufacturing and conversion sectors, one must have a solid understanding of value addition. A purposeful effort toward sustainable value development is necessary for circular economies.

Among the waste products that were frequently sorted and sold to garbage collectors were paper, plastic, and metal. According to Plastic Zero [29], sorting increases the value of polymers by classifying waste materials and polymers according to their kind, purity, and color. By adding value, the recovered garbage's quality and value are raised. In less developed economies, most rubbish collection is done by informal waste collectors [37, 38], emphasizing how important it is to consider how to give recovered garbage greater value. A

solid grasp of value addition is necessary to enhance sustainable value creation processes in the manufacturing and conversion sectors. Setting a high priority on sustainable value creation is necessary to create circular economies.

3.2 The activities of waste management

One of the community's solid waste management objectives is to separate recyclables from residual and decomposable rubbish, such as metals, paper, and plastics. Eighty percent of the forty-five respondents to the direct interview survey were requested to sort and collect recyclable solid waste for additional processing, while twenty percent of them opted not to participate. Ninety-three percent of individuals who separated their waste indicated that they would be open to selling it to waste collectors and collecting it with their community, whilst the remaining seven percent stated they would not be taking part in this activity.

31% of survey respondents who sorted their solid garbage said that community leaders' advice was the reason behind their actions (Table 2). The majority (55%) stated that they were motivated by self-awareness, whereas only 14% said they were motivated by training. This is consistent with the Indonesian government's objectives for the Bantul Regency to establish a waste management system that revolves around the settlements.

Table 2. Reasons of respondents in performing waste management

Reasons	Percentage (%)
Self-awareness	55
Community leader instruction	31
Effect of training	14
Total	100

The reasons provided by respondents (Table 3) for not classifying solid waste are as follows: The primary causes are a shortage of facilities for holding sorted solid waste materials (22%) and a lack of technological know-how for additional treatment (88%).

Table 3. Reasons for respondents who did not do waste management

Reasons	Percentage (%)
No technical knowledge for further treatment	88
No facilities for storage of the sorted solid waste materials	22
Total	100

When asked if non-compostable goods such plastics, paper, and metals are sold directly to waste pickers, the majority of respondents (72%) who sorted solid debris gave this response (Table 4). In Bantul, Indonesia, homeowners frequently employ this tactic since it provides the most practical means of increasing revenue from solid garbage. After that, the waste is sold to a company that performs basic processing tasks on recyclable solid waste, such as cleaning, shredding, pelletizing, and packaging the plastic waste.

Table 4. Treatment of waste by community.

Treatment of waste	Percentage (%)
Directly sold to waste pickers	72
Treated by other means	28
Total	100

These incidents were common in poor Asian countries where crude recycling methods

were used. [36]. Processing-ready recycled materials are bought by industrial industries [32, 37]. Recyclable waste products were handled differently by the remaining 28% of respondents, either by putting them in solid waste banks or leaving them in the hands of rubbish pickers or community leaders.

3.3 Plastic waste Recycling

Table 5 shows a definite rise in awareness of plastic shredding devices following the promotion. These gadgets were instances of technology created to raise the worth of used plastic. Value addition raised both the monetary and quality value of the recovered garbage. Chopped plastic is more costly than plastic in its initial condition. This is due to the fact that when plastic trash is shredded into sorted plastic, businesses can recycle it more easily and for less money into new items.

Table 5. Knowledge of technology for plastic waste.

Knowledge of technology for plastic waste	Percentage (%)
No knowledge	0
Sufficient knowledge	93
High level of knowledge	7
Total	100

Table 6 demonstrates that as respondents were more aware of the benefits of shredding machines, every participant indicated that they would be willing to use this equipment to treat plastic trash. This is intended to increase its selling price and, as a result, their revenue.

Table 6. Willingness to use the technology

Willingness to use the technology	Percentage (%)
Willing	100
Not willing	0
Total	100

In many developing economies, waste collectors gather valuable but abandoned goods, like plastic, and reintroduce them into the economy, so generating a circular economy. But how much of a contribution these recovered materials make to a circular economy will depend on the processes they go through. Recycling processes are used to increase the value of recovered plastic trash, which increases the recycling operations' significance of these processes. This emphasizes how crucial it is to find value in recovered plastic trash in order to maximize recycling processes. Recycling is essential to the development of a circular economy because it converts trash into new resources that are incorporated back into production networks. Waste is viewed as a resource in a circular economy, hence methods for enhancing recovered plastic waste's value are crucial. Recycling is becoming more and more necessary to maintain life as the value of converting waste into useful items rises.

3.4 The relationship between the predictor and respondent variables

The community's use of technology to increase the value of plastic waste, as shown in Table 7, was correlated with a number of sociodemographic factors, including age, marital status, income, and education level; knowledge of waste management (including waste sorting); facilities related to waste management (like taking part in a 3R training program); activities related to waste management (like participating in waste management activities and being willing to sort waste); and waste management technology (like being familiar with the

technology and being willing to adopt it).

The community was taught the value of and procedure for sorting solid trash through the training program, which was linked to the execution of shredding activities. This result is consistent with earlier studies showing that trash generators' attempts to separate solid waste can be improved by regular training programs [7].

Additionally, a correlation between the participants' comfort level and technological readiness and the shredding exercise designed to add value to plastic waste was demonstrated by the test findings. Nevertheless, there was no correlation observed between the existence of trash banks and the shredding of plastic debris. In the absence of waste banks, it appears that the community has embraced shredding technology as part of their responsibility for managing home waste.

Table 7. Result of χ^2 correlation test between community using technology of plastic waste management and the predictor variables.

Predictor variables	df	χ^2 value	Result
Age (X1)	1	20.802	Reject H0
Education level (X2)	1	19.627	Reject H0
Marriage status (X3)	1	10.624	Reject H0
Income (X4)	1	8.852	Reject H0
Knowledge in waste sorting (X5)	1	5.280	Reject H0
Availability of waste bank (X6)	1	17.111	Accept H0
Availability of R training program (X7)	1	9.610	Reject H0
Activities of waste management (X8)	1	8.568	Reject H0
Willingness to sort waste (X9)	1	6.465	Reject H0
Knowledge in the technology (X10)	1	7.124	Reject H0
Willingness to apply the technology (X11)	1	8.148	Reject H0

4 Conclusion

Residents of Wonokromo II Bantul have actively participated in implementing 3R (reduce, reuse, recycle) activities for domestic solid waste, despite the lack of specialist facilities like garbage banks and environmental cadres. This shows a great degree of awareness and participation in 3R activities throughout the community. Establishing more defined and efficient roles for governmental and social institutions should be the top priority for promotion initiatives. Taking into consideration predictor variables that exhibit strong correlations with community activities aimed at increasing the value added of plastic rubbish may further boost the success of the promotion campaign. In industrial operations, the many types of value addition are essential elements of value generation. Understanding the various types of value addition is crucial for policymakers, plastic producers, and converters as they make critical choices that will support a sustainable circular economy.

Acknowledgments

The authors express their gratitude to Universitas Muhammadiyah Yogyakarta for the financial assistance provided. We also extend special appreciation to the households of Wonokromo II Bantul for their collaboration as our activity partners.

References

1. Tang Z, Li W, Tam V W Y and Xue C 2020 Advanced progress in recycling municipal

- and construction solid wastes for manufacturing sustainable construction materials *Resour. Conserv. Recycl. X* 6 100036
2. Zhang K, Shi H, Peng J, Wang Y, Xiong X, Wu C L P 2018 Microplastic pollution in China's inland water systems: A review of findings, methods, characteristics, effects, and management *Sci Total Env.*
 3. Zhao, Y.; Tan, Y.; Feng S 2020 Does reducing air pollution improve the progress of sustainable development in China? *J. Clean. Prod* 272
 4. Moharir, R.V.; Kumar S 2019 Challenges associated with plastic waste disposal and allied microbial routes for its effective degradation: A comprehensive review *J.Clean. Prod* 65–76
 5. Chow, C.-F.; So, W.-M.W.; Cheung, T.-Y.; Yeung S-K . *Plastic waste problem and education ment. In Emerhing Practices in Sholarship pf Learning and Teaching in a Digital Era* (Berlin/Heidelberg, Germany)
 6. Idumah, C.I.; Nwuzor I . 2019 Novel trends in plastic waste management *SN Appl. Sci* 1–14
 7. Sharuddin, S.D.A.; Abnisa, F.; Daud, W.M.A.W.; Aroua M . 2016 A review on pyrolysis of plastic wastes *Energy Convers. Manag* 308–26
 8. Wong, S.L.; Ngadi, N.; Abdullah, T.A.T.; Inuwa I . 2015 Current state and future prospects of plastic waste as source of fuel: A review. *Renew Sustain. Energy Rev* 1167–80
 9. Pan, D.; Su, F.; Liu, C.; Guo Z 2020 Research progress for plastic waste management and manufacture of value-added products. *Adv. Compos Hybrid Mater* 3 443–61
 10. Garcia, J.M.; Robertson M . 2017 The future of plastics recycling *Science (80-.)* 870–2
 11. Da Cruz, N.F.; Simões, P.; Marques R . 2014 Costs and benefits of packaging waste recycling systems *Resour. Conserv. Recycl* 1–4
 12. Gu, F.; Guo, J.; Zhang, W.; Summers, P.A.; Hall P 2017 From waste plastics to industrial raw materials: A life cycle assessment of mechanical plastic recycling practice based on a real-world case study *Sci. Total Env.* 1192–207
 13. Vollmer, I.; Jenks, M.J.F.; Roelands, M.C.P.; White, R.J.; van Harmelen, T.; de Wild, P.; van Der Laan, G.P.; Meirer F . and Keurentjes, J.T.F.; Weckhuysen B . 2020 Beyond mechanical recycling: Giving new life to plastic waste *Angew. Chew. Int. Ed* 15402–15423
 14. Psomopoulos, C.S.; Bourka, A.; Themelis N . 2009 Waste-to-energy: A review of the status and benefits in USA *Wate Manag* 1718–24
 15. Ashworth, D.C.; Elliott, P.; Toledano M . 2014 Waste incineration and adverse birth and neonatal outcomes: A systematic review. *Environ. Int* 120–32
 16. Franchini, M.; Rial, M.; Buiatti, E.; Bianchi F 2004 Health effects of exposure to waste incinerator emission: A reviecal studies *Ann. Dell'istituto Super. Sanità* 101–15
 17. Yang, N.; Zhang, H.; Chen, M.; Shao, L.-M.; He P-J 2012 Greenhouse gas emissions from SOLID WASTE incineration in China: Impacts of waste characteristics and energy recovery *Waste Manag* 2552–60
 18. I K A and L 1995 Community and private (formal and informal) sector involvement in municipal solid waste management in developing countries *Background Paper for the UMP Workshop. Ittigen: 10-12*
 20. Chakrabarti S, Majumder A C S 2009 Public-comunity participation in household waste management in India: an operational approach *Habit Int.* 125–30
 21. K J Stakeholder participation for sustainable waste management *Habit Int* 863–71
 22. Tai J, Zhang W, Che Y F D 2011 Municipal solid waste source-separated collection in China: a comparative analysis. *Waste Manag* 1673–82
 23. Martin M, Williams ID and C M 2006 Social, cultural and structural influences on

- household waste recycling: a case study. *Resources, Conservation, and Recycling* 357–95
24. Zhuang Y, Wu SW, Wang YL, Wu WX C Y 2008 Source separation of household waste: a case study in China *Waste Manag* 2022–30
 25. Anon 2009 Undang Undang No. 32 Tahun 2009 Tentang: Perlindungan Pengelolaan Lingkungan Hidup
 26. A H 2016 *Environment and tourism* (Routledge)
 27. Sauv  S B S and S P 2016 Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research *Environ Dev* 48–56
 28. Fan D X F L A and Q R T R 2019 Revisiting the relationship between host attitudes and tourism development: A utility maximization approach *Tour Econ* 171–88
 29. J T Eco-tourism and Sustainable Community Development in Cuba: Bringing Community Back into Development *J,Int.Glob.Stud.* 9
 30. T S and S 2018 Integrated sustainable waste management in Malang City, East Java, Indonesia AIP Conference Proceedings *AIP Publ.* p 30043
 31. Rasha N P L and 2018 *Penyuluhan Sanitasi Higiene dan Perilaku Hidup Bersih Sehat pada Masyarakat Kawasan Candi Batujaya sebagai Dasar Membangun Desa Wisata yang Bersih, Sehat, dan Ramah Lingkungan* (Jakarta)
 32. Anon 2008 *Undang-Undang No. 18 Tahun 2008 tentang Pengelolaan Sampah*
 33. Hasanah U, Tarma T N P L and S R 2018 *Penyuluhan Family Literacy untuk Meningkatkan Literasi Budaya pada Masyarakat Wilayah Candi Batujaya Karawang Sarwahita*
 34. Suparmini S S S and S D R S 2013 Pelestarian Lingkungan Masyarakat Baduy Berbasis Kearifan Lokal *J* 18
 35. I C M and C 2017 *Managing sustainable development* (Routledge)
 36. M. Asim, S.A. Batool M N C Scavengers and their role in the recycling of waste in Southwestern Lahore.” *Resources Conservation and Recycling* 152–62
 37. Denmark T U of 2013 *ZERO, Plastics. Plastics ZERO-Public Private Corporations for Avoiding Plastic as a Waste* (Copenhagen)
 38. D.C. Wilson, A.O. Araba, K. Chinwah C R C 2009 Building recycling rates through the informal sector *Waste Manag.* 29 629–35
 39. C.A.Velis, D.C. Wilson, O. Rocca, S.R. Smith, A. Mavropoulos C R C 2012 An analytical framework and tool (‘InteRa’) for integrating the informal recycling sector in waste and resource management systems in developing countries *Waste Manag. Res.* 43–66
 40. Almeda J, Capistrano T S G 2010 *Textbook in elementary statistics* (Quezon City: UP Press)
 41. Tejada J P J 2012 On the misuse of slovin’s formula *Philipp. Stat.* 129–36
 42. GA T 2003 *Draft: Handbook on Designing of Household Sample Surveys, Chapter Two: Sampling Strategies. United Nations Secretariat, Statistics Division, New York*