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CASE STUDY

# EVALUATION OF ENVIRONMENTAL AWARENESS DURING THE COVID-19 PANDEMIC: A BEHAVIOURAL STUDY OF SINGLE-USE PLASTIC

**Muhammad Alfarizi**

*Cluster of Interaction, Community Engagement and Social Environment*
*School of Environmental Science Universitas Indonesia, Jl.*
*Salemba Raya No 5, Central Jakarta, Jakarta 10430*
*Department of Management, BINUS Online Learning,*
*Bina Nusantara University*

Email: muhammad.alfarizi@binus.ac.id

**Dr Herdis Herdiansyah**

*School of Environmental Science, Universitas Indonesia*
*Central Jakarta, DKI Jakarta 10430, Indonesia*

Email: herdis@ui.ac.id

**Sinan Vidi Lazuardi**

*Cluster of Interaction, Community Engagement and Social Environment*
*School of Environmental Science Universitas Indonesia, Jl.*
*Salemba Raya No 5, Central Jakarta, Jakarta 10430, Indonesia*

Email: sinan.vidi@ui.ac.id

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## ABSTRACT

**PURPOSE:** Plastic waste management must be pursued, one method is through the role of the community as plastic users. This study aims to evaluate the environmental awareness factor of the community in Makassar, Indonesia, as it is severely affected by plastic waste.

**DESIGN/METHODOLOGY/APPROACH:** The paper used a Structural Equation Modelling (SEM) analysis method with nine latent variables and a probability proportional size cluster sampling system.

**LIMITATION:** The study is limited to Makassar City, potentially affecting the generalisability of its findings. Future research should explore cross-border plastic waste issues and implement practical solutions, such as Mangrove-Bin technology, to address waste in diverse regions and enhance the effectiveness of waste management strategies.

**FINDINGS:** This study found that knowledge is essential and should be worked together with an attitude towards tackling plastic waste in general and post-COVID-19 pandemic in particular.

**ORIGINALITY/VALUE:** In addition to technological advancement, knowledge and attitude as part of environmental awareness could solve plastic waste issues. Knowledge and attitude could also influence many people's attitudes towards plastic waste.

**PRACTICAL IMPLICATION:** The study underscores the importance of public knowledge and attitudes towards plastic waste management, emphasising the role of government in promoting education and initiatives to reduce plastic waste. These efforts align with UN SDG 12, advocating for sustainable production and consumption through effective waste management and recycling policies.

**KEYWORDS:** *Awareness; Waste; Environment; Behaviour; Plastic; Structural Equation Modelling*

## INTRODUCTION

Plastic waste generation in Indonesia has become a concern, with around 7.3 tonnes of plastic waste being produced annually (Ministry of Environment and Forestry, 2020). In addition to the generation rate, plastic waste has become a concern because of its complexities, such as the very long decomposition time, causing toxic fumes when it is burned, and causing harm to the oceans and marine life (Ding *et al.*, 2018; Klemeš *et al.*, 2020; Yao *et al.*, 2021). As more waste pollutes the oceans each year, it is predicted that by 2050 more plastic will be in the oceans than fish. Meanwhile, improper treatment of plastic waste could result in secondary pollution and health issues caused by microplastics (Pan *et al.*, 2020; Tulashie *et al.,* 2019). From these problems, it can be seen that plastic waste is an issue that cannot be underestimated, and some efforts to reduce consumer plastic waste properly should be taken immediately.

This situation has been worsened by the COVID-19 pandemic. COVID-19 has caused environmental issues, such as reduced recycling rates and increased plastic waste by consumers (Debata *et al.*, 2020). This happens because consumption behaviour causes a decrease in recycling rates and an increase in plastic waste. Silva *et al*. (2020) argue that there is a need for technological advancements, such as biodegradable plastic, and that they are essential to tackling the issue. Meanwhile, shifting behaviour towards the environment could be an alternative to reducing plastic waste, especially

  

during pandemics (Daryanto *et al.*, 2022). Environmental awareness is essential to tackling plastic waste issues; this could result in the proper implementation of technological advancement.

Environmental awareness that grew during the COVID-19 pandemic also encouraged the energy efficiency of plastic production (Ahmad *et al.*, 2022; de Sousa, 2021), encouraging innovation of eco-friendly products (Klemeš *et al.*, 2020), encouraging people to have sustainable consumption behaviour that leads to purchasing environmentally friendly products (Butar *et al.,* 2024), and improving the performance of sustainable development goals (SDGs) (Wang and Huang, 2021). However, previous studies have not brought evidence of confirmed cases of environmental awareness or provided applied implications for the movement through the use of plastics following the COVID-19 pandemic. This raises questions that must be researched, namely "What are the real factors of people's environmental awareness after the COVID-19 pandemic?" and "How do the real factors of environmental awareness after the COVID-19 pandemic cause the Go Green movement to reduce single-use plastic consumption?".

Therefore, from the research questions, this study explored more in-depth behavioural aspects of reducing plastic waste. Environmental awareness also relates to the knowledge that could reduce plastic waste. This is because knowledge forms beliefs that subsequently perceive reality, provide a basis for decision-making and determine behaviour (Hategan, 2021). On the other hand, knowledge relates to the willingness to pay (Madigele *et al.*, 2017). Attitude and knowledge became essential in this study because consumerism during the pandemic led to a reduced recycling rate but an increment of waste generation during the COVID-19 pandemic (Zambrano-Monserrate *et al.*, 2020). However, these studies have shown that the debate about environmental awareness on reducing plastic waste is still based on general aspects. Therefore, this study was essential to be researched in urban communities because, during the COVID-19 pandemic, waste generation in urban communities tended to produce more waste, especially plastic-based personal protective equipment (PPE) (Mahmoudnia *et al.*, 2022).

This case study is intended to evaluate the environmental awareness factor of the community by taking a case study of the city of Makassar as being severely affected by plastic waste. This study will resolve the gaps, and link previous research to factors of public awareness of the environment in the region with the potential for large plastic waste disasters. The implications of waste management policies that follow people's consumption behaviour and become a catalyst for the movement of environmental awareness in various ways are expected to appear in this study.

## DATA AND METHOD

### Research Design

Based on a review of previous research literature, this study will consider several environmental awareness factors in using single-use plastics in Makassar City, a city with high waste volume in Indonesia. This study established a research model framework and hypotheses with explanatory

  

quantitative research methods. A quantitative approach is an approach that relies on positivist principles by using variables and hypotheses; it involves the measurement of variables for testing objective theories through numbered data that will be analysed through statistical analysis (Creswell and Creswell, 2017; Neuman, 2014). Therefore, the research results will prove the hypotheses and further evaluate the relationship between causal variables. Figure 1 is a framework of the proposed research model.

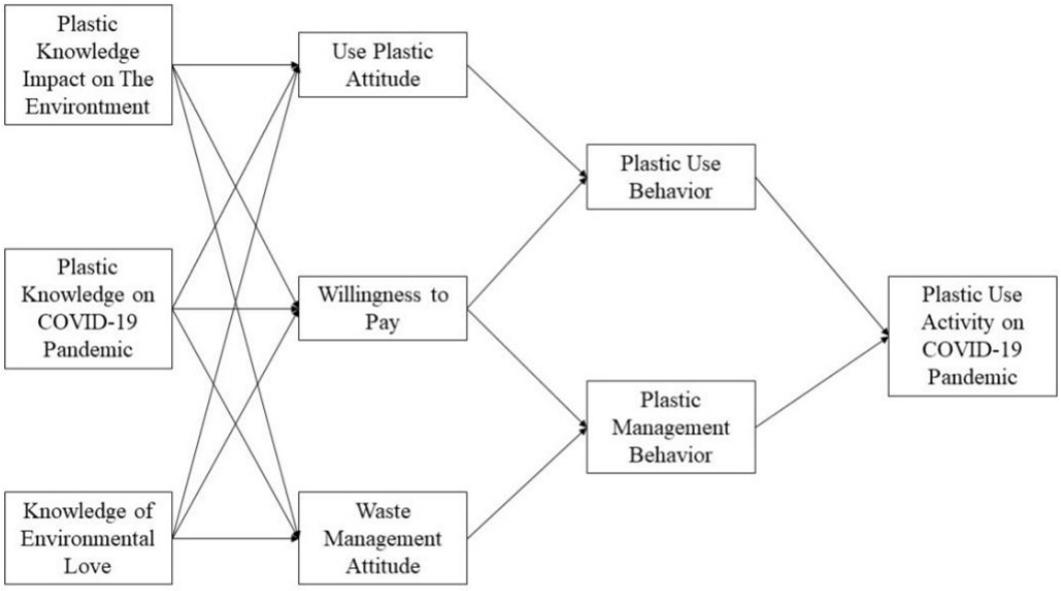


**Figure 1 Research Model Framework**

*Source*: Constructed by authors

This study will use two and five-point Likert scales on the questionnaire, with each variable having more than five indicators. The research has 15 hypotheses that can be seen from the framework of this study (Figure 1). Also, the hypotheses development and the research instruments can be seen in the supplementary material provided. The hypotheses are as follows:

**H1:** Plastic Knowledge Impact on The Environment has a significant effect on Use of Plastic Attitude

**H2:** Plastic Knowledge Impact on The Environment has a significant effect on Willingness to Pay

**H3:** Plastic Knowledge Impact on The Environment has a significant effect on Waste Management Attitude

**H4:** Plastic Knowledge on the COVID-19 Pandemic has a significant effect on the Use of Plastic Attitude

**H5:** Plastic Knowledge on the COVID-19 Pandemic has a significant effect on Willingness to Pay

**H6:** Plastic Knowledge on the COVID-19 Pandemic has a significant effect on Waste Management Attitude

**H7:** Knowledge of Environmental Love has a significant effect on Use of Plastic Attitude

**H8:** Knowledge of Environmental Love has a significant effect on Willingness to Pay

**H9:** Knowledge of Environmental Love has a significant effect on Waste Management

**H10:** Use of Plastic Attitude has a significant effect on Plastic Use Behaviour

**H11:** Willingness to Pay has a significant effect on Plastic Use Behaviour

**H12:** Willingness to Pay has a significant effect on Plastic Management Behaviour

**H13:** Waste Management Attitude has a significant effect on Plastic Management Behaviour

**H14:** Plastic Use Behaviour has a significant effect on Plastic Use Activity on COVID-19 Pandemic

**H15:** Plastic Management Behaviour has a significant effect on Plastic Use Activity on COVID-19 Pandemic

## Data Collection

This study targets the people of Makassar City, a densely populated area divided into 15 sub-districts. The study took a sample with three population clusters, namely large-developing population clusters, business centres and coastal regions. This is shown in more detail in Table 1.

**Table 1 Sub-District Cluster Division**

| *Sub-District Cluster* | *District Name* |
|---|---|
| Large and growing populated districts | Biringkayana, Tamalanrea, Manggala, Panakukang, Rappocini and Tallo |
| Saturated regional districts and business centres | Wajo, Makassar and Ujung Pandang |
| Coastal districts | Sangkarang, Ujung tanah, Bontoala, Mariso, Tamalate and Ujung Pandang |

*Source*: Constructed by authors

After the clustering process, probability proportional to size sampling was conducted based on the number of sub-districts in the category. After the sub-districts were set, five villages with

  

large populations were established. Each selected village selected ten households as a sample. Household determination was selected randomly with the following conditions: the first sample was the first residential house on the right side of the village chief's office. The second sample used an interval of five households from the previous sample, and so on. Table 2 shows a list of selected sample sub-districts.

**Table 2 Selected Sample Sub-Districts**

| *District* | *Neighbourhoods* | *Population* |
|---|---|---|
| Biringkanaya | Laikang | 18.932 |
| | Sudiang | 13.542 |
| | Pai | 8.724 |
| | Sudiang Raya | 17.841 |
| | Berua | 5.039 |
| Manggala | Manggala | 9.194 |
| | Batua | 14.159 |
| | Borong | 8.753 |
| | Bangkala | 9.326 |
| | Antang | 8.653 |
| | Tamangapa | 7.044 |
| Wajo | Melayu | 3.220 |
| | Malimongan Tua | 1.811 |
| | Malimongan | 3.328 |
| | Pattunuang | 1.933 |
| | Melayu Baru | 1.662 |
| Ujung Tanah | Cambaya | 4.262 |
| | Pattingalloang | 3.720 |
| | Camba Berua | 3.712 |
| | Tabaringan | 2.848 |
| | Tamalabba | 2.515 |

**Table 2 Selected Sample Sub-Districts *(Cont.)***

| *District* | *Neighbourhoods* | *Population* |
|---|---|---|
| Mariso | Panambungan | 3.718 |
| | Lette | 2.948 |
| | Mariso | 3.453 |
| | Bontonrannu | 3.760 |
| | Tamarunang | 4.476 |

*Source*: Family Welfare Empowerment of Makassar City, 2024

## Data Analysis

Data that were successfully collected and included in the sample were processed using the data analysis method using *SmartPLS software version 3*. This study analysed the data using PLS-SEM (Partial Least Square – Structural Equation Modelling). PLS-SEM is a variant-based SEM that can simultaneously test measurement and structural test models (Memon *et al.*, 2021). Measurement models are used for validity and reliability tests, while structural models are used for causality tests (hypothesis testing with prediction models) (Hair *et al.*, 2019; Sarstedt *et al.*, 2019). The CB-SEM was more suitable for theory testing, while the PLS-SEM was more suitable for theory development (Dash and Paul, 2021). Therefore, the aim of the study, which was to develop a construct for evaluating environmental awareness, was the reason for using PLS-SEM.

Rigdon *et al.* (2017) stated that PLS is a *soft modelling* analysis method because it does not assume the data must be within a particular scale measurement; this means the number of samples can be small (under 100 samples). Another advantage is that *variance-based* PLS can avoid two major problems faced by *covariance-based* SEM, namely *inadmissible solution* and *factor indeterminacy* (Hair *et al.*, 2017; Streukens and Leroi-Werelds, 2016; Zeng *et al.*, 2021).

Following the formulated hypothesis, in this study, inferential statistical data analysis was measured using *Smart PLS* (*Partial Least Square*) software, starting from measuring the model (outer model) for research, model structure (*inner* model) for testing the strength of the model and proving the hypothesis.

# RESULTS

## Characteristics of Respondents

This study found 301 respondents, with a general majority in the 41–50 years range, followed by respondents aged 31–40. Marital status showed that 82% of the respondents were married. The respondents' education level showed that nearly half graduated from high school. The details of the characteristics of respondents are shown in Table 3 below.

  

**Table 3 Characteristics of Respondents.**

| *Characteristic* | *Sum* | *Percentage* |
|---|---|---|
| **Age** | | |
| <20 Years | 16 | 5% |
| 20–30 Years | 67 | 22% |
| 31–40 Years | 75 | 25% |
| 41–50 Years | 78 | 26% |
| 51–60 Years | 44 | 15% |
| >60 Years | 21 | 7% |
| **Marital Status** | | |
| Single | 41 | 13% |
| Married | 247 | 82% |
| Divorce | 5 | 2% |
| Widow | 8 | 3% |
| **Education Level** | | |
| Never Went to School | 3 | 1% |
| Did not graduate from Primary School | 4 | 1% |
| Primary school | 51 | 17% |
| Junior High School | 51 | 17% |
| High School | 138 | 46% |
| Vocational High School | 17 | 6% |
| College (Diploma/Bachelor) | 37 | 12% |

*Source*: Constructed by authors

## Outer Measurement Model

The first phase of the PLS-SEM analysis tested the validity and reliability of the study. This validity test was carried out by designing a measurement or outer model, first testing convergent validity followed by reliability testing. According to Afthanorhan *et al.* (2020), convergent validity is reviewed from the value of outer loadings and Average Variance Extracted (AVE), where the

cut-off value of each required value is 0.70. However, for the initial stage, the value of 0.50–0.70 is still declared to have passed the convergent validity test (Afthanorhan *et al.*, 2020). After obtaining the validity test result data, a reliability test was conducted by looking at Cronbach's Alpha and Composite Reliability values. The variable can be reliable if the Cronbach's Alpha value >0.7 (Hair *et al.*, 2017, 2019).

Based on the results of the calculation of the outer loadings scale of each indicator and the AVE in Table 4, it is known that all items tested in this study are valid because they produce an AVE value of >0.5. In addition, it is known that all variables are reliable because they have a Cronbach's Alpha value and composite reliability >0.7. It can therefore be concluded that the validity and reliability of the research are met and can be continued to the next stage.

**Table 4 Outer Measurement Result**

| *Variable* | *Loadings Factor Scale* | *AVE* | *Composite Reliability* | *Cronbach's Alpha* |
|---|---|---|---|---|
| Plastic Knowledge Impact on the Environment | 0.707–0.918 | 0.620–0.741 | 0.865 | 0.761 |
| Plastic Knowledge on COVID-19 Pandemic | 0.718–0.888 | 0.562–0.690 | 0.773 | 0.783 |
| Knowledge of Environmental Love | 0.714–0.931 | 0.539–0.727 | 0.919 | 0.947 |
| Use of Plastic Attitude | 0.727–0.894 | 0.590–0.648 | 0.777 | 0.872 |
| Willingness to Pay | 0.720–0.911 | 0.638–0.771 | 0.850 | 0.846 |
| Waste Management Attitude | 0.767–0.852 | 0.583–0.675 | 0.924 | 0.958 |
| Plastic Use Behaviour | 0.771–0.915 | 0.510–0.765 | 0.783 | 0.859 |
| Plastic Management Behaviour | 0.750–0.986 | 0.617–0.738 | 0.975 | 0.913 |
| Plastic Use Activity on COVID-19 Pandemic | 0.799–0.845 | 0.549–0.650 | 0.886 | 0.790 |

*Source*: Constructed by authors

## Inner Structural Model

The Inner Model test (Structural Model) can be seen from the relationship between constructs, significant values and R-square (Sarstedt *et al.*, 2019). Inner Model Structural testing was performed through the bootstrapping procedure on SmartPLS Version 3 statistical application (Figure 2).

  

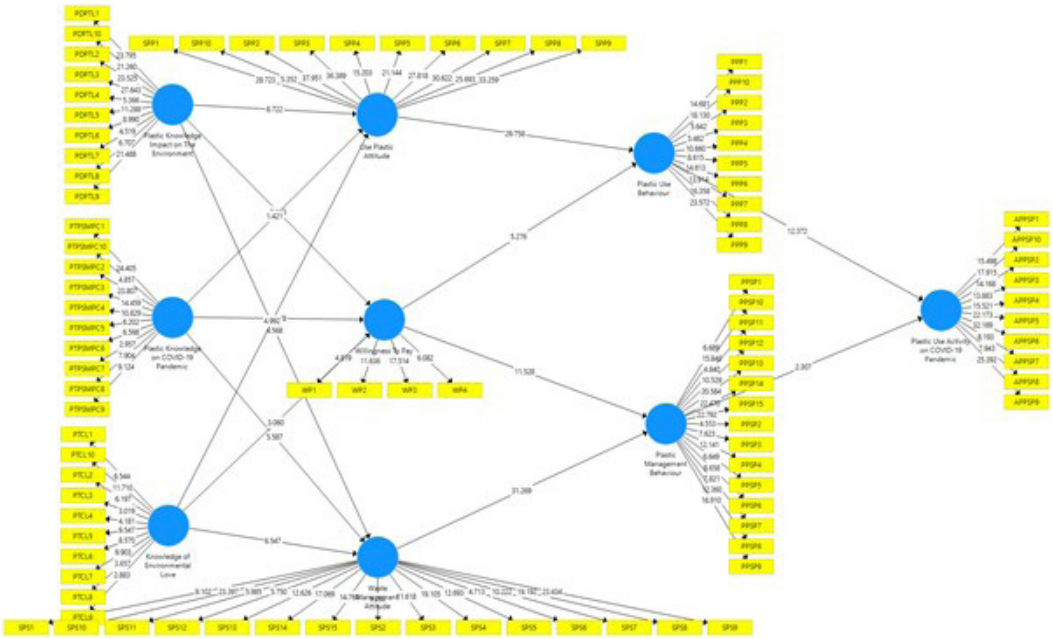

**Figure 2 Inner Model Structural Output**

*Source*: Constructed by authors

R-square testing is divided into three categories. An R-square value of 0.75 is a strong category, an R-square value of 0.50 is a moderate category, and 0.25 is a weak category (Hair *et al.*, 2019). R-square values were used as a model goodness-of-fit or alignment test for a structural model. Based on R-square testing, Table 5 shows that the variables use of plastic attitude, waste management attitude, plastic use behaviour, plastic management behaviour and plastic use activity during the COVID-19 pandemic are strongly influenced by the exogenous variables because they are above the figure of 0.750 or 75%. Meanwhile, willingness to pay is in the moderate category because it passes the minimum figure of 0.50 according to the rule of thumb.

After the R-square value was obtained, a *t*-test was performed to determine the significance of the structural path parameter coefficient. The critical value of path coefficients indicated by the value of *t* for hypotheses with two tails is 1.96 at a significance level of 5% or *P*-Value below the critical value of 0.05 according to the rule of thumb (Hair *et al.*, 2019; Rigdon *et al.*, 2017; Sarstedt *et al.*, 2019). Based on the inner structural model results (Table 5), the overall test results of the hypotheses are accepted. However, the second hypothesis rejects the effect of plastic knowledge on the environment on willingness to pay. The following sub-section will present an analysis of the hypotheses and implications of the recommendations.

  

**Table 5 Inner Model Structural Result**

| *Hypothesis* | *T-Test* | *P-Value* | *Decision* | *R-Square* |
|---|---|---|---|---|
| H1: Plastic Knowledge Impact On The Environment → Use of Plastic Attitude | 8,722 | 0.000 | Accepted | 0.875 |
| H2: Plastic Knowledge Impact On The Environment → Willingness to Pay | 133 | 0.910 | Decline | 0.702 |
| H3: Plastic Knowledge Impact On The Environment → Waste Management Attitude | 4,568 | 0.000 | Accepted | 0.914 |
| H4: Plastic Knowledge on COVID-19 Pandemic → Use of Plastic Attitude | 1,421 | 0.156 | Decline | 0.875 |
| H5: Plastic Knowledge on COVID-19 Pandemic → Willingness to Pay | 4,778 | 0.000 | Accepted | 0.702 |
| H6: Plastic Knowledge on COVID-19 Pandemic → Waste Management Attitude | 5,587 | 0.000 | Accepted | 0.914 |
| H7: Knowledge of Environmental Love → Use Plastic Attitude | 4,992 | 0.000 | Accepted | 0.875 |
| H8: Knowledge of Environmental Love → Willingness to Pay | 3,060 | 0.002 | Accepted | 0.702 |
| H9: Knowledge of Environmental Love → Waste Management Attitude | 6,547 | 0.000 | Accepted | 0.914 |
| H10: Use of Plastic Attitude → Plastic Use Behaviour | 29,758 | 0.000 | Accepted | 0.942 |
| H11: Willingness to Pay → Plastic Use Behaviour | 5,276 | 0.000 | Accepted | 0.942 |
| H12: Willingness to Pay → Plastic Management Behaviour | 11,529 | 0.000 | Accepted | 0.899 |
| H13: Waste Management Attitude → Plastic Management Behaviour | 31,269 | 0.000 | Accepted | 0.899 |
| H14: Plastic Use Behaviour → Plastic Use Activity on COVID-19 Pandemic | 12,372 | 0.000 | Accepted | 0.797 |
| H15: Plastic Management Behaviour → Plastic Use Activity on COVID-19 Pandemic | 2,307 | 0.021 | Accepted | 0.797 |

*Source*: Constructed by authors

## DISCUSSION

Table 5 shows that the level of public knowledge about plastics and their impact on the environment forms an attitude towards minimum plastic use, and people would prefer to spend more on waste management, including efforts to avoid plastic waste for food supplies or shopping bags.

  

Understanding the use of plastic, including amid the COVID-19 situation with efforts to minimise transmission and the potential of plastic as a medium of infection, also affects the attitude and willingness to pay users to use plastic. The cultural understanding of awareness of the environment echoed by the government to the community also encourages the formation of attitudes towards the use of plastic as a necessity, including how to manage waste so as not to damage the surrounding environment.

Waste management knowledge needs to be sought by every community because knowledge will encourage a person to have a confident attitude. Therefore, attitude forms interests that determine the realisation of a person's behaviour. However, an environmental shock is a form of evaluation of an individual's feelings that will encourage a reaction to undertake efforts to respect the environment by protecting and avoiding adverse impacts. This argument has been supported by previous studies that showed that social norms through regulation and education that lead to increasing knowledge and awareness influence urban communities to manage their waste correctly (Pangsuma and Surtikanti, 2024; Dong *et al.*, 2023).

The results of the analysis of this study highlight the importance of synergy between various parties in waste management, with many directed at efforts to overcome waste (end of the pipe) in the form of reuse and recycling (by the government, Waste Bank, plastic core producers), incineration and landfilling. Also, Integrated Plastic Waste Management can be a solution and is divided into six categories:

(1) waste production;
(2) sorting and processing of waste at source;
(3) collection;
(4) separation and processing;
(5) handling before transport to landfill and transportation; and
(6) innovative extermination.

At the same time, a preventive effort is needed to reduce the production of plastic since the habit of using plastic is still strong. Several government initiatives have been developed to optimise waste management:

(1) implementing standardisation of waste processing time;
(2) changing the authority to collect waste that involves neighbourhoods more;
(3) increasing public waste collection campaigns; and
(4) preparing policies and programmes for technical activities.

In addition, the government has developed a national strategic plan to reduce plastic waste through behaviour change, where the willingness to pay variable is very influential. This strategy

  

is needed to build awareness of reducing waste (reduce). Without increased environmental awareness, the use of landfill will remain high because it is faster than the waste processing rate. However, reducing waste is vital to urban communities because public awareness leads to the public's intention to solve waste management issues (Cudjoe *et al.*, 2020). Another study also states that awareness was inadequate for waste management behaviour and knowledge. The study says that age significantly influences waste management behaviour and knowledge in urban areas (Wang *et al.*, 2020).

Given that the main problem falls on public awareness, the government and penta helix stakeholders provide education to reduce plastic consumption and sort waste continuously to the community. This is done through various opportunities, for example, through activities at the village level or through community organisations. It becomes vital that they participate in the waste banks to sell disaggregated waste to waste banks or scavengers, as waste pickers are not very interested in collecting plastic. Also, the government could facilitate training activities, build networks and assist in marketing waste bank products. In addition, financial support is very likely to be given at the beginning of the establishment of the waste bank until it can be released by itself because it is independent. The government's attention is also essential to the scavengers and collectors since they are involved in the municipal waste management system. This argument from the result of this study could be supported by previous research that has stated that government intervention in waste banks could lead to participation from the community in tackling waste management issues and help sustain the involvement with the waste banks (Challcharoenwattana and Pharino, 2015).

The formal and informal sectors must work together; for example, the government can hire waste pickers to work at community-owned waste purchasing depots. Although they are in the informal sector, the government can manage groups of scavengers and collectors so that their activities can ease the burden on the government. A study by Kubota *et al*. (2020) in Makassar shows that informal and formal sectors should collaborate since waste banks are still regarded as informal sectors of waste management. Therefore, the collaboration of informal sectors, other than assisting the scavengers and collectors, could also empower the waste banks. Creating a waste collection ecosystem by the community and waste banks integrated with recyclers is also essential.

The problem of waste in Indonesia, especially plastic waste, can be overcome with the collaboration of all stakeholders. The pattern of waste management in Indonesia has also begun to be encouraged to transition from a linear economy concept to a circular economy. The circular economy processes waste back to its source or into other value-added products. Therefore, the paradigm of society towards waste management has begun to change. Education and assistance are needed to change people's behaviour because education could change pro-environmental behaviour, leading to the generation of less waste (Halkos and Petrou, 2020) and the provision of infrastructure from stakeholders in waste management.

  

## CONCLUSIONS

Unmanaged plastic waste can reduce the environment's and public health's carrying capacity. This study found that the influence of plastic knowledge in general and after the COVID-19 pandemic, accompanied by a love of the environment, determines factors in people's attitudes and behaviours towards plastic, both usage decisions and waste treatment after plastic use activities. Knowledge, followed by an attitude towards waste management, is essential to solving plastic waste issues because it promotes positive waste management behaviour. Therefore, the government's involvement is urgently needed to facilitate efforts to reduce plastic waste through education and promotion. The findings of this study are also crucial because UN SDG 12 (sustainable production and consumption) involves recycling rates and the reduction of waste generation. The findings of this study on reducing plastic waste in Makassar could be a policy recommendation that aims to reach SDG 12.

However, this study has limitations on the area limited to Makassar City. It is enough to perceive the situation of a large enough plastic waste area and how the community responds to this phenomenon. Future research should study plastic waste with cross-border coverage combined with applied analysis that could give an active solution to the problem of plastic waste fire circles that are difficult to extinguish. As a city with an enormous water flow, Makassar City has much plastic waste in the water area. This issue, especially in the downstream region of Makassar, can be solved by integrating Mangrove-Bin technology to trap debris in downstream areas, especially mangrove areas. This concept has been applied to garbage-cleaning activities in rivers. Examples are the *Cleantec instrument* used to clean the Ganges in India and the trash skimmer boat used to clean up garbage in the Port of *Baltimore City*.

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## BIOGRAPHY

**Muhammad Alfarizi** was the Most Outstanding Student of BINUS Business School 2022. He also consistently researches diverse topics, especially in the socio-economic field. Currently, Alfarizi contributes as a research assistant at the Research Cluster of Interaction, Community Engagement, and Social Environment, School of Environmental Science, Universitas Indonesia.

**Dr Herdis Herdiansyah** is an associate professor at the School of Environmental Sciences, Universitas Indonesia, and head of the Research Cluster of Interaction, Community Engagement, and Social Environment, School of Environmental Science, Universitas Indonesia. His research interests lie in Social Environment, Social Interaction and Environmental Philosophy.

**Sinan Vidi Lazuardi** is a recent graduate from the Department of Sociology, Universitas Indonesia. Currently, he is a research assistant at the Research Cluster of Interaction, Community Engagement, and Social Environment, School of Environmental Science, Universitas Indonesia. His research interests lie in Environmental Sociology, Waste Management and Sustainable Development Goals.